ENVIRONMENTAL IMPACT ASSESSMENT

REVISION 1

THE SETAI - KAKONA RESORT DEVELOPMENT

LEEWARD HARBOUR, CONCH SOUND POINT, AND HIGH BANK BAY

SOUTH ABACO, BAHAMAS



Submitted to:
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Ministry of Environment and Natural Resources
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Date Submitted:
03 July 2024

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1 Executive Summary

The Project proposes to develop a luxury destination in The Bahamas poised to become a one-of-a-kind peaceful oasis which features natural amenities and focused on luxury, longevity and legacy.

Potentially moderate to adverse impacts result from those that affect geology, marine and terrestrial (flora and fauna) and historical/cultural resources. Mitigation strategies are identified that have the potential to lessen and even eradicate environmental impacts due to project activities. Recommendations on best practices and industry standards will be provided in the Environmental Management Plan (EMP) for the Project.

The Setai - Kakona Resort Development is expected to stimulate the economy of Abaco, as well as the wider Bahamian economy by providing job opportunities and contributing to the ever-growing tourism industry. Mitigation strategies will be employed where possible to lessen the overall environmental impact of the project, allowing the full socio-economic benefits of the project to be realized by New Providence residents and stakeholders.

1.1 Project Details

The Setai - Kakona Resort Development features three (3) properties and emphasizes natural amenities focused on luxury, longevity and legacy. These properties are known as Leeward Harbour (LH), High Bank Bay (HBB) and Conch Sound Point (CSP).

The proposed Leeward Harbour project is known as 'The Harbour Club' and proposes to develop an estimated 225 total of boat slips, with capabilities to accept a 200' yacht, residences, boutique hotel, retail, food and beverage outlets, local landfill modifications, and Sandy Point airstrip improvements, as well as road improvements.

The proposed High Bank Bay project is known as the 'Sporting Club' and proposes to include a boutique hotel, wellness/fitness facilities, tennis, pickle ball, pools and spa, residences and a full 18-hole golf course.

Finally, the proposed Conch Sound Point project is known as 'The Residence Club' and will include a boutique hotel, spa, retail village, golf practice area and private residences. Additional amenities are included in each location's development design.

1.2 Project Development Phases and Timelines

Each Project location has its own distinct phasing schedule independent of the others. Leeward Harbour's 'The Harbour Club' is intended to begin development works as Phase One prior to High Bank Bay's 'The Sporting Club' (Phase Two), and Conch Soud Point's 'The Residence Club' (Phase Three). Timing of the Projects and their specific phases will depend on market conditions and progress on the current project phase(s) being worked on at the time.

1.3 SOCIO-ECONOMIC IMPACTS

The Project will bring significant economic benefits to the South Abaco community and residents. Aside from direct economic benefits for persons employed at the development, or owning a commercial venture related engaged with the development, the Project developer proposes to implement a series of improvements external to the project, including repairs to the old ferry dock, upgrades and renovations to the Sandy Point Airstrip, improvements to the Sandy Point Landfill, road improvements to Lighthouse road and road 50, and provision of staff housing during construction and operations.

Over a ten-year period, total construction expenditures estimated at $985 million will generate an estimated $366 million in Gross Domestic Product (GDP) for The Bahamas; of which an estimated $264 million will generate directly from the construction sector. Direct construction employment averages over 736 persons, peaking at 1,000 jobs for Bahamians. Over a 23-year period, this new project will generate an estimated $1.9 billion in government revenues, the majority of which will come from import duties. It is assumed that 3% of the residential and fractional units will turn over per year, generating ongoing stamp tax.

1.4 ENVIRONMENTAL IMPACTS

The most potentially adverse impacts result from those that affect geology, groundwater resources, marine and terrestrial (flora and fauna) and historical/cultural resources.

Construction activity on the Project has the potential to impact the surrounding environment due to site runoff, exposure to wave activity and influenced sedimentation. The removal of upland vegetation increases the likelihood for the erosion of topsoil, which can negatively impact surrounding habitats if not properly managed by erosion control strategies on site. As the Project will be completely landscaped once construction activities are done, it is anticipated that erosion and sedimentation risks related to land clearing will last only the duration of the construction period.

Dredging could impact marine resources due to habitat loss and increased sound frequency. Habitat loss is a direct impact due to dredging activity; which is the removal of the seabed and sediment. Habitat loss due to the proposed development could include the possible removal of coral reefs, mangroves and seagrass beds. Furthermore, this form of construction deters marine activity, as species avoid areas of disruption, which would then negatively impact biodiversity within this area.

Terrestrial habitats to be impacted by construction activities includes the permanently flooded wetland, semi-permanently flooded wetland, ephemeral shrubland, coastal coppice, rocky shore, sand dune and mangrove wetlands. The marine benthic habitats to be impacted included soft and hard bottom benthic habitats.

Land clearing in the Pine woodland areas present the risk of impacting nesting sites for the Abaco Parrot, and clearing of coppice vegetation will have impacts on local food sources for the Abaco Parrot and other resident and migratory birds for the duration of the construction period.

1.5 Summary of Environmental and Social Mitigation Measures

Identified protected plant species should be flagged and preclearance surveys conducted to avoid removal or destruction of mature species. These plants should be relocated to an onsite nursery and incorporated into the Project's landscape design. Landscaping activities should take place as soon as possible to reinstate ecosystem function and will aim to incorporate native flora into the design. The Developer will apply for a protected tree removal permit from the Forestry Unit. Which will help guide the land clearing process. If bird nests are observed during the preclearance surveys, they should be removed and placed in a similar habitat away from construction and human interference.

Invasive species will be removed from the site during the land clearing activities of the Project. Invasive species of *Casuarina equisetifolia* and *Scaevola taccada* should be removed from all coastal areas on the properties. Both species will continue to accelerate coastal erosion of the dune system along the western shoreline of the property, as well as decrease biodiversity in the immediate areas of colonization.

Proper site drainage and construction site orientation can reduce impacts to the water table and surrounding surface bodies of water. Once the site is elevated, the groundwater level will be deeper below the surface. Appropriate spill management will be implemented to prevent construction related accidental oil and fuel spills from percolating through the limestone to the water table.

Preclearance surveys of the marine environment should be conducted near the entrance and flushing channel areas prior to marina construction and lagoon excavation. This is to ensure that slow moving marine organisms and those confined to the benthos are relocated away from the active dredge and excavation zone. Revetment and bulkhead construction should be completed prior to flooding the marina basin. A silt fence will be utilized to prevent sediment into the new marina. Precautions during construction will be taken to prevent any sediment from reaching the basin. Turbidity curtains should be installed prior to entrance channel dredge activity to reduce increased sedimentation.

2 INTRODUCTION

Bron Ltd. (BRON) was engaged by SALDCO Ltd. to provide an Environmental Impact Assessment (EIA) for the proposed 'The Setai - Kakona Resort Development' on the island of Abaco, in Commonwealth of The Bahamas. Environmental baseline studies were conducted by BRON to support the preparation of this EIA in accordance with standards set by the Department of Environmental Planning and Protection (DEPP).

2.1 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OBJECTIVE

The objective of this EIA is to provide an accurate assessment of the potential environmental impacts of the proposed development of The Setai - Kakona Resort Development in the southern district of Abaco, The Bahamas (hereinafter referred to as the "Project"). The Project is inclusive of three (3) locations within South Abaco known as Leeward Harbour (LH), High Bank Bay (HBB) and Conch Sound Point (CSP).

For the purposes of this EIA, the assessment of the South Abaco environment is inclusive of biological, physical and socio-economic resources, as well as the processes that have the potential to be directly and/or indirectly impacted by the proposed Project. Mitigation measures for potentially adverse environmental impacts during the construction and operations phases of the Project will be discussed to ensure that the development adheres to the best environmental practices. The evaluation of potential impacts on environmental resources is a critical step in the environmental compliance process in The Bahamas, as well as successful project planning and execution. An Environmental Management Plan (EMP) will be produced upon the approval of the EIA, to outline mitigation measures for the prevention and/or minimization of environmental impacts during the developmental and operational phases of the Project.

2.2 SCOPE OF THE EIA

The scope of this EIA covers the biological and physical footprint of the Project sites at South Abaco and its immediate terrestrial, marine and near-shore environments. Possible impacts associated with the proposed development and mitigation strategies to avoid or lessen such influences within and surrounding the Project area will be evaluated and discussed. The Project aims to provide a luxury experience which incorporates the emphasis of the natural beauty of the existing South Abaco location. Therefore, consideration for the surrounding socio-economic environment is inclusive of the residents of South Abaco and surrounding communities. Which encompasses responsible practices with respect to the resources of cultural significance.

3 SITE LOCATION

3.1 GEOGRAPHIC LOCATION

The islands of The Commonwealth of The Bahamas occupy approximately 5,358 square miles of area, spanning between the United States of America's (U.S.A) State of Florida to the north and the islands of Cuba, Turks and Caicos and Hispaniola to the south. The Bahamas is an archipelagic nation that is described as encompassing twenty one (21) main islands, seven hundred (700) Cays and thousands of rocks, islets and emerging sand banks throughout the country's territory.

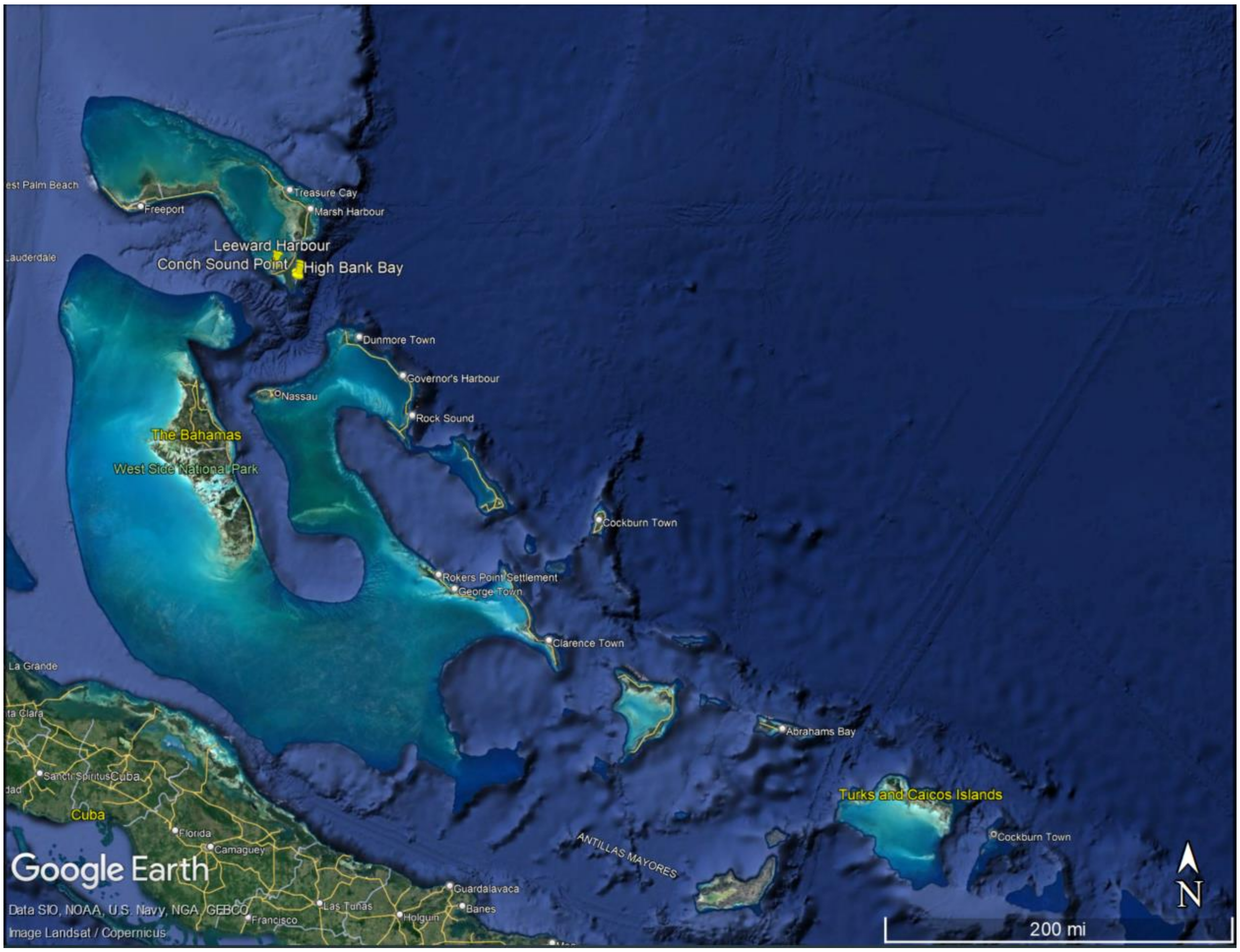


Figure 3.1. Project locations in The Bahamas (Google Earth, 2023).

The island of Abaco stretches over 100 miles from its northern most mainland point of Crown Haven down to the southernmost point located at Hole in The Wall. Many islands and cays surround Abaco on all sides, and are sites for development of homes, residences and other developments.

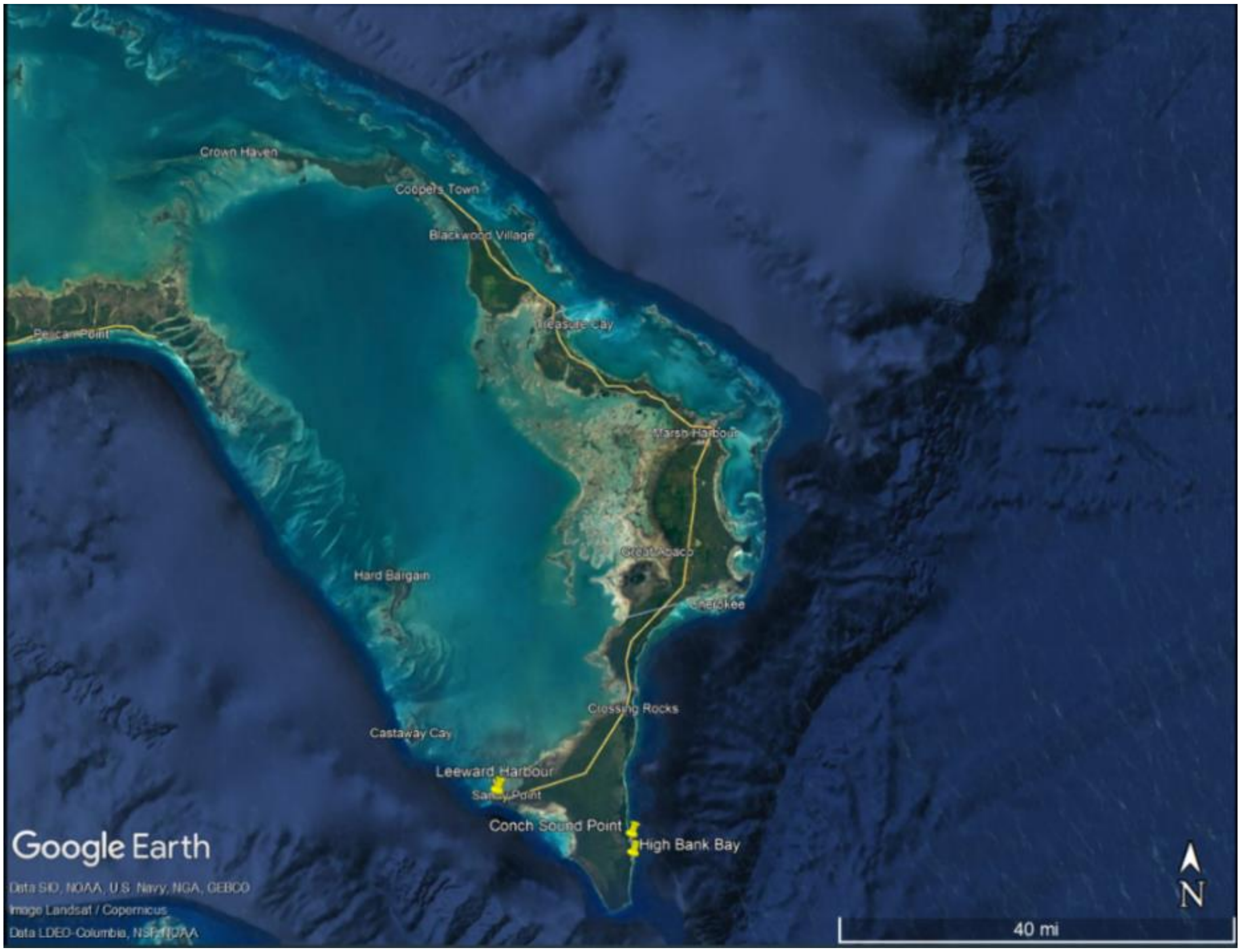


Figure 3.2. Project locations on the island of Abaco (Google Earth, 2023).

Figure 3.3. Project locations in South Abaco (Google Earth, 2023).

The Project is inclusive of three (3) locations in the southern district of Abaco known as 'South Abaco'. These locations are identified as Leeward Harbour (LH), High Bank Bay (HBB) and Conch Sound Point (CSP).

3.1.1 Leeward Harbour Location

Leeward Harbour (25° 59' 54.74" N, 77° 24' 12.94" W) is located in South Abaco along the western shoreline of the island. The southernmost settlement of Sandy Point is located approximately one (1) mile north of the site, and a small subdivision of Sandy Point called Sands Cove is located two (2) miles east of the site. Other human settlements are scarce in South Abaco, the next nearest population center being Crossing Rock, located approximately 15 miles northeast of the site.

Immediately adjoining the site along its northern boundary is a restricted airstrip. No infrastructure other than the runway currently exists at the Sandy Point airstrip. Approximately nine (9) miles to the northwest lies the island known as Castaway Cay, a stop-over point for the Disney Cruise line. The island employs some of the residents from Sandy Point and wider South Abaco areas. Approximately nine (9) miles due east of the Leeward Harbour site is the Abaco National Park, one of five (5) National Parks on Abaco managed by The Bahamas National Trust. The Park protects critical breeding habitat for the endemic Abaco Parrot.

Adjacent to Leeward Harbour is a closed dock known as Rocky Point Dock, once functional for mailboats to transport cargo into South Abaco. In its current state of dilapidation, this dock is unfit for use.

Figure 3.4. Leeward Harbour property boundary (Google Earth, 2023).

Figure 3.5. Aerial image of Leeward Harbor property in relation to Sandy Point settlement.

Figure 3.6. Satellite image depicting the Leeward Harbour property in relation to the Sandy Point settlement and Sands Cove Community (Google Earth, 2023).

3.1.2 High Bank Bay Location

High Bank Bay (25° 54' 32.08" N, 77° 11' 28.49" W) is located in South Abaco along the eastern shoreline of the island. The southernmost settlement of Sandy Point is located approximately 16 miles west of the site, and a small subdivision of called Sands Cove is located approximately 11 miles west of the site. Other human settlements are scarce in South Abaco, the next nearest population center being Crossing Rock, located 13 miles northeast of the site.

Abutting the HBB site to the west, is the Abaco National Park, one (1) of five (5) National Parks on Abaco managed by The Bahamas National Trust. The Park protects critical breeding habitat for the endemic Abaco Parrot.

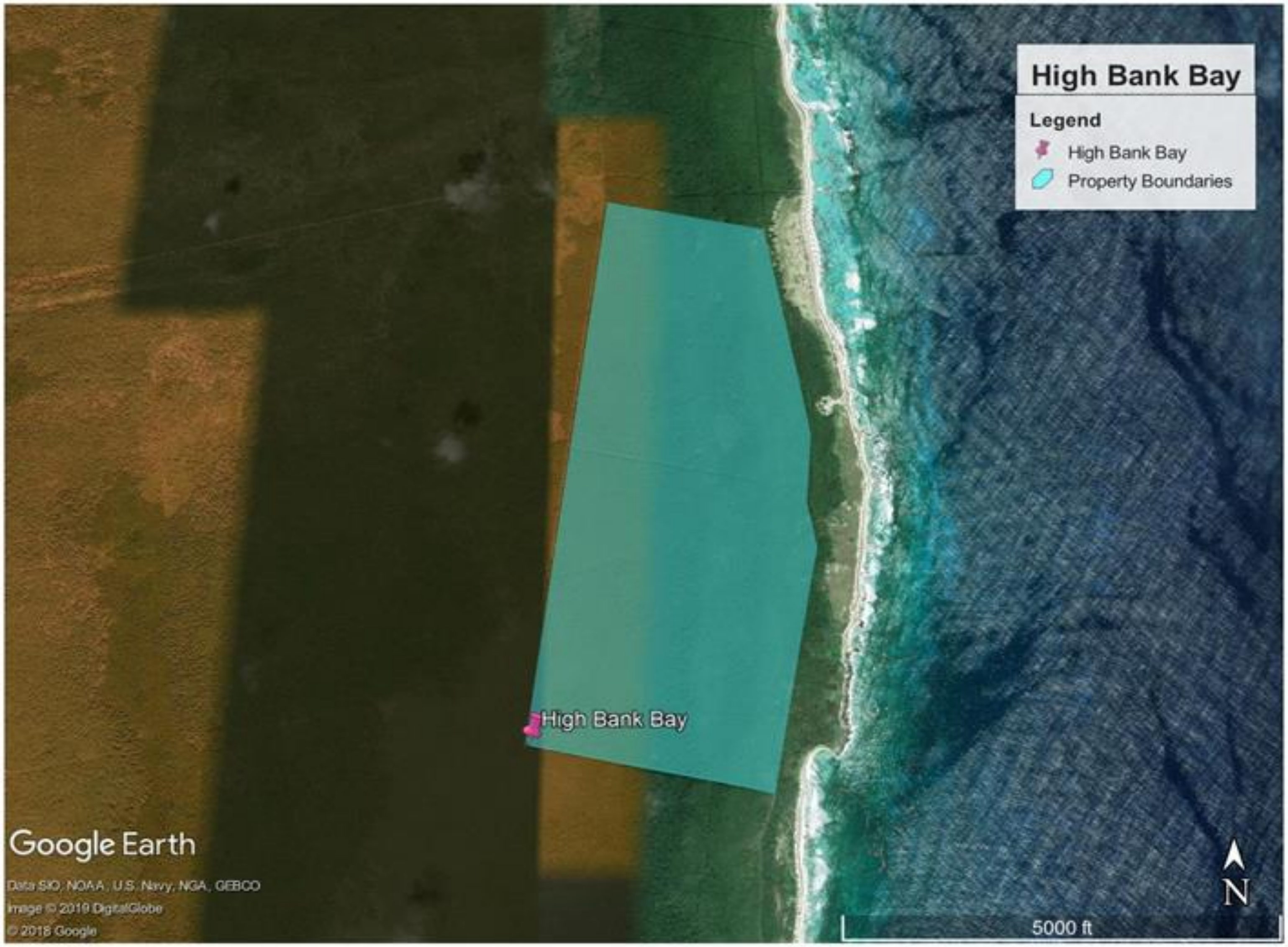


Figure 3.7. High Bank Bay property boundary (Google Earth, 2023).

3.1.3 Conch Sound Point Location

Conch Sound Point (25° 56' 36.09" N, 77° 11' 13.93" W) similar to HBB is located in South Abaco along the eastern shoreline of the island. The southernmost settlement of Sandy Point is located approximately 16 miles west of the site, and a small subdivision called Sands Cove is located approximately 11 miles west of the site. The second nearest population center is Crossing Rock which is located approximately 12 miles northeast of the site. CSP also abuts the Abaco National Park.

CSP and HBB are separated by approximately 150 acres of privately owned land comprised of two (2) tracts; Tract #1 - R. Menendez/ 50 acres / B1-13 and Tract #2 - J. Roberts / 100 acres / B1-15.

Figure 3.8. Conch Sound Point property boundary (Google Earth, 2023).

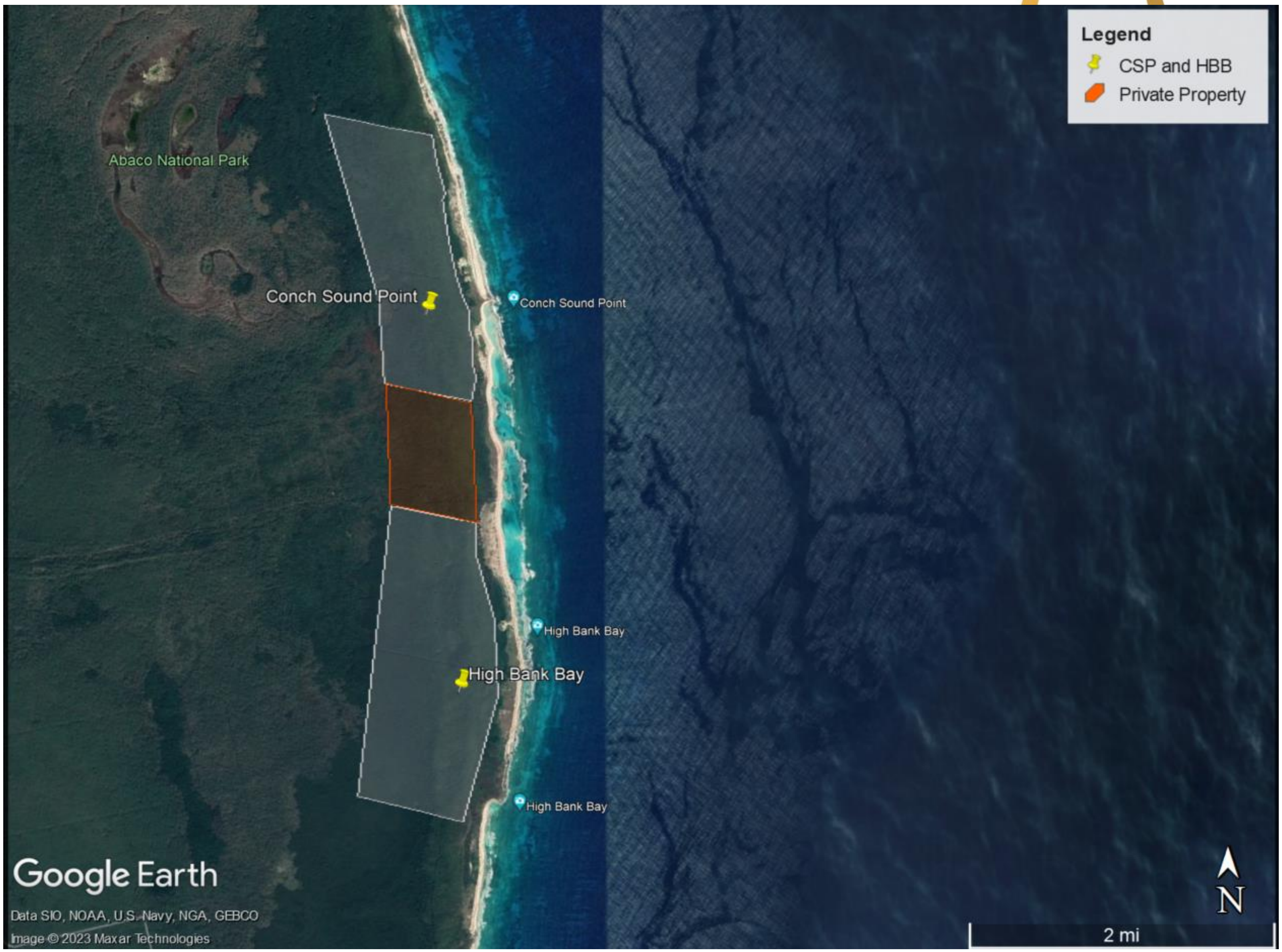


Figure 3.9. CSP and HBB locations (Google Earth, 2023).

3.2 SITE DESCRIPTION

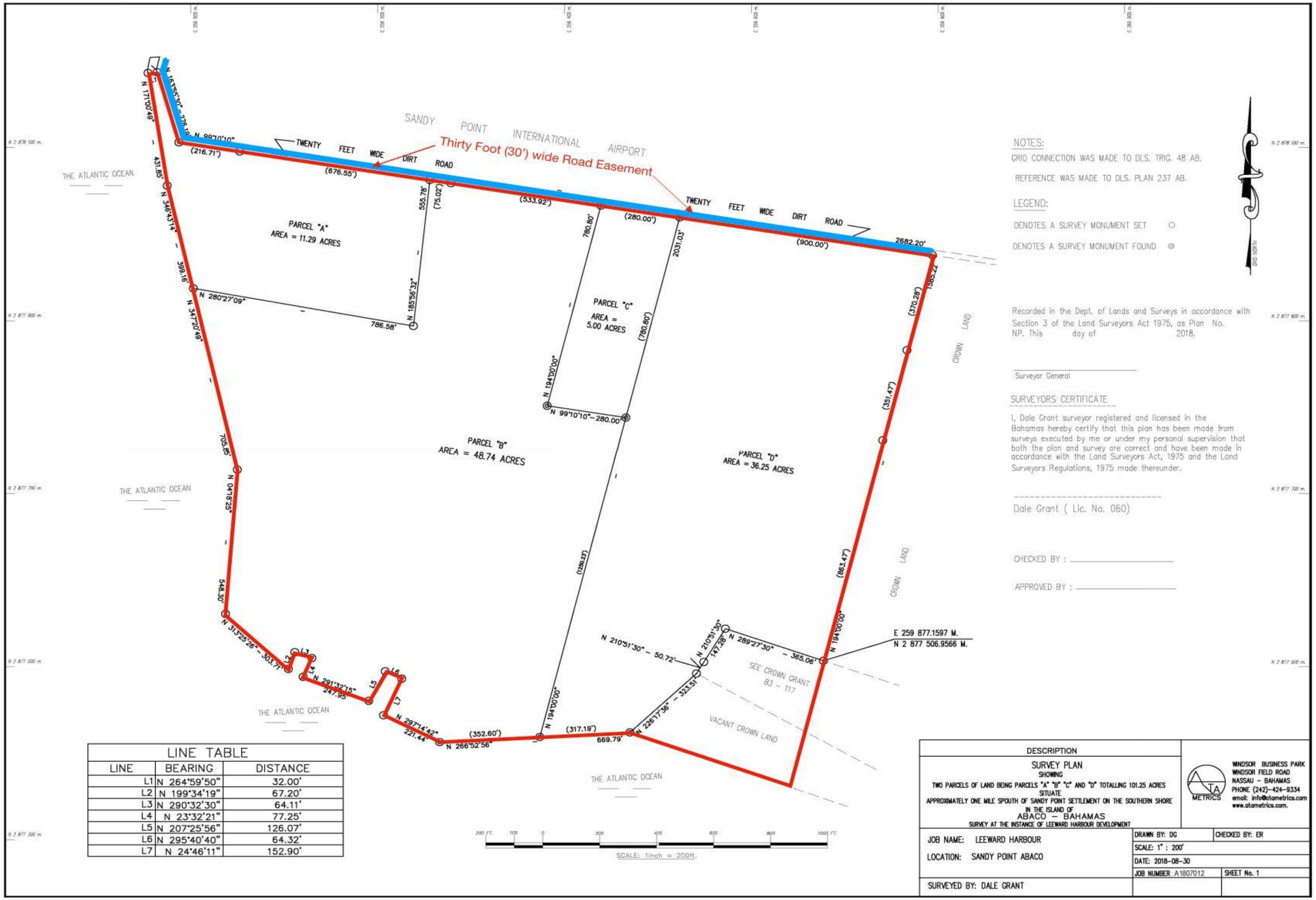
3.2.1 Leeward Harbour Site Description

The LH site is approximately a 105 -acre low lying area south of Sandy Point which historically served as an over wash area for the shallow mangrove basin east of the Sandy Point settlement. The terrestrial areas of the property consist of semi-permanently flooded wetlands, pinelands, mangroves, sandy beaches, rocky shorelines and coastal coppice. The wetlands within the Leeward Harbour property are connected to a large brackish wetland east of the site. The marshlands extending into the Leeward Harbour site originate from the wetland, which supports a diversity of waterfowl utilizing the space for breeding and feeding.

Figure 3.10.Permanently flooded wetland east of the Leeward Harbour property.

Figure 3.11. Permanently flooded wetland east of the Leeward Harbour property.

The eastern boundary of the LH site is approximately 1,585.22 ft. in length with a bearing of N 194.00’00’’; the western coastal boundary is approximately 2,085.16 ft. long; the southern coastal boundary is approximately 1,442.89 ft.; south-western interior boundary is approximately 835.85 ft. ; and the northern interior boundary is approximately 2,603.37 ft. with a bearing of N99.10’ 10’’.



LINE TABLE

LINE	BEARING	DISTANCE
L1	N 264°59'50"	32.00'
L2	N 199°34'19"	67.20'
L3	N 290°32'30"	64.11'
L4	N 23°32'21"	77.25'
L5	N 207°25'56"	126.07'
L6	N 295°40'40"	64.32'
L7	N 24°46'11"	152.90'

Figure 3.12. Property boundaries of Leeward Harbour.

3.2.2 High Bank Bay Site Description

The HBB site is an approximately 503-acre coastal parcel with elevations of about 91ft. The terrestrial areas of the property consist of semi-permanently flooded wetlands, pinelands, mangroves, sandy beaches, rocky shorelines and coastal coppice. The wetlands within the HBB property are approximately 350 feet west of the coastal shrubland. The marshlands extending into the HBB site originate from the wetland, which supports a diversity of waterfowl utilizing the space for breeding and feeding.

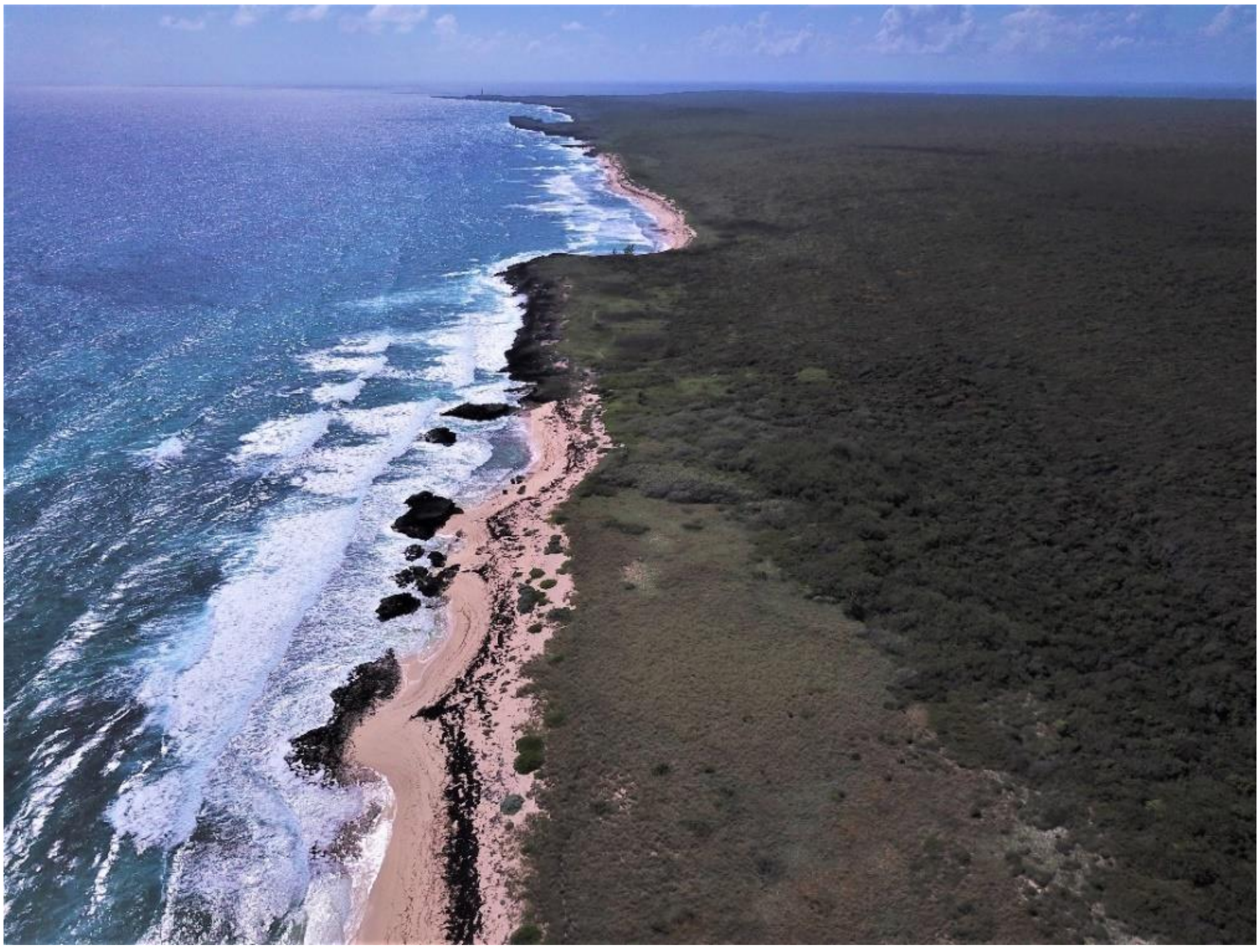


Figure 3.13. Aerial view of the coastline at High Bank Bay.

The western boundary of the site is approximately 3,848.96' in length with a bearing of (N 187° 27' 36"); the northern boundary is approximately 2,182.26' in length with a bearing of (N 282° 31' 26"); eastern interior boundary is approximately 7,885.81' in length with a bearing of (N 344° 10' 25"); and the southern interior boundary is approximately 2,794.76' long with a bearing (N 102° 30' 48").

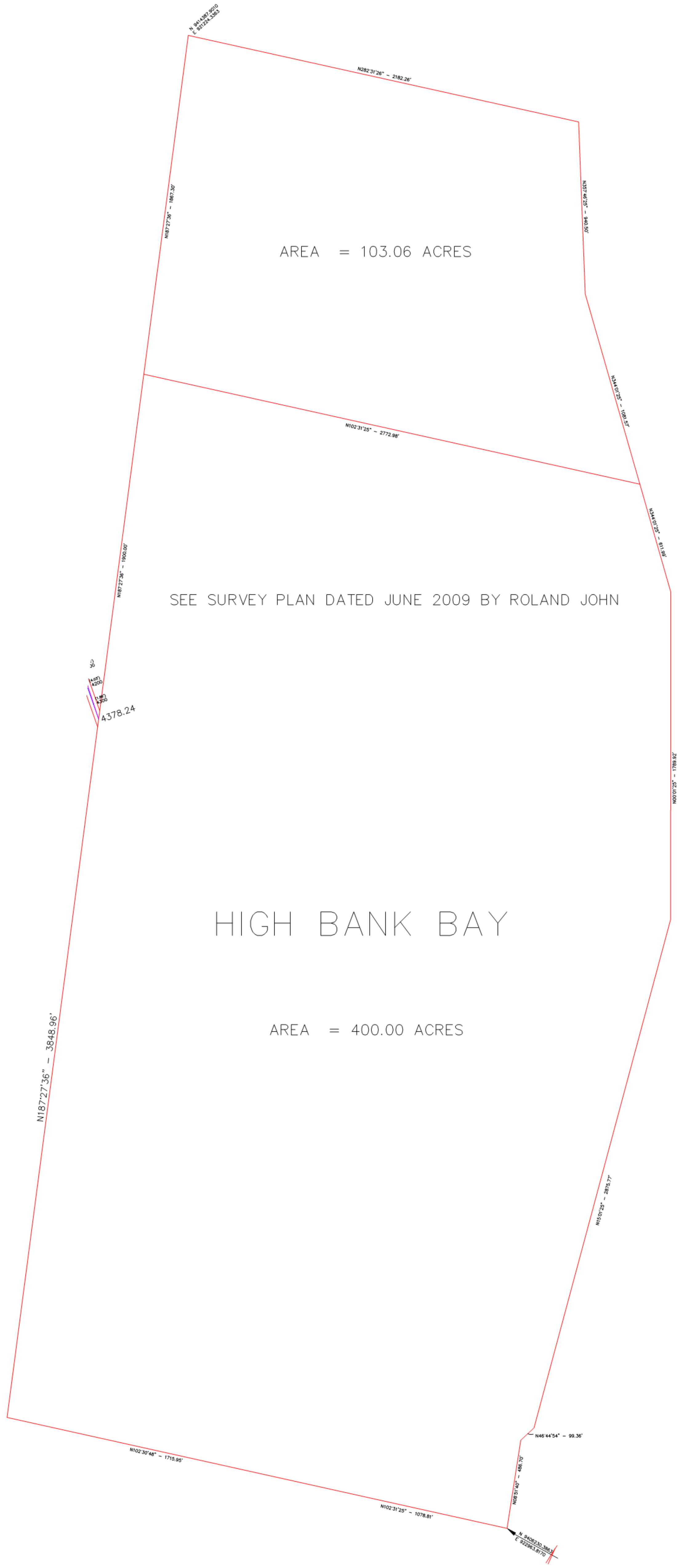


Figure 3.14. Property boundaries of High Bank Bay.

3.2.3 Conch Sound Point Site Description

The CSP site is an approximately 375-acre coastal parcel with elevations of about 58ft. The terrestrial areas of the property consist of semi permanently flooded wetlands, pinelands, mangroves, sandy beaches, rocky shorelines and coastal coppice. The wetlands within the CSP property are approximately 350 feet west of the coastal shrubland. The marshlands extending into the CSP site originate from the wetland, which supports a diversity of waterfowl utilizing the space for breeding and feeding.

Figure 3.15. Aerial view of the eastern coastline at Conch Sound Point.

The western boundary of the site is approximately 7,215.36’ in length with a bearing of (N 344° 30’ 44”); the northern boundary is approximately 2,772.17’ in length with a bearing of (N 282° 31’ 33”); eastern interior boundary is approximately 6,221.69’ in length with a bearing of (N 173° 07’ 43”); and the southern interior boundary is approximately 2,182.81’ long with a bearing (N 282° 30’ 53”).

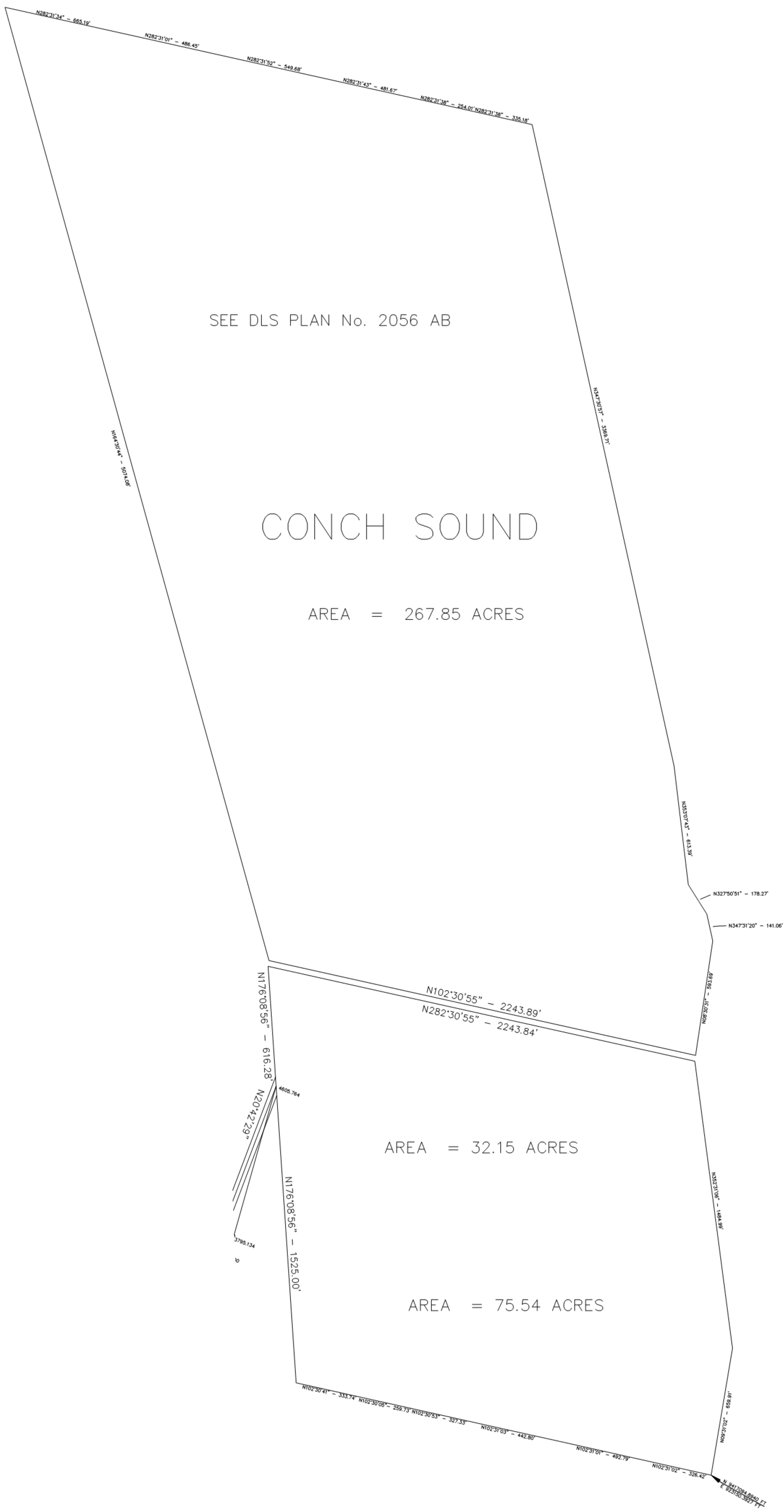


Figure 3.16. Conch Sound Point property boundaries.

3.3 AREAS OF INFLUENCE

The two (2) settlements of South Abaco, Sandy Point and Crossing Rock, and their respective residents are primarily influenced by the Project due to their proximity to the proposed developments, and their isolation from other large-scale developments in South Abaco. The surrounding terrestrial and near shore environments, inclusive of the beaches, mangrove and sandy flats around Sandy Point are also under influence of impacts stemming from the Project.

Furthermore, the areas of influence associated with the Project include direct and indirect economic impacts on the South Abaco communities, as well as the wider Bahamas. This includes the likelihood of on-site job creation, disbursement of salaries within the South Abaco and extended Abaco communities, and the likelihood of the national economic benefit of generated government tax revenue. Moreover, influencing the refurbishment and development of existing infrastructure that serve these communities.

Sandy Point has been a popular destination for sports fishing and diving for Bahamian and international boaters. The Project development at LH may influence the local and international boating community that utilize the surrounding water for recreational fishing. Also, Project developments at the HBB and CSP areas may native and endemic wildlife.

4 EXISTING LAND USE AND OWNERSHIP

Currently, the Developer owns approximately 400 acres at the HBB and approximately 300 acres at the CSP locations. The LH site consists of approximately 48.74 acres and is owned by Leeward Harbour Investments Ltd. (LHI). This area is under contract with closing to occur by July 2024. Another parcel of which, approximately 52.54 acres is Treasury Land with the addition of an approximately 5-acre privately held tract is under negotiation. The total parcel (including the LHI Tract) is approximately 105 acres. The Developer is in the process of negotiating the purchase of this land per an Approval to Purchase from the Bahamas Investment Authority (BIA).

Additionally, the Developer has an Approval to Purchase and has under contract approximately 75 acres at the CSP, approximately 103 acres at the HBB, and approximaytely105 acres at the LH locations, made up of privately held and Treasury Land. Approval to Purchase documents are included in Appendix A.

5 PROJECT DESCRIPTION

5.1 PROJECT DETAILS

The Setai - Kakona Resort Development intends to be a luxury destination in The Bahamas poised to become a one-of-a-kind peaceful oasis. Which features three (3) properties and emphasizes natural amenities focused on luxury, longevity and legacy.

The complete Kakona Conceptual Plan / Master Plan Package is included in Appendix B. All plans and programs are preliminary and conceptual. The plans outlined will change as the development matures.

5.1.1 Leeward Harbour Project Details

Harbour Development

The Leeward Harbour parcel is approximately 105 acres, which has the capacity to support various developmental structures associated with the design of the Kakona Harbor master plan. The Kakona Harbor plays host to a range of vessels from super yachts to sport fishing and smaller center consoles. The basin will be encompassed by a tropical, mixed-use harbor village, catering to all boater's and crew's needs, while providing a lively destination for residents and guests alike to enjoy various recreational activities.

The proposed Kakona Harbor will support:

- An estimated 225 total of boat slips, with capabilities to accept a 200' yacht.
- This marina design includes approximately 30.95 acres of wet area, Flushing Channel (approximately 1,634 ft. long, 60 ft. wide, 6 ft. deep and 2.25-acres) and Entrance Channel (approximately 885 ft. long, 125 ft. wide, 15 ft. deep and 2.54-acres). The proposed flushing channel will extend approximately 800 ft. off the west shoreline and the Entrance Channel will extend approximately 800 ft. off the south shoreline.
- The Back of House (BOH) service area consists of a 100-unit dry stock storage facility.
    - BOH facilities to include:
        - Dry storage,
        - Coolers and freezers,
        - Harbor operations and maintenance shop,
        - Fuel dock and pump out station.
- Ten (10) Staff housing
- Hotel to include thirty-five (35) core hotel keys, twenty (20) Cottages and five (5) luxury bungalows.
- Residential to include one hundred and five (105) residential harborside homes and ten (10) lofts over retail
- Retail/commercial areas are included in the overall design of this development. These added amenities include:
        - Yacht Club
        - Club Restaurant
        - Boutique Hotel
        - Casino

- Lounge
- Library
- Retail Shops
- Harbor store /Chandlery
- Pool & Pool Bar
- Spa & Wellness
- Beach Bar & Grill (Palapa)
- Bahamas Customs & Immigration Port of Entry
- Harbor Operations & Service Office
- Charter Office

Aerodrome Development

Abaco's southern airfield located near Sandy Point, has the potential to serve as a point of entry into South Abaco. Thus, allowing guests a swift arrival into South Abaco to enjoy all that the Project has to offer and partake in the local culture. The development of the aerodrome is inclusive of:

– Fixed Based Operation (FBO),
– Customs House operations and office.
– Aircraft staging; staging would be used to store aircraft at this airfield, adding an element of safety for pilots and passengers.
– Runway extension. Extending the runway would allow private aircraft to safely and frequently utilize the airfield for air transportation of guests and locals.
– As part of a future phase, it is planned to include aircraft hangars for plane storage.

The FOB and Customs House allows Bahamas Customs to collect taxes and properly practice boarder control for South Abaco.

External Project Improvements

The Developer proposes to include external Project improvements with the proposed Harbor development, which would enrich the South Abaco community's existing infrastructure. These improvements include:

– Repair and rebuild the old ferry dock at Rocky Point in South Abaco. This renovation would include the extension (length and width) of the existing ferry dock and would consist of a roll on roll off (RoRo) dock to accept container delivery.
– Development of container receiving and storage facilities.
– Staff housing,
– Construction man camp.
– South Abaco landfill upgrades and the development of a utility area near the existing landfill are included in this proposed development.

Figure 5.1. Conceptual drawing of the Kakona mixed-use harbor village.

Figure 5.2. Conceptual drawing of Kakona Harbor.

Table 5.1 . Total Development Acreage for Leeward Harbor.

DEVELOPMENT PROGRAM	QTY	CONDITIONED AREA		UNCONDITIONED AREA		
THE HARBOUR CLUB						
Entry & Reception	1.00 ea	1,000 sf	1,000 sf	sf	sf	
Club Restaurant / Boutique / Lounge / Library	1.00 ea	8,000 sf	8,000 sf	5,000 sf	5,000 sf	
Pool & Pool Bar	1.00 ea	4,500 sf	4,500 sf	5,000 sf	5,000 sf	
Spa & Wellness	1.00 ea	5,000 sf	5,000 sf	2,000 sf	2,000 sf	
Beach Bar & Grill (Palapa)	1.00 ea	6,500 sf	6,500 sf	5,000 sf	5,000 sf	
Club Rooms	20.00 ea	500 sf	10,000 sf	250 sf	5,000 sf	
Branded Villas	5.00 ea	1,800 sf	9,000 sf	500 sf	2,500 sf	
Staff Housing	10.00 ea	400 sf	4,000 sf	200 sf	2,000 sf	
Back of House	1.00 ea	2,000 sf	2,000 sf	2,000 sf	2,000 sf	
Landscape / Hardscape	1.00 ea			8,500 sf	8,500 sf	
Total Setai Harbour Club			**50,000 sf**		**37,000 sf**	
Harbour Club Private Villas						
Harbor Front Home	75.00 ea	2,000 sf	150,000 sf	1,000 sf	75,000 sf	
Loft Residences	6.00 ea	1,000 sf	6,000 sf	300 sf	1,800 sf	
Infrastructure						
Exterior Access Road	5,280 lf	20 lf			105,600 sf	
Interior Roads	8,580 lf	20 lf			171,600 sf	
Pedestrian Paths & Cart Paths	8,580 lf	10 lf			85,800 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
Harbor Basin	35.00 ac	43,560 sf/ac			1,524,600 sf	
Harbor Walk – Retail / Boutiques / Restaurants	3.50 ac	43,560 sf/ac			152,460 sf	
DEVELOPED AREA					**2,795,460 sf**	**64.17 ac**

Note: All plans and programs are preliminary and conceptual. The plans outlined will change as the development matures.

5.1.2 High Bank Bay Project Details

HBB encompasses approximately 503 acres in South Abaco. The proposed development will include:

- The Sporting Club is comprised of:
  - Thirty (30) Hotel Suites
  - Twenty-Five (25) Cottages
  - Spa and Wellness Center (racquetball, golf simulators)
  - Pool / Pool Bar
  - Beach Bar and Grill (Palapa)
  - Hotel Restaurant
  - Boutique
  - Lounge
  - Library
- Private Residential Homes will consist of:
  - One hundred and six (106) - Private Estate Lots
  - Nine (9) - Private Enclave Golf Club Villas
  - Ten (10) - Private Beach front Enclave Villas
  - Twenty-five (25) - Luxury Bungalows at hotel
  - (total for sale units are approximately 150 total).
- Hotel inclusive of thirty (30) core hotel suites.
- Links style 18-Hole Golf Course (~7,355 yards)
- Back of House (BOH) building which facilitates resort operational services.
- Staff Housing
- Amenities inclusive:
  - Sound Studio
  - Beach / Golf Club
  - Movie Theater
  - Members Lounge
  - Humidor
  - Outdoor Recreation Area.
- New road infrastructure within the proposed development.

Table 5.2. Total Development Acreage for High Bank Bay.

DEVELOPMENT PROGRAM	QTY	CONDITIONED AREA		UNCONDITIONED AREA		
THE SPORTING CLUB						
Entry & Reception	1.00 ea	1,000 sf	1,000 sf	sf	sf	
Hotel Restaurant / Boutique / Lounge / Library	1.00 ea	12,500 sf	12,500 sf	5,000 sf	5,000 sf	
Pool & Pool Bar	1.00 ea	4,500 sf	4,500 sf	5,000 sf	5,000 sf	
Spa & Wellness	1.00 ea	26,000 sf	26,000 sf	8,000 sf	8,000 sf	
Beach Bar & Grill (Palapa)	1.00 ea	5,000 sf	5,000 sf	5,000 sf	5,000 sf	
Hotel Suites	30.00 ea	1,000 sf	30,000 sf	250 sf	7,500 sf	
Cottages	25.00 ea	2,800 sf	70,000 sf	1,000 sf	25,000 sf	
Staff Housing	25.00 ea	400 sf	10,000 sf	200 sf	5,000 sf	
Back of House	1.00 ea	10,000 sf	10,000 sf	5,000 sf	5,000 sf	
Landscape / Hardscape	1.00 ea			169,000 sf	169,000 sf	
Total Setai Sporting Club			**169,000 sf**		**234,500 sf**	
Sporting Club Private Villas						
Private Estate Home Model	1.00 ea	7,500 sf	7,500 sf	2,500 sf	2,500 sf	
Preserve Lots	58.00 ea	3,500 sf	203,000 sf	1,000 sf	58,000 sf	
Tier 1 - Beachfront	10.00 ea	6,500 sf	65,000 sf	2,500 sf	25,000 sf	
Tier 2 - Hillside	12.00 ea	5,000 sf	60,000 sf	1,500 sf	18,000 sf	
Tier 3 - Hilltop	25.00 ea	5,000 sf	125,000 sf	1,500 sf	37,500 sf	
Private Enclave Beachfront	10.00 ea	5,000 sf	50,000 sf	1,500 sf	15,000 sf	
Infrastructure						
Exterior Access Road	4,605 lf	20 lf			92,100 sf	
Interior Roads	41,725 lf	20 lf			834,500 sf	
Pedestrian Paths & Cart Paths	9,563 lf	10 lf			95,630 sf	
Golf Course	.00 ac	43,560 sf/ac			sf	
Golf Course Maintenance	1.00 ea	10,000 sf			10,000 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
DEVELOPED AREA					**2,537,830 sf**	**58.26 ac**

Note: All plans and programs are preliminary and conceptual. The plans outlined will change as the development matures.

5.1.3 Conch Sound Point Project Details

CSP will occupy approximately 375 acres in South Abaco. CSP plans to develop:

- The Residence Club features a main facility inclusive:
  - Twenty-five (25) cottages
  - Spa and Wellness center
  - Pool / Pool Bar
  - Hotel Restaurant / Boutique / Lounge / Library
- One Hundred (100) private estate lots
- Twenty -two (22) Village townhouses (future development)
- Hotel inclusive of twenty-five (25) luxury bungalows (for Sale)
- Golf Practice Area
- Back of House facilities
- Staff housing
- Additional amenities include:
  - Waterway
  - Beach bar and grill
  - Public Amenity Areas such as:
    - Bowling Alley
    - Cinema
    - Billiards
    - Bar
    - Multiple dining venues and Wine Room
- New road infrastructure within the proposed development.

The architectural design at CSP creates a soft blend of tropical and contemporary elements. The design encompasses natural elements with features of clean, crisp coral stone interlaced with weathered wood that allows the building to complement the surrounding tropical vegetation and rough-edged coastline.

Table 5.3. Total Development Acreage for Conch Sound Point.

DEVELOPMENT PROGRAM	QTY	CONDITIONED AREA		UNCONDITIONED AREA		
The Residence Club						
Entry & Reception	1.00 ea	1,000 sf	1,000 sf	sf	sf	
Hotel Restaurant / Boutique / Lounge / Library	1.00 ea	12,500 sf	12,500 sf	5,000 sf	5,000 sf	
Pool & Pool Bar	1.00 ea	4,500 sf	4,500 sf	5,000 sf	5,000 sf	
Spa & Wellness	1.00 ea	26,000 sf	26,000 sf	8,000 sf	8,000 sf	
Beach Bar & Grill (Palapa)	1.00 ea	5,000 sf	5,000 sf	5,000 sf	5,000 sf	
Cottages	25.00 ea	2,800 sf	70,000 sf	1,000 sf	25,000 sf	
Staff Housing	25.00 ea	400 sf	10,000 sf	200 sf	5,000 sf	
Back of House	1.00 ea	10,000 sf	10,000 sf	5,000 sf	5,000 sf	
Landscape / Hardscape	1.00 ea			139,000 sf	139,000 sf	
Total Setai Residence Club			**139,000 sf**		**197,000 sf**	
Residence Club Private Villas	58.00 ea	5,000 sf	290,000 sf	1,500 sf	87,000 sf	
Infrastructure						
Exterior Access Road	4,605 lf	20 lf			92,100 sf	
Interior Roads	36,868 lf	20 lf			737,360 sf	
Waterway	10.00 ac	43,560 sf/ac			435,600 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
DEVELOPED AREA					**2,413,660 sf**	**55.41 ac**

Note: All plans and programs are preliminary and conceptual. The plans outlined will change as the development matures.

Figure 5.3. Rendering of the wellness center.

Figure 5.4. Rendering of the two-story guest villa.

Figure 5.5. Rendering of the guest cottage.

5.2 PROJECT SCHEDULE

Each Project location has its own distinct phasing schedule independent of the others. The Harbour Club at LH (Phase One) is intended to begin development works prior to the HBB (Phase Two) and CSP (Phase Three) Projects. The Sporting Club at HBB will follow, then The Residence Club at CSP will be developed as the last of the three (3) Projects to be developed. Timing of the projects and their specific phases will depend on Market conditions and progress on the current project phase(s) being worked on at the time.

The Project and road improvement phasing plan is included in Appendix C.

5.2.1 Leeward Harbour Phasing

Four (4) phase development plan outlined below:

1. Phase One – Harbour Basin Excavation, Placement and Compaction of Excavated Material.
2. Phase Two – Setai Harbour Club, Setai Beachfront Cottages, Back of House / Marina OPS Fuel Storage, FBO and Fuel Center, Runway Expansion.
3. Phase Three – Branded Residential and Club Facility, Harbour Walk Expansion, Residential and Casino.
4. Phase Four – Residential

5.2.2 High Bank Bay Phasing

Five (5) phase development plan outlined below:

1. Phase One – Golf Course, Infrastructure – Roads, Irrigation Lakes, and Amenity Areas/Green Space.
2. Phase Two – Setai Boutique Hotel, Setai Cottages, Villas and Estates Homes, Golf and Beach Club, Golf Club Cottages, Tennis and Racquet Club/Pro Shop and Back of House.
3. Phase Three – Retail Village Center, Oceanview and Golf View Private Estate Lots, Ocean Front Estates, and Ocean Front Villas.
4. Phase Four – Estate Homes and Golf Couse Residential.
5. Phase Five – Golf Course Residential.

Road clearing for the HBB and CSP properties will be completed in two (2) phases.

1. Phase One – includes the road clearing of the existing 30ft. wide road reservation along the western boundary of both HBB and CSP. This also includes road clearing of the CSP southern property boundary and the HBB northern property boundary.
2. Phase Two – includes the continued clearing of the existing 30ft. wide road reservation along the western boundary of the CSP and HBB properties, as well as the northern property boundary for CSP and the southern property boundary for HBB.

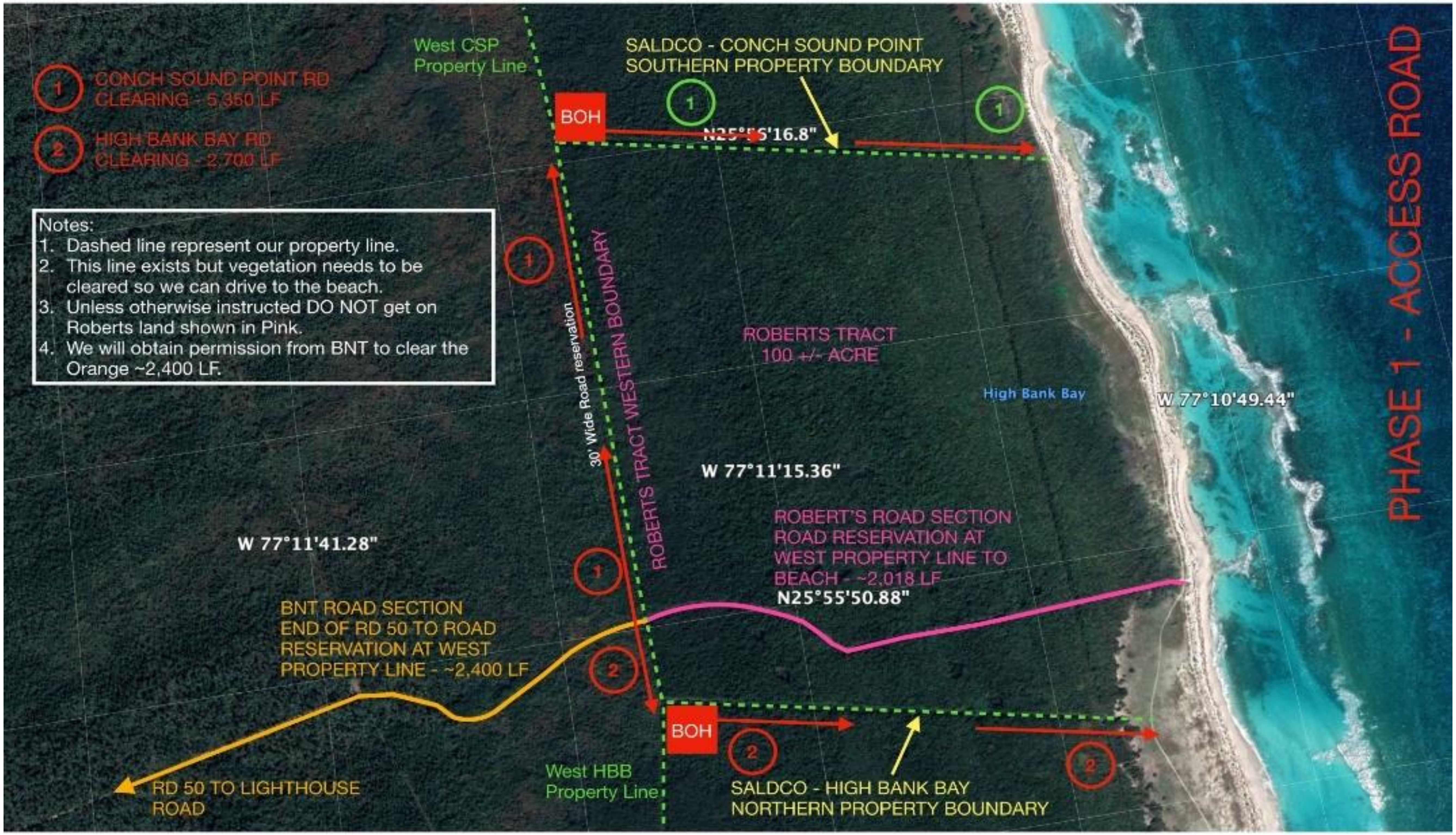


Figure 5.6. High Bank Bay and Conch Sound Point access road clearing phasing plan (Phase 1).

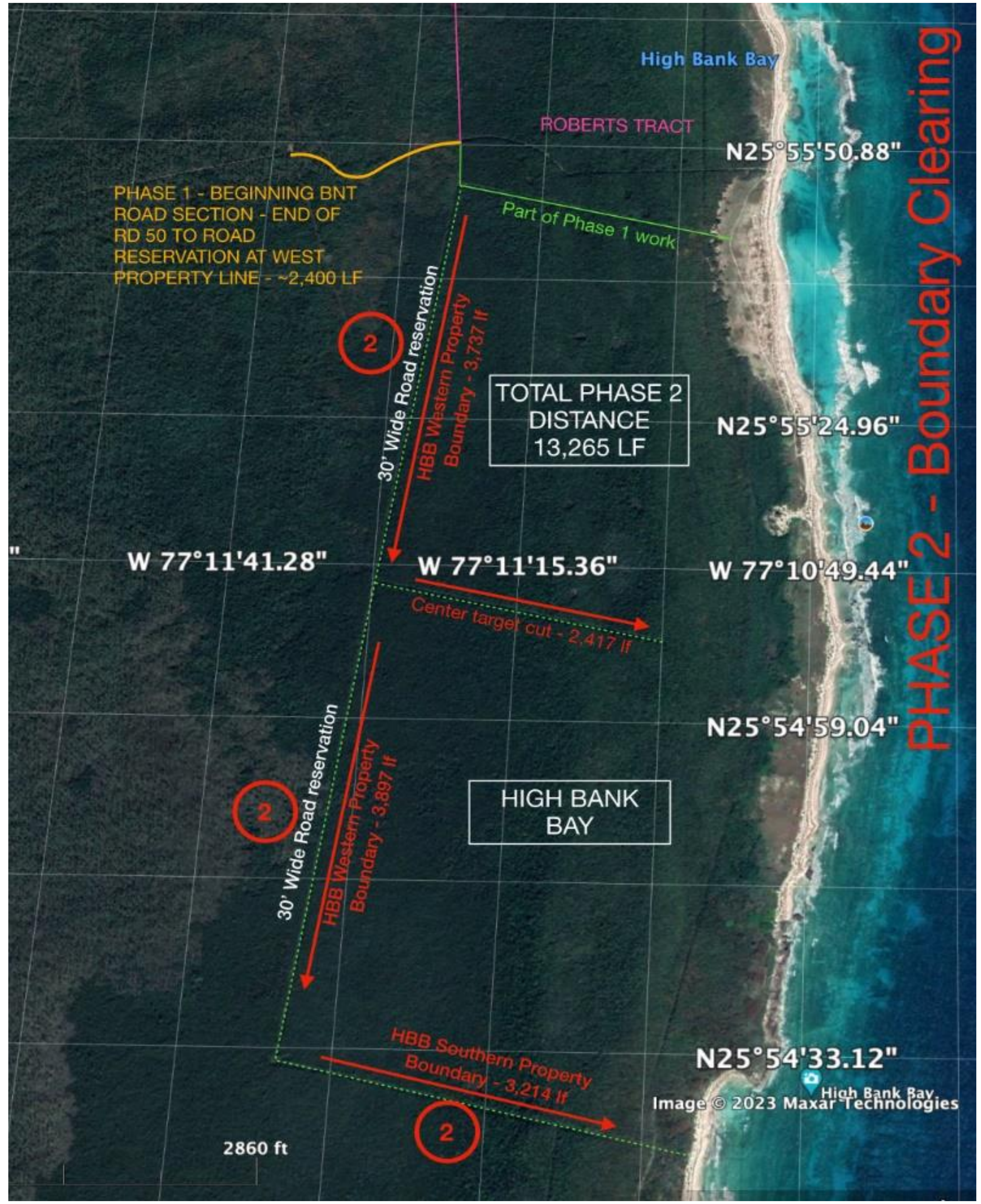


Figure 5.7. High Bank Bay access road clearing phasing plan (Phase 2).

5.2.3 Conch Sound Point Phasing

Four (4) phase development plan outlined below:

1. Phase One – Infrastructure and Back of House.
2. Phase Two – Setai Boutique Hotel and Villas, Beach Club, Spa and Wellness, Beach Front Private Estate Lots (South), Golf Practice Area, and Water Features.
3. Phase Three – Retail Center, Fitness Center, Village Cottages, and Beach Front Private Estate Lots (North).
4. Phase Four – Event Area, Garden, Kids Beach Club, Water Features, and Equestrian Residential.

5.3 MASTER PLAN

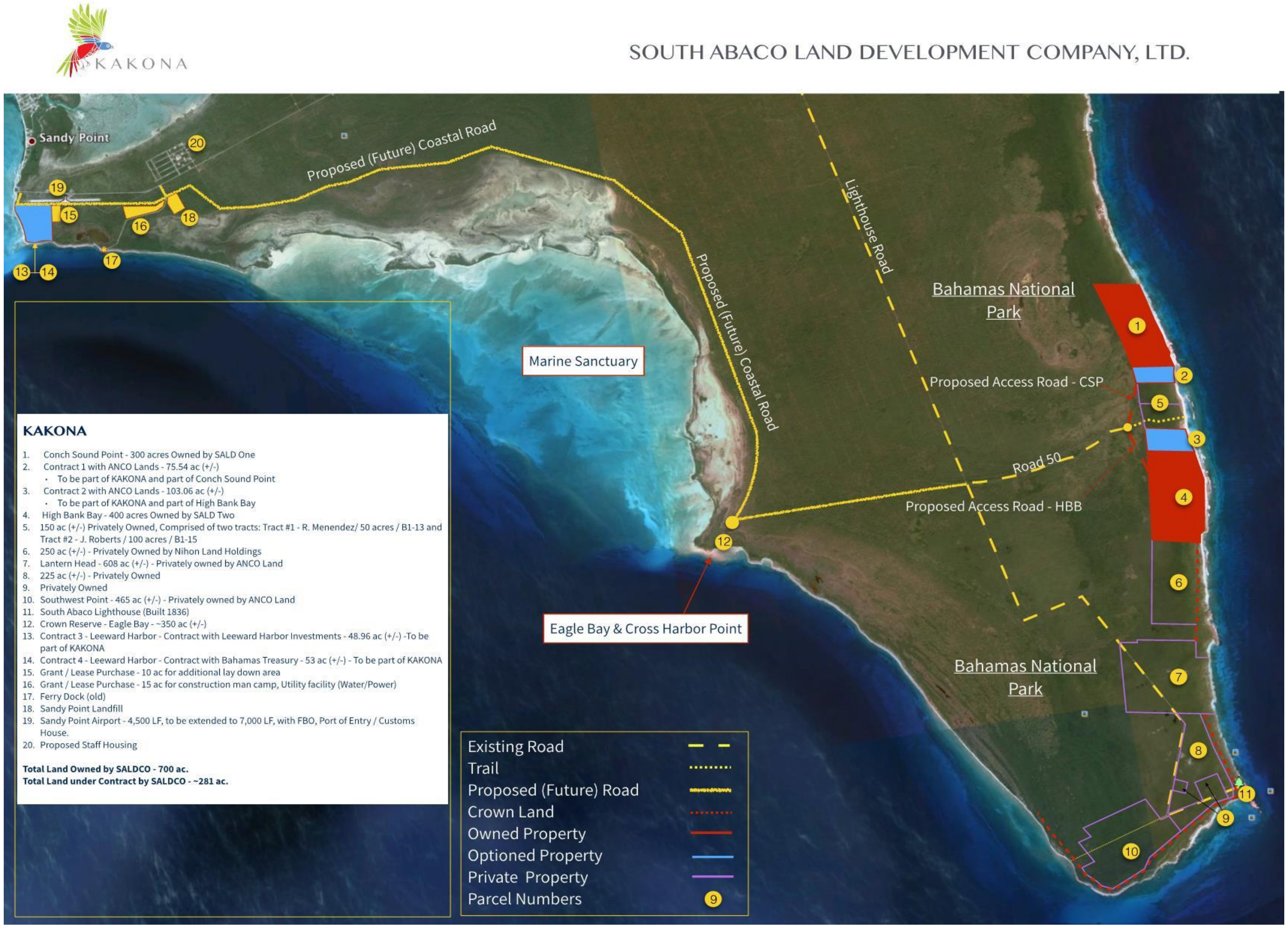


Figure 5.8. Kakona site plan.

5.3.1 Leeward Harbour Master Plan

5.3.2 High Bank Bay Master Plan

5.3.3 Conch Sound Point Master Plan

5.4 UTILITIES DESCRIPTION

All water, wastewater and electricity demands presented are an estimate based on the current concept plans, and approved programs for each property, conforming with the development approval received from the Bahamas Investment Authority. The values presented and shown herein represent the main demands but are not inclusive of all system demands.

5.4.1 Potable Water

A reverse osmosis (RO) system will provide the domestic water supply and provide water treatment for The Project. This potable water production from the RO system will have the capacity to produce enough water supply for the entire Project, inclusive of LH, CSP and HBB. A high-density polyethylene pipe (HDPE) of sufficient size will deliver the saltwater from the Atlantic Ocean through a filtration system to a day tank on the influent side of the plant. Additional filtration / treatment will occur prior to being delivered to the RO system. The source of water for the water facilities depends on a few factors; if the facilities are combined near LH or if the facilities will be separate. If separated, the intake for CSP and HBB will be via deep wells located on each property supporting golf course irrigation and domestic water use. The intake for the LH facility will be built into the bulkhead of the harbor, whether stand alone or as a combined facility.

The RO plant's components:

- Front end fine screening at the intake, with pre-treatment to extend the life of the RO membranes
- Ultra-fine screening at the plant prior to entering the RO system,
- RO system,
- Disinfection via Ozone, and Ultraviolet sterilization and Chlorine disinfection.
- Storage tanks will be glass lined as manufactured by AquaStore™.

The plant storage specifications if combined, are as follows:

- If combined into one facility near LH- the storage unit will occupy a capacity of 1.5 million gallons of water.
- If the RO system is separated to supply CSP, HBB and LH; 500,000 gallons of water will be stored at LH, 1 million gallons at CSP and HBB, with an additional 500,000-gallon storage tank at CSP.

The disposal of brine from the RO system will be executed in an environmentally safe and sensitive manner. The RO system will use deep well injection to dispose of brine at LH. An alternative method is possible for the discharge process at LH. This involves discharging produced brine into a mixing system with a set mix ratio with subsequent diffused discharge along the marina bulkhead. This action will assist in flushing the marina. Most of the flushing will occur with tidal fluctuations. This method of brine disposal will provide a mixed ratio with no chance of aquifer contamination or marine habitat disturbance or damage. A model to prove this method will be prepared and submitted for review prior to construction of the facility. The complete Water & Wastewater Demand Matrix is located in Appendix D and is representative of estimated values of the Project's total water demand. All water demands presented are an estimate based on the current concept plans. The values presented in Sections 5.4.1.1, 5.4.1.2, and 5.4.1.3 below and shown herein represent the main demands but are not inclusive of all system demands.

5.4.1.1 Leeward Harbour Potable Water Demand Estimates

The water and wastewater demand for development in Leeward Harbour is calculated based on a factor of Gallons Per Day (GPD) by the quantity of units. The flow projection assumptions support water and wastewater usage for real estate, retail space, hotel villas, restaurants, restaurant safety factor, spa, tennis center, harbor and aerodrome.

Table 5.4. Summary estimated potable water capacity required to support developments in Leeward Harbour.

Structure	Estimated Water Capacity (gpd)
Real Estate	34,500
The Harbour Club	26,400
Retail	3,435
Utility	3,950
Employees	2,500
BOH Hotel Laundry and Spa	5,625
Marina	125,000
Pool Evaporation -Hotel	7,790
Pool Evaporation - Private Home	3,506
Pool Evaporation - Hotel Cottages	2,337
Safety Factor	13,632
Total Estimated Capacity	**~223,000**

5.4.1.2 High Bank Bay Potable Water Demand Estimates

The water and wastewater demand for developments in High Bank Bay is calculated based on the factor of gallons per day (GPD) the quantity of units. The flow projection assumptions support water and wastewater usage for real estate, retail space, hotel villas, restaurants, restaurant safety factor, spa, tennis center and golf center.

Table 5.5. Summary estimated potable water capacity required to support developments in High Bank Bay.

Structure	Estimated Water Capacity (gpd)
Real Estate	34,800
The Sporting Club	30,694
Clubs	7,000
Utility	1,600
Employees	2,500
Laundry	2,700
Golf Course Irrigation	144,000 (640,000 during grow in)
Pool Evaporation - Hotel	7,790
Pool Evaporation - Private Homes	5,422
Pool Evaporation - Hotel Cottages	1,402
Safety Factor	23,790
Total Estimated Capacity	**~261,700**

5.4.1.3 Conch Sound Point Water Demand Estimates

The water and wastewater demand for developments in Conch Sound Point is calculated based on the factor of gallons per day (GPD) the quantity of units. The flow projection assumptions support water and wastewater usage for real estate, retail space, hotel villas, restaurants, restaurant safety factor, spa, tennis center and golf center.

Table 5.6. Summary estimated potable water capacity required to support developments in Conch Sound Point.

Structure	Estimated Water Capacity (gpd)
Real Estate	30,000
The Residence Club (Hotel)	28,337
Clubs	7,000
Utility	1,600
Employees	2,500
Back of House Laundry and Spa	5,600
Pool Evaporation	12,000
Golf Practice Area	25,000
Safety Factor	7,500
Total Estimated Capacity	**~115,000**

5.4.2 Energy

The electrical demand estimates for The Project are based on industrial, residential, commercial and restaurant power assumptions for facilities. The estimated power requirements of the Project are calculated based on square footage of the amenities by a factor of the Annual Kilowatt Hours. These structures require power supply to meet the electrical demand suitable for their respective sizes. It is intended to produce additional power capacity at the Project's central power plant (located at LH outline as item 16 in Section 5.3) to service the Project and provide excess supply to the South Abaco grid through an agreement with Bahama Power and Light Ltd. Co.

The complete Project Electrical Demand Matrix is included in Appendix E and the Project Utility Supplement is included in Appendix F. All electricity demands presented below in Sections 5.4.2.1, 5.4.2.2, and 5.4.2.3 are an estimate based on the current concept plans. The values presented and shown herein represent the main demands but are not inclusive of all system demands.

5.4.2.1 Leeward Harbour Power Assumptions

Power supply on LH will support various building structures including the boutique hotel, hotel amenities, harbor, aerodrome and residential lodging. Additional energy supply is needed to support golf cart charging stations, utilities, resort utilities, resort lighting and BOH laundry facilities.

Table 5.7. Estimated electrical demand at Leeward Harbour.

Building Structure	Square footage (sf)	Annual Energy Consumption (KWh's)	Alternative Thermal Savings (10%)
The Harbour Club (Hotel)	22,500	474,525	427,073
The Harbour Club (Hotel Public Areas and BOH)	48,460	1,169,848	1,052,863
Harbor	39,612	916,965	825,269
Residential	270,000	5,694,300	5,124,870
Staff & Crew Residences	10,000.00	210,900.00	189,810.00
Utilities	189,000	69,363	62,427
Golf Cart Charging Allocation	N/A	14,615,885	5,846,354 (60%)
Resort Common Area Lighting	N/A	131,400	118,260
Laundry	N/A	18,478	16,630.31
Total Estimated Capacity Requirement		**~42,850,000**	**~35,500,000**

5.4.2.2 High Bank Bay Power Assumptions

Power supply for HBB will support various building structures such as the Hotel, Longevity & Wellness Centre, Residential, Golf Club, Beach Club, Golf Club Villas and Beach Club Villas. Additional energy supply is needed to support golf course pumping, golf cart charging stations, utilities, resort utilities, resort lighting and BOH laundry facilities..

Table 5.8. Estimated High Bank Bay electrical demand.

Building Structure	Square Footage (sf)	Annual Energy Consumptions (KWh's)	Alternative Thermal Savings (10%)
The Sporting Club (Cottages)	60,000	1,265,400	1,138,860
The Sporting Club (public Areas and BOH)	178,660	4,291,731	3,862,558
Residential	576,000	12,147,840	10,933,056
Staff and Crew Residential	10,000.00	210,900.00	189,810.00
Golf Course Pumping	N/A	876,000	876,000 (0%)
Utilities	380,400	139,607	125,646
Golf Cart Charging Allocation	N/A	31,359,398	12,543,759 (60%)
Laundry	N/A	32,850	29,565.00
Common Area Lighting	N/A	131,400	118,260
Total Estimated Capacity Requirement		**~50,455,126 (~4.2 MW Peak)**	**~29,817,514**

5.4.2.3 Conch Sound Point Power Assumptions

Power supply on CSP will support various building structures such as hotel accommodations and residential estate homes. Additional energy supply is required to support golf course pumping, golf cart charging stations, utilities, resort utilities, resort lighting and BOH laundry facilities.

Table 5.9. Estimated Conch Sound Point electrical demand.

Building Structure	Total Square Footage (sf.)	Annual Energy Consumption (KWh's)	Alternative Thermal Savings (10%)
The Residence Club (Hotel Villas)	5,000	105,450	94,905
The Residence Club (Hotel Public Areas and BOH)	165,460	3,993,096	3,593,787
Residential	704,500	14,857,905	13,372,115
Staff and Crew Residential	10,000	210,900	189,810.00
Golf Cart Charging Station	N/A	18,223,603	7,289,441 (60%)
Golf Course Pumping	N/A	122,640	122,640 (0%)
Utilities	122,400	44,921	40,429
Resort Common Area Lighting	N/A	131,400	118,260
Laundry	N/A	10,266	9,239.06
Total Estimated Capacity Requirement		**~37,700,181 (~3.5MW peak)**	**~24,830,625**

5.4.2.3.1 Kakona Power Options

There are multiple sustainable program options for energy production to support The Project. It is intended to produce additional power capacity at the central power plant to service the Project and provide excess supply to the South Abaco grid through an agreement with Bahama Power and Light Ltd. Co. The intended power generation facility will comprise a facility at Leeward Harbour to support the Marina demand as well as produce excess power for grid placement, as well as a second facility at HBB to support both the HBB and CSP Projects. As the Project is in its preliminary design phases, The Developer will conduct a study on the cost to benefit analysis on the development of one (1) facility in comparison to two (2) separate facilities. In addition to the central power plant, options for renewable energy will be generated through use of select solar, liquified natural gas and geothermal technology opportunities. Any power not required for the development will be made available to the grid.

5.4.2.3.1.1 Liquified Natural Gas

The power facility is being planned as a joint venture between the Developer and a leading provider of Liquified Natural Gas (LNG) and power generation facilities in the Caribbean. The liquified natural gas will be delivered to the old ferry dock, in LNG ISO containers where it will then be utilized in the power plant(s). This allows for plant location flexibility. The type of power generation equipment to be installed has not yet been decided. However, an example of the investment of Capstone CHP Micro turbines fulfills a dual role of production and supply of power to the properties. The development is not limited to Capstone. Other alternative options will be reviewed. Also, through Combined Heat and Power (CHP) this captures the heat that is typically lost from the power generation process and uses it to produce hot water and air conditioning for some or all of the commercial and residential units planned at LH. Hot water heating systems require copious amounts of energy in any system. The intent is to utilize natural gas to all commercial facilities and each residential unit allowing for the energy efficient heating of water when required. Calculations to determine the viability of this option and the amount of resulting air conditioning are in process.

5.4.2.3.1.2 Wind

Wind energy is not an option and will not be utilized due to the negative effects on the protected Abaco Parrot.

5.4.2.3.1.3 Solar Power

Alternative energy such as solar panels would provide power for ornamental lighting, electric vehicle charging, accent lighting, street lighting, maintenance & pump station supplemental power. The estimated reduction to the normal base load through sustainable operations is 10%. These systems will be integrated so as not to create an aesthetics issue. Furthermore, the developer intends to incorporate advanced technologies such as solar shingles, to promote sustainable energy use throughout the development of the Project. The Project design team intends to utilize one manufacturer, maintaining design continuity and aesthetics while the overall demand for energy. Thus, reducing the overall cost. Additionally, the use of this type of solar component will reduce the amount of fuel required to produce base load power and aid in achieving an environmentally sustainable development.

5.4.2.3.1.4 Geothermal Energy

Geothermal energy is another alternative energy source to aid with power supply for the Project. This would be used to support the Project cooling systems. An example of a geothermal facility has been established in Schooner Bay, Abaco. This type of energy production system utilizes deep wells, pumps for circulation of a low flash point fluid, a network of buried primary delivery and secondary effluent piping and a network of heat pumps inside the structures where it is being utilized. The United States Environmental Protection Agency (USEPA) stated in a report (EPA Report 430-R-93-004) that, “Geothermal Systems are the most energy efficient, environmentally clean, and cost-effective space conditioning systems available.” The operating premise behind the Geothermal System is very simple as follows:

a) The low flash point fluid is cooled as it is circulated at depth in the primary closed system piping.
b) Each residential unit or commercial space will have a specific number of heat pumps that facilitate cooling.
c) The heat pump removes the heat from the interior space and transfers it into the geothermal piping network where it is then cooled through transmission within the buried

piping network and at depth and the process begins again. The system is a closed loop, so no fluid exchange occurs.

d) Two geothermal plants will be constructed and placed in use, one at Leeward Harbor and one for CSP and HBB. The plants will be centrally located to conserve space and maximize efficiency.

5.4.3 Communication

A proposed agreement with the local cable and wireless provider is necessary to facilitate internet connectivity throughout the Project. It is mandatory to tie into the fiber that lands at LH. A network of fiber conduit will be installed for each of the three properties facilitating the connectivity to a centralized servicing point. This plan mandates that conduit run along the right of way of the new coastal road, and down Road 50 for delivery and distribution through CSP and HBB. The conduit will also be installed to and through Leeward Harbor as well as the FBO at the airport. Currently it is not known who will be responsible for the actual fiber installation, but Johnson Controls will provide the design and oversight for this to ensure a quality and trouble-free system upon its completion.

5.4.4 Solid Waste

Currently, South Abaco has a landfill located to the southeast of the Sandy Point airstrip and labeled point ‘18’ on the parcel summary illustrated above in Section 5.3 Master Plan. The amount of public solid waste delivered to this site daily or management is currently unknown. Per the Heads of Agreement, it is proposed that the Developers control the management of this landfill and add additional acreage for expansion and proper operation. This agreement would allow suitable management of the South Abaco Landfill. Thus, eliminating potential environmental issues caused by an unmanaged landfill and aiming to be an example of landfill management for The Bahamas. Prior to this, a detailed comprehensive operations plan will be submitted for comment and approval. This plan will provide details on the following:

1. Assessment of the current state of the landfill with recommendations for remediation of the site and the estimated time to complete or a plan for site closure with no further landfilling in the old site and the commissioning of a new minimal landfill with active recycling.
2. Estimate daily incoming waste in tons per day.
3. General waste characterization.
4. Description of operations outlining required staff and equipment.
5. A small fleet of specialized small collection vehicles will be placed in service and all collected material will be delivered to the landfill processing area.
6. It will be the policy during Project operations phases to conduct recycling sorting methods such as separating all solid waste into its various constituents of aluminum, ferrous metal, plastic, glass, and organics.
7. Delivered recycled material will be processed and placed in shipping containers. Once the containers are full, shipping will be arranged for transport of the recycled materials to a joint venture partner in the U.S. State of Florida.

8. The organic materials that are collected (food waste, paper and sludge) will be placed in a BioNova Waterless Digester or equivalent where it is processed into a high quality, nutrient rich soil amendment. This material will be incorporated with shredded wood waste to create nutrient rich mulch for use in the property landscape operations.

The municipal solid waste generated by the Project is characterized by plastic, paper, glass, cardboard, and organic material.

Table 5.10. Summary table of the Project's estimated solid waste characterization and quantity (%).

Solid Waste	Estimated Percentage
Organic Materials	~ 15.17%,
Paper	~ 26.03%
Glass	~ 4.42%
Metals	~9.14%
Plastic	~13.16%
Wood	~3.17%
Landscape Debris	~6.80%
Rubber/Leather/Textiles	~0.0082%
Other/Miscellaneous	~ 22.43%

The complete Project Municipal Solid Waste Production Estimate is included in Appendix G. The Figures below outline the municipal solid waste estimates for each location associated with the Project.

LEEWARD HARBOR

								ANNUAL PRODUCTION		MONTHLY	DAILY
RESIDENTIAL	**GSF**		**UNITS**				**FACTOR**	**TONS/YR**	**LBS/YR**	**LBS/MO**	**LBS/DAY**
R1 - Townhomes	144,000.00	96,480.00	48.00				0.91	43.68	87,360.00	7,280.00	239.34
R2 - Villas	114,600.00	76,782.00	58.00				0.91	52.78	105,560.00	8,796.67	289.21
R3 - Condos	323,136.00	115,060.00	132.00				0.91	120.12	240,240.00	20,020.00	658.19
Total	**581,736.00**	**288,322.00**	**238.00**	-	-	-		**216.58**	**433,160.00**	**36,096.67**	**1,186.74**
RESIDENTIAL OVER RETAIL	**1st Level - GSF**	**2nd Level - GSF**	**Units**								
M1A - Loft Over Retail	9,000.00	9,000.00	10.00				0.91	9.10	18,200.00	1,516.67	49.86
M1B - Loft Over Retail	18,000.00	18,000.00	15.00				0.91	13.65	27,300.00	2,275.00	74.79
Total	**27,000.00**	**27,000.00**	**25.00**	-	-	-		**22.75**	**45,500.00**	**3,791.67**	**124.66**
HOSPITALITY	**Keys**		**GSF**								
S2 - Harbor House Inn & Cafe	42.00		41,285.00				0.0011	43.35	86,698.50	7,224.88	237.53
Over the Water Villas	-		-				0.0011	-	-	-	-
Total	**42.00**	-	**41,285.00**	-	-	-		**43.35**	**86,698.50**	**7,224.88**	**237.53**
OFFICE	**1st Level - GSF**	**2nd Level - GSF**									
Harbor Master / Marina Ops	1,000.00	500.00					0.0013	1.95	3,900.00	325.00	10.68
Customs House & Immigration	1,000.00	500.00					0.0013	1.95	3,900.00	325.00	10.68
Port Security	750.00						0.0013	0.98	1,950.00	162.50	5.34
Charter & Yacht Sales	1,000.00						0.0013	1.30	2,600.00	216.67	7.12
Property Leasing & Sales	2,500.00						0.0013	3.25	6,500.00	541.67	17.81
Development Offices		2,000.00		500.00			0.0013	2.60	5,200.00	433.33	14.25
Total	**6,250.00**	**3,000.00**	-	**500.00**	-	-	**0.01**	**12.03**	**24,050.00**	**2,004.17**	**65.89**
RESTAURANT	**1st Level - GSF**	**2nd Level - GSF**	**1st Level Outdoor Space**	**2nd Level Outdoor Space**	**Seats**	**TYPE**					
Dining - Sit Down (2 levels)	2,000.00	1,500.00	1,000.00	1,500.00			0.0057	34.20	68,400.00	5,700.00	187.40
Dining - Sit Down (2 levels)	2,000.00	1,500.00	1,000.00	1,500.00			0.0057	34.20	68,400.00	5,700.00	187.40
Bahamas Style Restaurant	750.00		500.00				0.0057	7.13	14,250.00	1,187.50	39.04
Harbor House - Mariner's Inn & Café	3,706.00										
Sports Bar & Grill	1,500.00		500.00				0.0057	11.40	22,800.00	1,900.00	62.47
Seafood Grill	980.00		400.00				0.0057	7.87	15,732.00	1,311.00	43.10
Café - Coffee & Pastries	1,000.00		500.00				0.0057	8.55	17,100.00	1,425.00	46.85
Deli, Sandwiches, Pizza, etc	750.00		500.00				0.0057	7.13	14,250.00	1,187.50	39.04
Juice Bar	750.00		-				0.0057	4.28	8,550.00	712.50	23.42
Ice Cream / Gelato	750.00		-				0.0057	4.28	8,550.00	712.50	23.42
Total	**14,186.00**	**3,000.00**	**4,400.00**	**3,000.00**	-	-	**0.05**	**119.02**	**238,032.00**	**19,836.00**	**652.14**
LEEWARD HARBOR											
RETAIL	**1st Level - GSF**	**2nd Level - GSF**									
Fresh Market	2,500.00	-					0.0045	11.25	22,500.00	1,875.00	61.64
Fish Munger / Butcher	1,500.00	-					0.0045	6.75	13,500.00	1,125.00	36.99
Liquor / Beer / Wine	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66
Tobacco & Humidor	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66
Womens Clothing Boutique	1,750.00	-					0.0045	7.88	15,750.00	1,312.50	43.15
Mens Clothing Boutique	1,750.00	-					0.0045	7.88	15,750.00	1,312.50	43.15
Bahamas Art Gallery	1,250.00	-					0.0045	5.63	11,250.00	937.50	30.82
Salon - hair & nails	1,250.00	-					0.0045	5.63	11,250.00	937.50	30.82
Sundry	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66
Chandlary / Marine Store / Sport Fishing and Fly Fishing	2,500.00	-					0.0045	11.25	22,500.00	1,875.00	61.64
Jewelry Store	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66
Fitness Center	-	2,000.00					0.0045	9.00	18,000.00	1,500.00	49.32
Scuba Diving, Rental (scooters, kayaks, parasailing, day sailing etc)	1,500.00						0.0045	6.75	13,500.00	1,125.00	36.99
Marina Laundry	1,000.00						0.0045	4.50	9,000.00	750.00	24.66
Total	**19,000.00**	**2,000.00**	-	-	-	-	**0.06**	**94.50**	**189,000.00**	**15,750.00**	**517.81**
COMMERCIAL	**1st Level - GSF**	**2nd Level - GSF**	**SLIPS**								
BOH, Central Receiving & Housekeeping	7,480.00						0.0016	11.97	23,936.00	1,994.67	65.58
Maintenance & Service Area	7,860.00						0.0013	10.22	20,436.00	1,703.00	55.99
Admin Space	1,700.00						0.0013	2.21	4,420.00	368.33	12.11
Circulation	5,112.00						0.0013	6.65	13,291.20	1,107.60	36.41
FBO	2,250.00						0.0013	2.93	5,850.00	487.50	16.03
				OCCUPANCY							
Marina			225.00	100%			2.55	573.08	1,146,150.00	95,512.50	3,140.14
Total	**24,402.00**	-	**225.00**	**1.00**	-	-		**607.04**	**1,214,083.20**	**101,173.60**	**3,326.26**
TOTAL LEEWARD HARBOR MSW ESTIMATE								**1,115.26**	**2,230,523.70**	**185,876.98**	**6,111.02**
TOTAL KAKONA MSW								**2,206.33**	**4,412,657.50**	**367,721.46**	**12,089.47**

Figure 5.9. Leeward Harbour municipal solid waste production estimate.

HIGH BANK BAY

								ANNUAL PRODUCTION		MONTHLY	DAILY
RESIDENTIAL	**GSF**		**UNITS**				**FACTOR**	**TONS/YR**	**LBS/YR**	**LBS/MO**	**LBS/DAY**
Estate Homes	7,500.00		115.00				2.55	292.91	585,810.00	48,817.50	1,604.96
Golf & Beach Club Villas	13,500.00	9,000.00	9.00				0.91	8.19	16,380.00	1,365.00	44.88
Private Enclave Beachfront Villas	50,000.00	20,000.00	10.00				0.91	9.10	18,200.00	1,516.67	49.86
Grand Ana Villas	105,000.00	56,800.00	30.00				0.91	27.30	54,600.00	4,550.00	149.59
Total	**176,000.00**	**85,800.00**	**164.00**	-	-	-		**337.50**	**674,990.00**	**56,249.17**	**1,849.29**
HOSPITALITY	**Keys**	**Condo**	**GSF**	**Amenity Deck (sf)**							
The Grand Ana				100,000.00							
Sound Studio			2,520.00				0.0011	2.65	5,292.00	441.00	14.50
Public areas & BOH			40,193.00				0.0016	64.31	128,617.60	10,718.13	352.38
Conference / Banquet Facilities			7,680.00				0.0011	8.06	16,128.00	1,344.00	44.19
Spa, Treatment Rooms, Yoga and Fitness			13,944.00				0.0011	14.64	29,282.40	2,440.20	80.23
Beach & Golf Club			16,678.00				0.0011	17.51	35,023.80	2,918.65	95.96
Studio Suites	8.00		6,400.00	1,920.00			0.0011	6.72	13,440.00	1,120.00	36.82
Beach & Golf Club Villas	10.00		12,840.00				0.0011	13.48	26,964.00	2,247.00	73.87
Over the Water Bungalows	-		-				0.0011	-	-	-	-
Total	**18.00**	-	**100,255.00**	**101,920.00**	-	-		**127.37**	**254,747.80**	**21,228.98**	**697.94**
OFFICE	**GSF**	**NRSF**									
Reception / Back Offices	1,160						0.0013	1.51	3,016.00	251.33	8.26
Executive & Admin	980						0.0013	1.27	2,548.00	212.33	6.98
Total	**2,140**							**2.78**	**5,564.00**	**463.67**	**15.24**
RESTAURANT	**1st Level - GSF**	**2nd Level - GSF**	**1st Level Outdoor Space**	**2nd Level Outdoor Space**	**Seats**	**TYPE**					
Specialty Restaurant	3,000.00		1,536.00		168.00	Fine Dining	0.0057	25.86	51,710.40	4,309.20	141.67
Bar Lounge	896.00		672.00		56.00		0.0057	8.94	17,875.20	1,489.60	48.97
Café / Bar / Lounge / entertainment	2,880.00				120.00		0.0057	16.42	32,832.00	2,736.00	89.95
Waterside / Beach Grill	1,824.00				78.00		0.0057	10.40	20,793.60	1,732.80	56.97
Total	**8,600.00**	-	**2,208.00**	-	**422.00**	-		**61.61**	**123,211.20**	**10,267.60**	**337.56**
HIGH BANK BAY											
Retail	**1st Level - GSF**	**2nd Level - GSF**									
Retail shops	2,750.00						0.0045	12.38	24,750.00	2,062.50	67.81
Total	**2,750.00**	-	-	-	-	-		**12.38**	**24,750.00**	**2,062.50**	**67.81**
Commercial / Industrial	**GSF**										
Golf Course Maintenance	5,000.00						0.0016	8.00	16,000.00	1,333.33	43.84
Total	**5,000.00**	-	-	-	-	-		**8.00**	**16,000.00**	**1,333.33**	**43.84**
TOTAL HIGH BANK BAY MSW ESTIMATE								**549.63**	**1,099,263.00**	**91,605.25**	**3,011.68**

Figure 5.10. High Bank Bay municipal solid waste production estimate.

CONCH SOUND POINT

RESIDENTIAL	GSF		UNITS				FACTOR	ANNUAL PRODUCTION TONS/YR	ANNUAL PRODUCTION LBS/YR	MONTHLY LBS/MO	DAILY LBS/DAY
Estate Homes	10,000.00		100.00				2.55	254.70	509,400.00	42,450.00	1,395.62
The Kakona Club Villa and Condos	179,040.00		60.00				2.55	152.82	305,640.00	25,470.00	837.37
TOTAL RESIDENTIAL	**189,040.00**	**-**	**160.00**					**407.52**	**815,040.00**	**67,920.00**	**2,232.99**
HOSPITALITY	**Keys**		**GSF**	**Amenity Deck (sf)**							
The Kakona Club	60.00	-	52,806.00	100,000.00			0.0011	55.45	110,892.60	9,241.05	303.82
Spa, Treatment Rooms, Yoga and Fitness			7,900.00				0.0011	8.30	16,590.00	1,382.50	45.45
TOTAL HOSPITALITY	**60.00**	**-**	**60,706.00**					**63.74**	**127,482.60**	**10,623.55**	**349.27**
OFFICE	**GSF**	**NRSF**									
Management Offcies	1,200						0.0013	1.56	3,120.00	260.00	8.55
TOTAL OFFICE	**1,200**	**-**	**-**	**-**	**-**			**1.56**	**3,120.00**	**260.00**	**8.55**
RESTAURANT	**1st Level - GSF**	**2nd Level - GSF**	**1st Level Outdoor Space**	**2nd Level Outdoor Space**	**Seats**	**TYPE**					
Waterfront Bar & Grill / Beach Bar	888.00		-		40.00		0.0057	5.06	10,123.20	843.60	27.73
Grill	1,000.00				40.00		0.0057	5.70	11,400.00	950.00	31.23
Grill Bar / Lounge	768.00				24.00		0.0057	4.38	8,755.20	729.60	23.99
Garden Dining Room	768.00				32.00		0.0057	4.38	8,755.20	729.60	23.99
Garden Terrace Dining			1,152.00		36.00		0.0057	6.57	13,132.80	1,094.40	35.98
Owner's Wine Room	400.00						0.0057	2.28	4,560.00	380.00	12.49
Private Dining	480.00						0.0057	2.74	5,472.00	456.00	14.99
Café	624.00				24.00		0.0057	3.56	7,113.60	592.80	19.49
TOTAL RESTAURANT	**4,928.00**	**-**	**1,152.00**	**-**	**196.00**			**34.66**	**69,312.00**	**5,776.00**	**189.90**
COMMERCIAL	**GSF**										
Golf Course Maintenance	5,000						0.0016	8.00	16,000.00	1,333.33	43.84
BOH & Public Areas	24,722						0.0011	25.96	51,916.20	4,326.35	142.24
TOTAL COMMERCIAL	**29,722.00**	**-**	**-**	**-**	**-**	**-**		**33.96**	**67,916.20**	**5,659.68**	**186.07**
TOTAL CONCH SOUND POINT MSW ESTIMATE								**541.44**	**1,082,870.80**	**90,239.23**	**2,966.77**

Figure 5.11. Conch Sound Point municipal solid waste production estimate.

5.4.5 Wastewater

Wastewater treatment plants will be located at the LH development to support the Project. The wastewater treatment facility would consist of Soneera Water Treatment Technology or comparable and is proposed to have few moving parts with low maintenance. The plant includes wastewater components such as screening, equalization, electro-flocculation, disinfection, reuse irrigation, and sludge handling.

HDPE pipe, fittings and related products will be utilized throughout the resort for all underground piping. It is anticipated that an HDPE system for vertical construction interior pipe systems will also be implemented. This system has various benefits such as quick installation, easy repairs, cost efficient, salt tolerance, leak and corrosion prevention.

Different situations require different grades of pipe and fittings, gravity conveyance versus forced or pressure conveyance. Gravity pipe systems are installed to gain benefit from nature and the ever-present force of gravity. This is only applied to sanitary and storm sewer applications. Gravity systems typically start with shallow burial depths and can become quite deep depending on the length of the pipe run and terrain. Gravity conveyance piping will be limited to only the storm water collection and conveyance system due to the geological landscape of the site. Pressure piping is used in the following situations:

1. Domestic water supply
2. Fire main
3. Low pressure wastewater transmission system piping
4. Irrigation reuse water distribution piping
5. Golf Course and ornamental irrigation piping
6. Geothermal cooling transmission main
7. Intake piping for the reverse osmosis plant
8. Cooling water intake for power generation plant

The gravity storm system and the irrigation systems will use iron pipe size (IPS) pipes and fittings. The domestic water, fire main, wastewater transmission and reuse supply main will be designed for ductile iron pipe size (DIPs) pipe and fittings. The purpose for the differentiation in the two pipe specifications allows for standard American Water Works Association (AWWA) fittings and materials applicable to the water and waste industry to be utilized in conjunction with materials applicable to the water and waste industry to be utilized in conjunction with the HDPE pipe.

The Project's sewage collection and conveyance system will be made up of several components. The system will be comprised of a low-pressure step collection system. Each residential unit or series of units will feed to a small grinder pump station from a standard septic tank where the sewage will be pumped via a small HDPE service lateral to the sewage force main. It will then be conveyed to the wastewater treatment plant or to a larger, centralized pump station where it will be conveyed to the treatment plant. All commercial locations, such as the hotels, restaurants, and spa(s), will be equipped with a primary grease interceptor that will require periodic maintenance. Depending on the anticipated strength of the waste from the commercial area, some pretreatment may be necessary.

All wastewater demands presented below in Sections 5.4.5.1, 5.4.5.2, and 5.4.5.3 are an estimate based on the current concept plans. The values presented and shown herein represent the main demands but are not inclusive of all system demands.

5.4.5.1 Leeward Harbour Wastewater Demand Estimates
LH wastewater demand is estimated at 100,000 gpd.

5.4.5.2 High Bank Bay Wastewater Demand Estimates
HBB wastewater demand is estimated at 120,000 gpd.

5.4.5.3 Conch Sound Point Wastewater Demand Estimates
CSP wastewater demand is estimated at 90,000 gpd.

5.4.6 Roads
The Developer intends to create and improve existing roads within South Abaco which include the following:

- Development of approximately three and one half (3.5) miles of Road 50.
- The extension of Road 50 will include a 30ft. wide Road Reservation that runs parallel to the western property boundary of CSP and HBB. The road will be 24ft. wide with 2ft.-8ft. aprons on either side.
- Development of approximately nine (9) miles of Lighthouse Road from the main highway (Great Abaco Highway) to Road 50.
- Construction of a Round-About at the intersection of Lighthouse Road and Road 50 and approximately ten (10) miles of New Coastal Road from the Sandy Point Airport around to Eagle Bay and east to the Round-About to be located at the intersection of Lighthouse Road and Road 50.
- Maintain all aforementioned road developments.

Road development is outlined in Section 5.3 Figure 5.6

5.4.6.1 Leeward Harbour Road Development
Proposed road development for LH allows visitors and staff easy access to building structures and amenities on the site. Five (5) roads will provide access to structures surrounding the harbor (See Figure below).

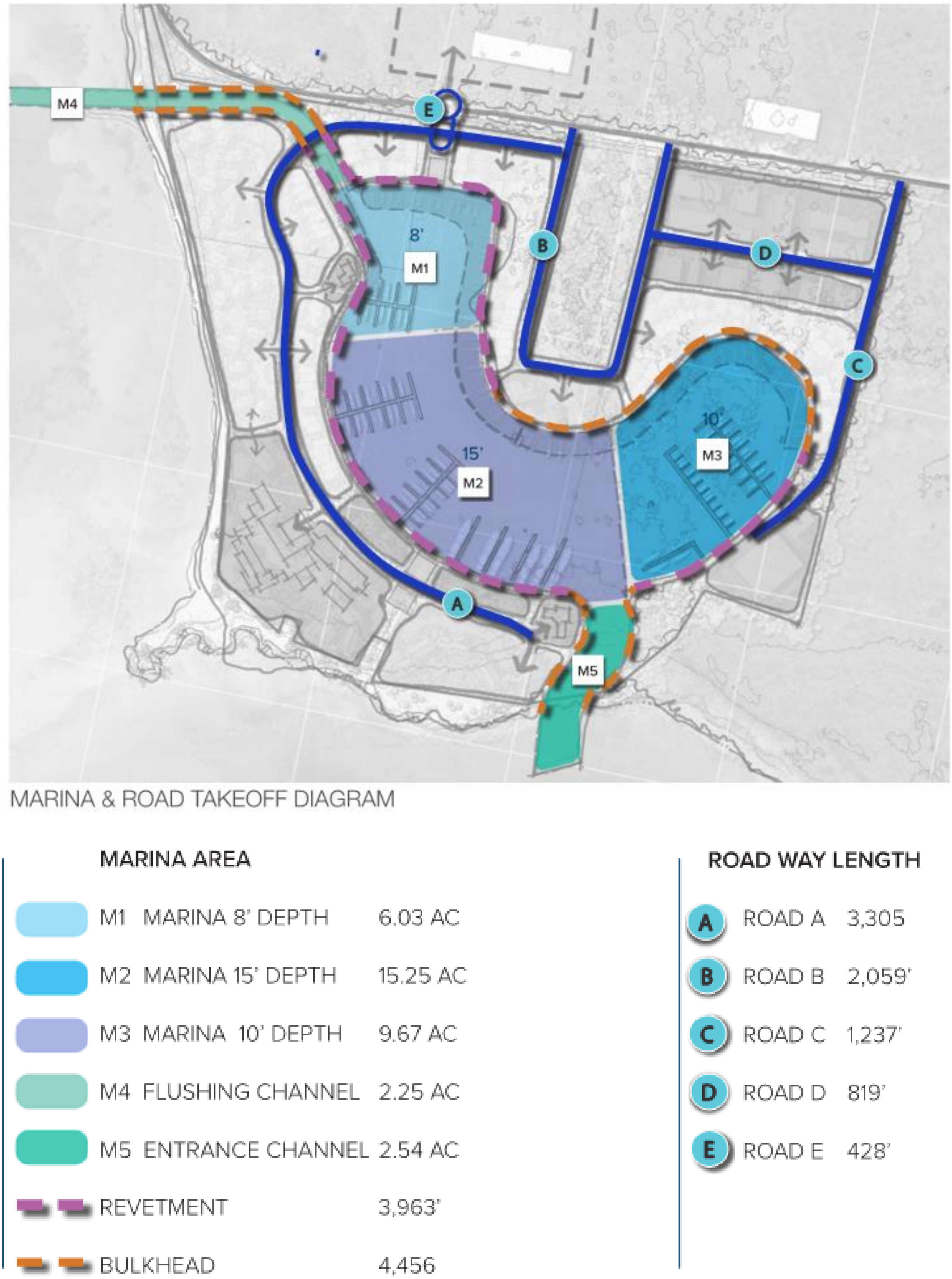


Figure 5.12.Leeward Harbour roadways design plan

5.4.6.2 High Bank Bay Road Development

Proposed road development for HBB allows visitors and staff easy access to building structures and amenities on the site. The Project proposes to develop a 10,731 Lf. exterior road, 40,975 Lf. (~7.76 miles) of interior roads, as well as pedestrian paths and cart paths. These roadways will accommodate pedestrians, golf carts and other vehicles. An additional road from HBB to CSP will be developed as an access point for the two development sites.

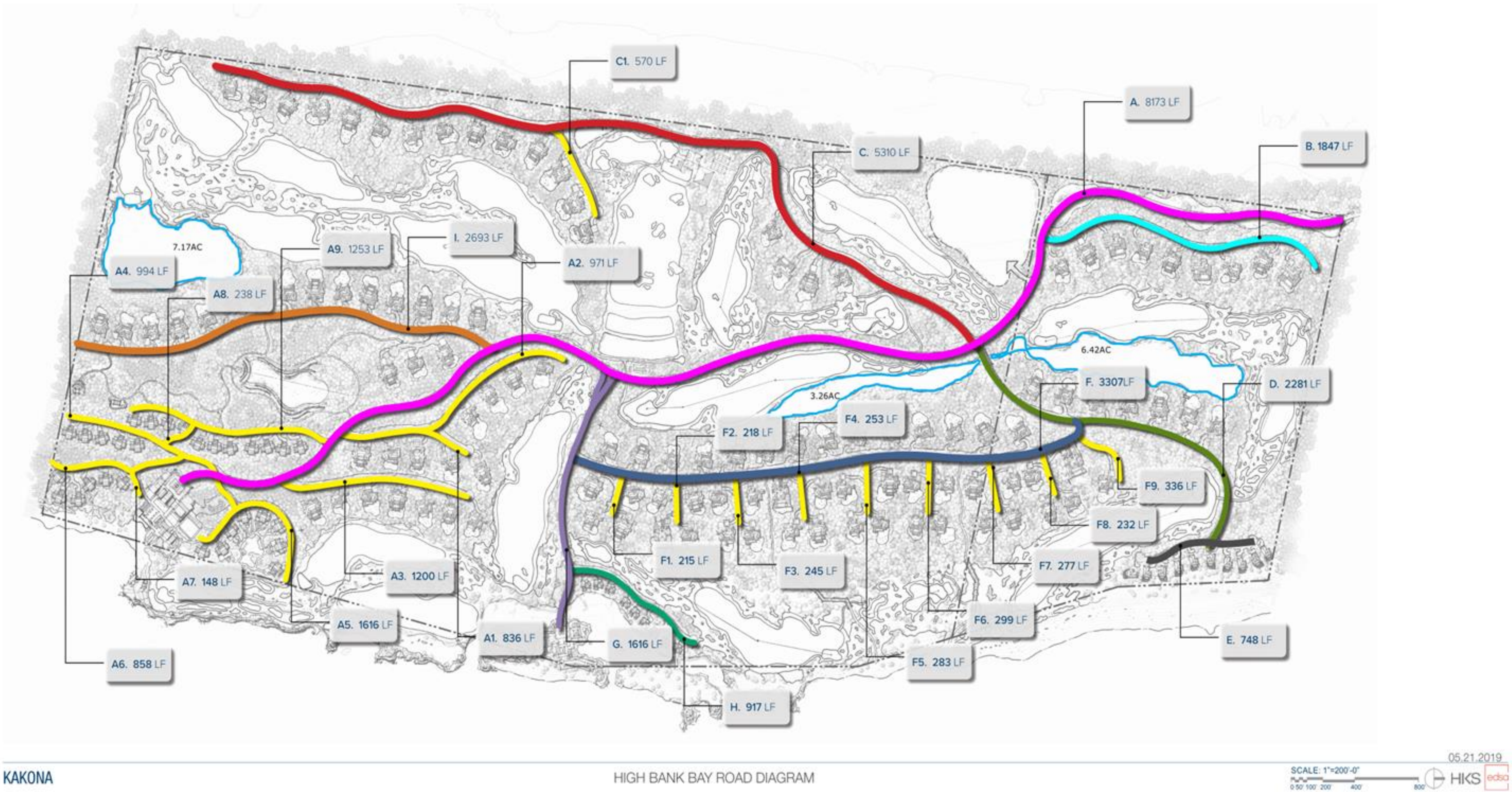


Figure 5.13. Kakona-High Bank Bay roadways design plan.

Table 5.11. Total road lengths for developments at High Bank Bay.

Road	Road Length (Linear Feet)
A	8,173
A1	836
A2	971
A3	1,200
A4	994
A5	1,616
A6	858
A7	148
A8	238
A9	1,253
B	1,847
C	5,310
C1	570
D	2,281
E	748
F	3,307
F1	215
F2	218
F3	245
F4	253
F5	283
F6	299
F7	277
F8	232
F9	336
G	1,616
H	917
I	2,693
Total Road Length	**37,934**

5.4.6.3 Conch Sound Point Road Development

Proposed road development for Conch Sound Point allows visitors and staff easy access to building structures and amenities on the site by creating sixteen (16) roadways. These roadways will accommodate pedestrians, golf carts and other vehicles. An additional road from Conch Sound Point to High Bank Bay will be developed as an access point for the two development sites.

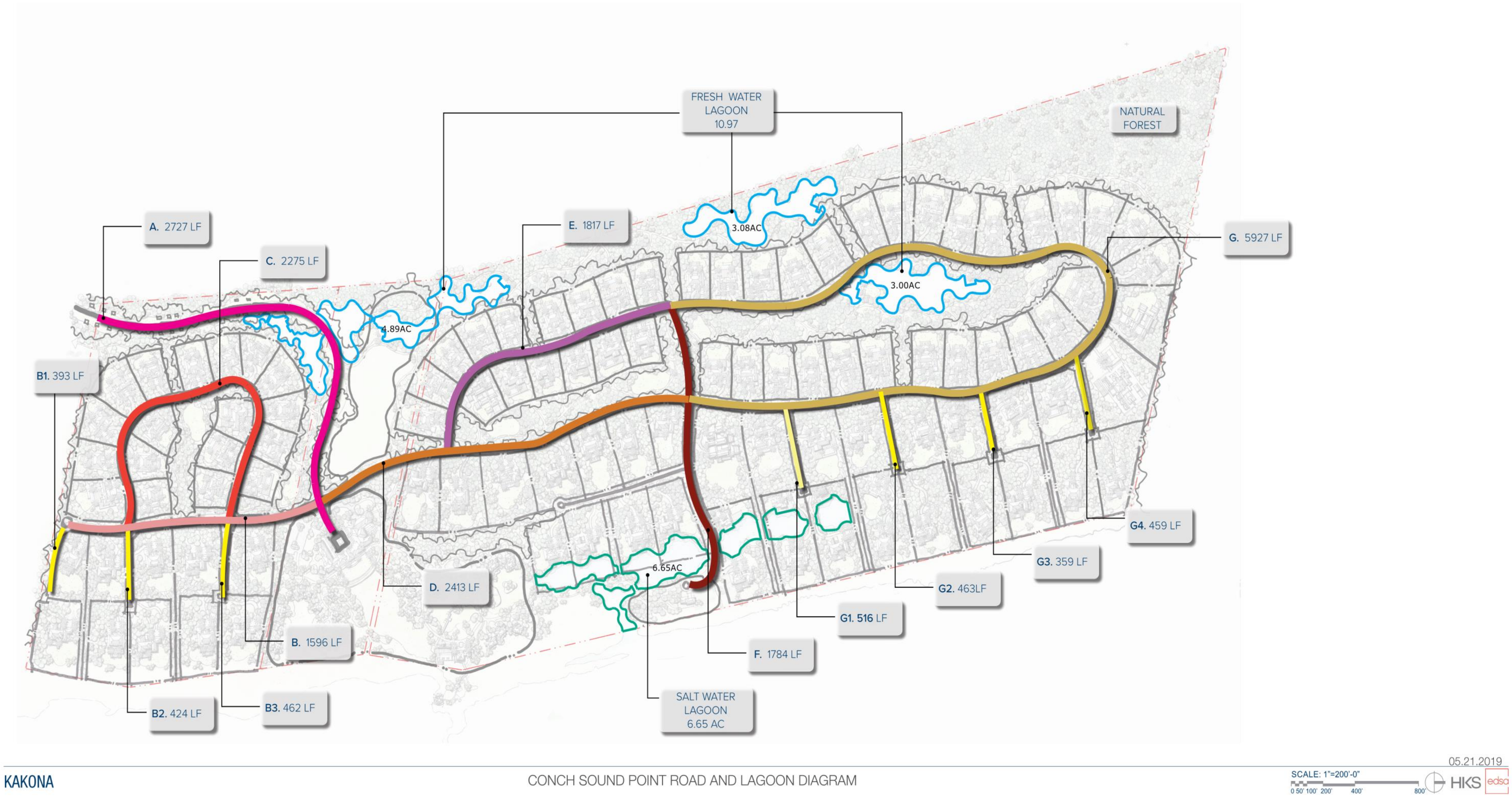


Figure 5.14. Kakona-Conch Sound Point roadways design plan.

Table 5.12. Kakona-Conch Sound Point road development and road lengths.

Road	Road Length (Feet)
A	2,727
B	1,596
B1	393
B2	424
B3	462
C	2,275
D	2413
E	1,817
F	1,784
G	5,927
G1	516
G2	463
G3	359
G4	459
Total Road Length	**21,615**

6 ALTERNATIVES

6.1 OTHER CONSIDERATIONS

The Project has undergone changes since its first approved design in 2008, primarily with a reduction of density. For example, the water features at CSP have been reduced in size and substituted for an equestrian component. The overall Project density was reduced on all three (3) properties. Thus, reducing its potential impacts.

6.2 SPECIFY "NO ACTION" ALTERNATIVE

Any development activity in South Abaco or elsewhere will not occur without an impact on the environment. Additionally, the lack of planned and approved development activities could promote and foster the further decline of economic activity in the collective South Abaco communities. The economic benefits that will occur as a result of this development such as employment during its construction and operational phases, will act to offset the economic decline and turn it into an opportunity zone benefiting all of South Abaco. Case in point, the Developer proposes to refurbish and enhance the Sandy Point airstrip to become an official Port of Entry for South Abaco. The airstrip will be upgraded with an area for staging aircraft as well as a building for a Fixed Based Operator of the airport and Bahamas Customs & Immigration. In its current state, the airstrip is restricted for air traffic and is not monitored or regulated. Leaving this point of entry exposed and a possible concern for national security. The Harbour will also serve as another means of transportation and regulated Port of Entry for South Abaco. Also, the ferry dock upgrade associated with the Development provides benefits for residents of South Abaco such as boat transportation for residents and availability for shipment of goods. Furthermore, proposed landfill management aids in proper waste disposal which reduces environmental impacts and concerns. All of the above are examples of planned opportunity, that produce good jobs for Bahamian residents.

7 Physical and Biological Baseline

7.1 Climate

The Bahamas is a tropical wet/dry savannah (Aw/As)[1] and lies within the Circum-Caribbean dry belt. The tropical dry savanna designation is characterized by average monthly temperatures above 18º C and total annual rainfall is generally lower than 60 mm. or less than. The yearly average rainfall in Abaco is approximately 88 mm. Rainfall patterns across the archipelago are dependent on island size, proximity to other islands, and relative position within the archipelago. The northernmost islands (GB, AB, NP, AN) tend to receive more rainfall and have a larger freshwater lens when compared to the southernmost islands (IN, RG, MY, SS).

The Bahamian climate is a tropical maritime wet and dry climate. Average temperatures for the Central Bahamas range from 60 to 75ºF in the winter, and from 78ºF to 90ºF and above in the summer months. The northernmost islands of Grand Bahama and Abaco tend to be colder than the remaining islands during the winter, and the southernmost islands up to 5º hotter in the summer months. Abaco's average yearly temperatures are approximately 82ºF (high) and 70ºF (low).

The climate of The Bahamas is influenced by global wind and ocean currents. Masses of warm and cold air are brought to the islands by global wind currents throughout the year. The Northeast Trade winds originate near the warm areas of the equator over Africa, and blow warm, moist air eastwards towards The Bahamas through most of the year. The Prevailing Westerlies, originating in the nearby North American continent, have more of an influence on the northern islands of the Bahamas. These winds may bring rain and storms originating in the Gulf of Mexico, but mostly bring masses of cold air to the northern islands during the winter months. Abaco's yearly average wind speed is approximately 11 kts., with southeast wind direction.

The insular nature of the Bahama Islands allows its climate to be influenced by ocean currents. The North Atlantic Gyre represents a synchrony of ocean currents involved in the global thermo-halocline cycle. The North Equatorial Current flows eastward from the coast of Africa along the equator towards South America. The encounter with the South American and the Antillean landmasses splits the current into the Gulf Stream and Antillean current, the former passing west of the Caribbean islands into the Gulf of Mexico and the latter passing along the eastern boundary of the Bahama Islands. The Gulf Stream warms considerably in the Gulf of Mexico and flows northward along the east coast of Florida as the Florida Strait towards its final destination in the colder waters off Greenland. The overall effect of these currents produces relatively warm oceans, with average sea surface temperatures for The Bahamas ranging between 74ºF in February and 83ºF in August. The yearly average water temperature in Abaco is approximately 78ºF.

[1] Beck, H. E., Zimmermann, N. E., McVicar, T. R., Vergopolan, N., Berg, A., & Wood, E. F. (2018). Present and future Köppen-Geiger climate classification maps at 1-km resolution. Scientific data, 5, 180214. doi:10.1038/sdata.2018.214

	average maximum temperature (°C)	average minimum temperature (°C)	average hours of sunshine per day	average days with precipitation per month	average mm precipitation per month	average sea temperature (°C)
January	23	15	7	7	💧💧	25
February	23	15	7	7	💧💧	24
March	25	17	8	7	💧💧	24
April	26	19	9	6	💧💧	25
May	28	21	9	10	💧💧💧💧	26
June	30	23	8	11	💧💧💧💧	28
July	31	24	9	12	💧💧💧	29
August	31	24	9	13	💧💧💧💧	29
September	30	24	7	12	💧💧💧💧	29
October	29	22	7	10	💧💧💧💧	28
November	26	19	7	7	💧💧	27
December	24	16	7	7	💧💧	26

nihil = 0-5 mm • 💧 = 6-30 mm • 💧💧 = 31-60 mm • 💧💧💧 = 61-100 mm • 💧💧💧💧 = 101-200 mm • 💧💧💧💧💧 = over 200 mm
nihil = 0-0.2 inches • 💧 = 0.2-1.2 inches • 💧💧 = 1.2-2.4 inches • 💧💧💧 = 2.5-4 inches • 💧💧💧💧 = 4.1-8 inches • 💧💧💧💧💧 = over 8 inches

Figure 7.1. Abaco average monthly temperature and rainfall data.

	chance of (very) hot weather	chance of (very) cool weather	chance of long-term precipitation	chance of hurricanes (cyclones)	chance of sunny days	UV-index
January	●●●	○	●●	○	●●●●	UV 3-6
February	●●●	○	●●	○	●●●●	UV 6-8
March	●●●●	○	●●	○	●●●●	UV 8-10
April	●●●●	○	●●	○	●●●●	UV 8-10
May	●●●●●	○	●●●	○	●●●●	UV 10+
June	●●●●●	○	●●●●	●●	●●●●	UV 10+
July	●●●●●	○	●●●	●●●●	●●●●	UV 10+
August	●●●●●	○	●●●	●●●●	●●●●	UV 10+
September	●●●●●	○	●●●●	●●●●	●●●	UV 8-10
October	●●●●	○	●●●	●●●●	●●●	UV 8-10
November	●●●●	○	●●	●●	●●●	UV 6-8
December	●●●	○	●●	○	●●●●	UV 3-6

Climate info component	symbol	explanation
chances of (very) warm weather	○	(almost) no chance of temperatures above 22 degrees Celsius (71.6°F)
	●	a chance of temperatures above 22 degrees Celsius (71.6°F)
	●●	a reasonable chance of temperatures above 22 degrees Celsius (71.6°F)
	●●●	fairly warm with a reasonable chance of a few days with temperatures above 30 degrees Celsius (82°F)
	●●●●	warm weather with a reasonable chance of temperatures above 30 degrees Celsius (82°F)
	●●●●●	very warm weather with temperatures around or above 30 degrees Celsius (82°F)
chances of wintry weather	○	(almost) no chance of subzero temperatures (during the night) and/or snowfall
	●	a small chance of subzero temperatures (during the night) and/or snowfall
	●●	a reasonable chance of subzero temperatures (during the night) and/or snowfall
	●●●	large chance of subzero temperatures during the night; a reasonable chance of wintry weather during the day
	●●●●	large chance of subzero temperatures and/or snowfall; both during the day and night
	●●●●●	mostly wintry weather with a large chance of subzero temperatures and/or snowfall
chances of long lasting precipitation	○	(almost) no chance of long lasting precipitation
	●	very small chance of long lasting precipitation
	●●	small chance of long lasting precipitation
	●●●	reasonable chance of long lasting precipitation
	●●●●	large chance of long lasting precipitation
	●●●●●	very large chance of long lasting precipitation
risk of hurricanes (cyclones)	○	risk of hurricanes is nil
	●	very small chance of hurricanes
	●●	beginning/end of hurricane season: risk of hurricanes or tropical storms
	●●●	hurricane season: chance of hurricanes or tropical storms
	●●●●	hurricane season: chance of hurricanes or tropical storms higher than normal
	●●●●●	hurricane season: area with a high risk of hurricanes or tropical storms
guaranteed sunshine	○	very small chance of sunny days
	●	relatively small chance of sunny days
	●●	chance of sunny days slightly lower than average
	●●●	sunshine reasonably guaranteed; more sunny days that days without sunshine
	●●●●	large chance of sunny days
	●●●●●	very large chance of sunny days; small chance of days without sunshine
UV-index figures	UV 0-3	maximum UV-index figure between 0 and 3 (low)
	UV 3-6	maximum UV-index figure between 3 and 6 (reasonably low)
	UV 6-8	maximum UV-index figure between 6 and 8 (reasonably high)
	UV 8-10	maximum UV-index figure between 8 and 10 (high)
	UV 10+	maximum UV-index is 10 or higher (extremely high)

Figure 7.2. Abaco average monthly UV-index and weather data.

7.2 TOPOGRAPHY

7.2.1 Leeward Harbour Topography

The topography of the areas in and around the LH site and airstrip is a gentle sloping trend from elevations of 14 ft. asl. in areas immediately east of the runway, to the lowest elevations of 2 ft. asl. in the permanently and semi-permanently flooded wetlands along the southern and western coastlines of the property. The topographic trend is exhibited in the surface flow patterns of water on the property, as water settles in low points throughout the water shed area. The large wetland east of the LH property extends into the site and represents the lowest point. Along the coastlines are dune ridges, extending up to 10 ft. asl. on the southern shoreline, and 5-8 ft. along the western shoreline. The coastal dune ridges encourage retention of surface water on the property, and overflow from the hypersaline wetland east of the LH property flows westward towards the southern and western shores of the property.

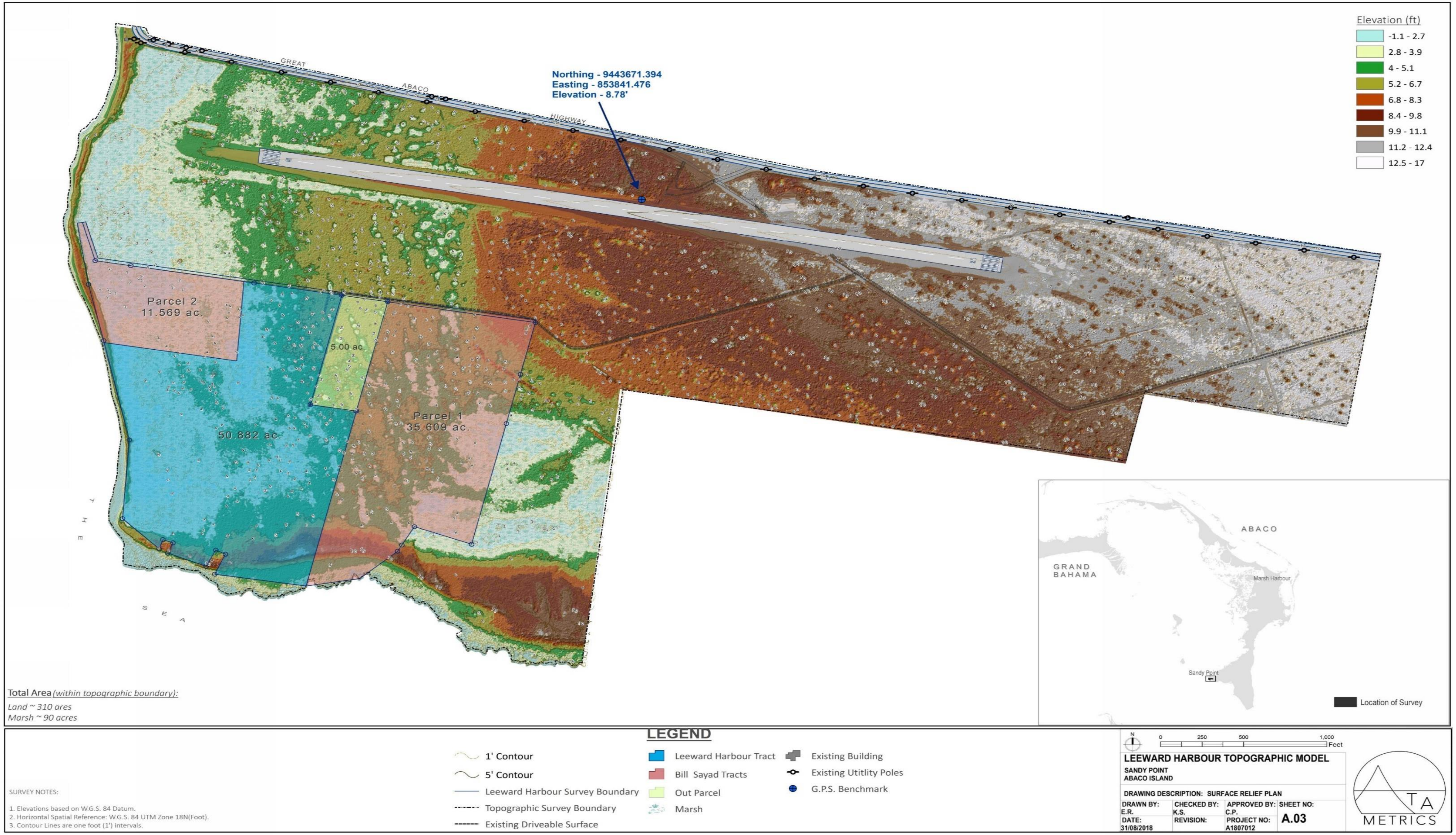


Figure 7.3. Topographic map of Leeward Harbour property, South Abaco.

7.2.2 High Bank Bay Topography

The coastal dunes along the eastern coastline of HBB have elevations of 0 ft. – 10 ft. Behind the coastal dunes, heading west, lie flat land which contains standing water and mangrove vegetation. The interior coppice at HBB contains central ridges with elevations of 10 ft. – 90 ft.; with 90 ft. marked as the highest point of elevation within the HBB parcel. This point is located along the southern boundary. These ridges quickly begin westward toward the flat Rockland which supports the pine woodland located near the ANP boundary.

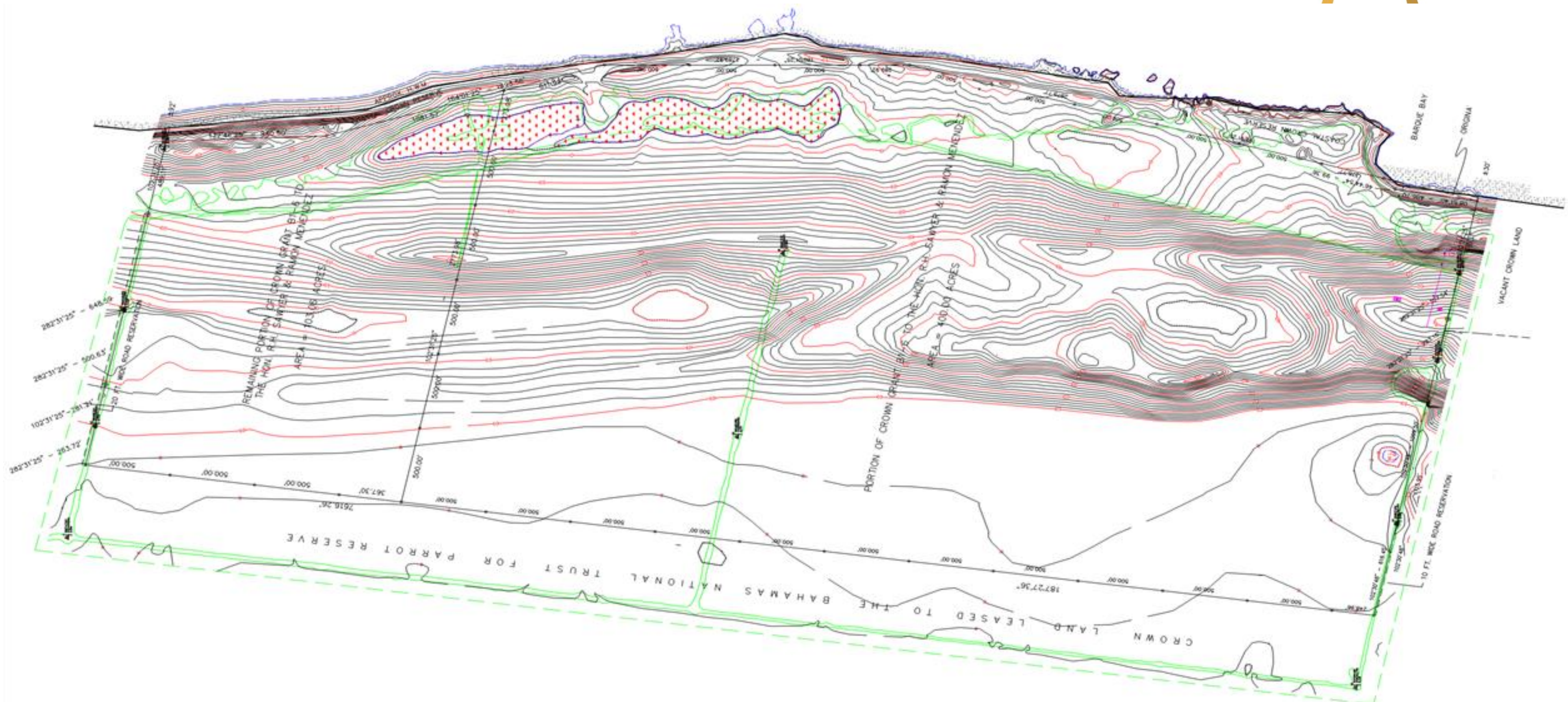


Figure 7.4. Topographic imagery of High Bank Bay- South Abaco.

7.2.3 Conch Sound Point Topography

The coastal dunes along the eastern coastline of CSP have elevations of 0 ft. – 10 ft. Behind the coastal dunes, heading west, lie flat land which contains standing water and mangrove vegetation. The interior coppice at CSP contains central ridges with elevations of 10 ft. – 34 ft.; with 32 ft. marked as the highest point of elevation within the CSP parcel. This point is located within the interior coppice within the site boundary. These ridges gradually begin to flatten westward toward the flat Rockland which supports the pine woodland located near the ANP boundary.

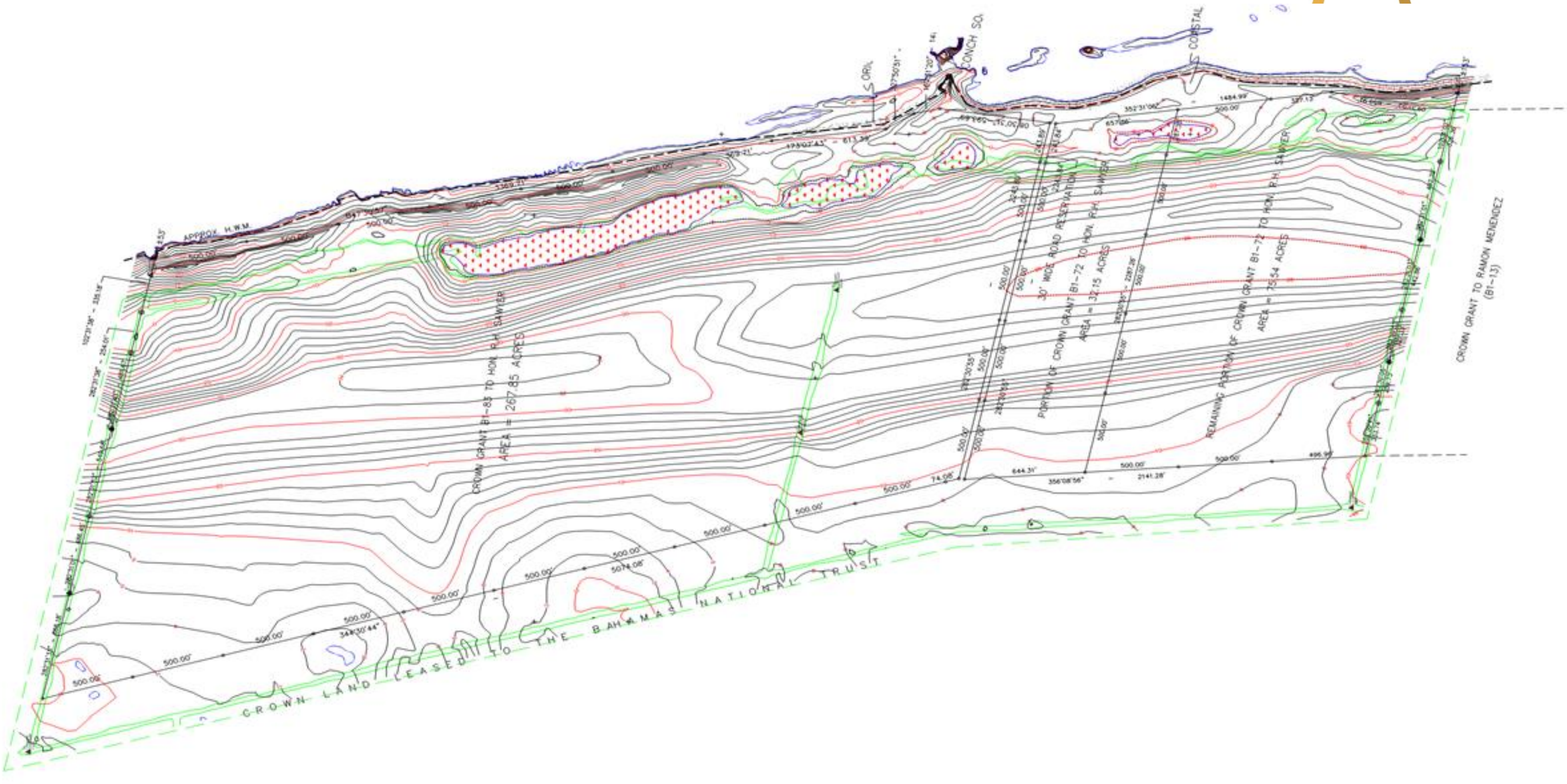


Figure 7.5. Conch Sound Point topographic imagery.

7.3 Bathymetry

7.3.1 Bathymetry Methodology

A thorough hydrographic survey was conducted encompassing the southern and western shorelines, inclusive of the proposed entrance channel to the marina basin. The survey was performed using a single beam echosounder. The horizontal positioning was recorded using a Real Time Kinematic (RTK) system, providing UTM easting and northing values in survey feet. Horizontal and vertical data were combined using Hypack software. The equipment was mounted on a small boat (15-20 ft.), allowing for the survey to be conducted in shallow and tight areas while still providing the necessary stability for accuracy. The Coastal Engineering report is available in Appendix H.

7.3.2 Bathymetry Results

The model is composed of a triangulated mesh which has varying resolutions and is enclosed by open boundaries. The mesh resolution varies between 15,200 m and 100 m in the local areas (see Figure below), and 20 m to 1 m at the three project sites.

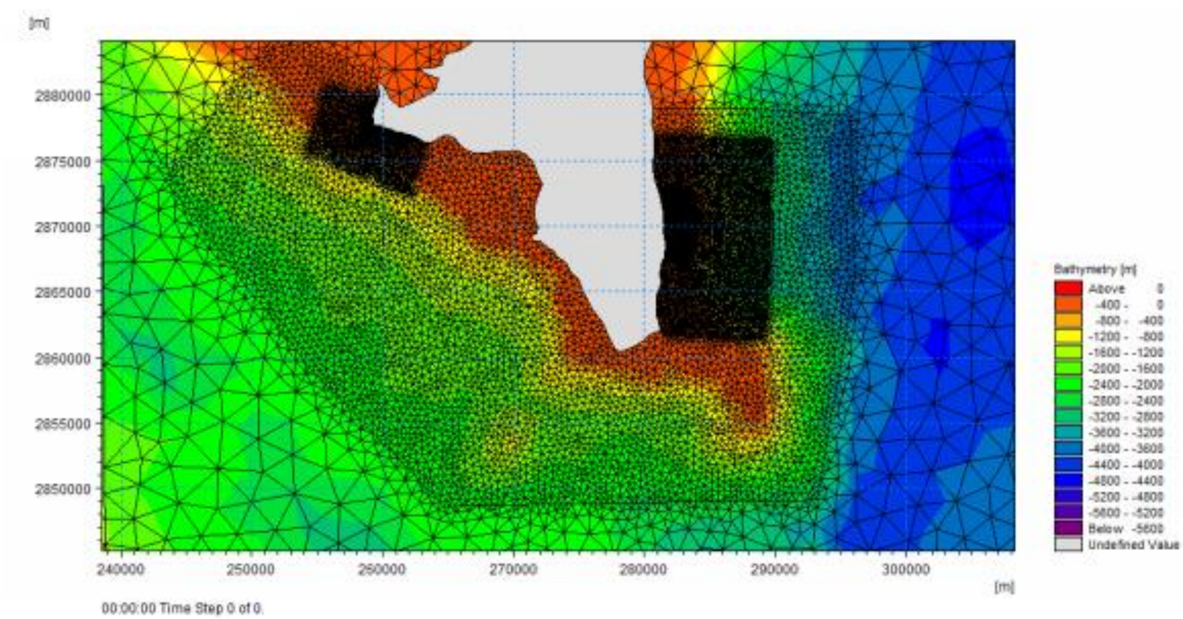


Figure 7.6. Local Area Bathymetry (m MSL).

7.3.2.1 Leeward Harbour Bathymetry Results

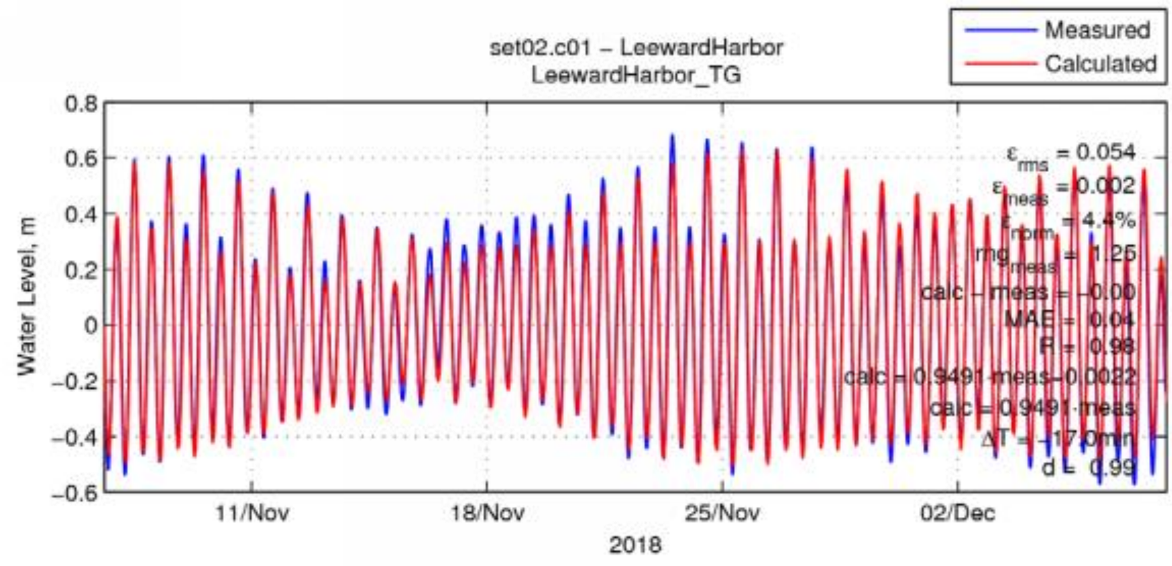


Figure 7.7. HD Model Calibration - Leeward Harbour Tide Gauge.

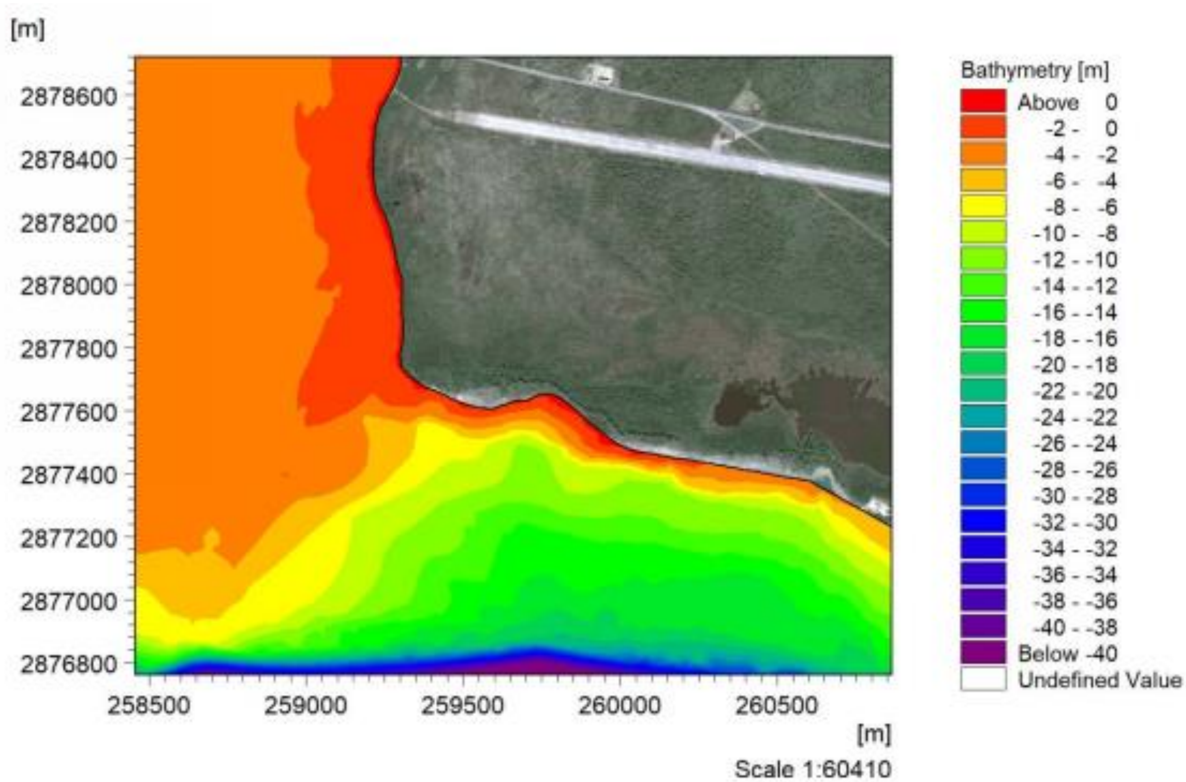


Figure 7.8. Leeward Harbour existing bathymetry (m MSL).

7.3.2.2 High Bank Bay Bathymetric Results

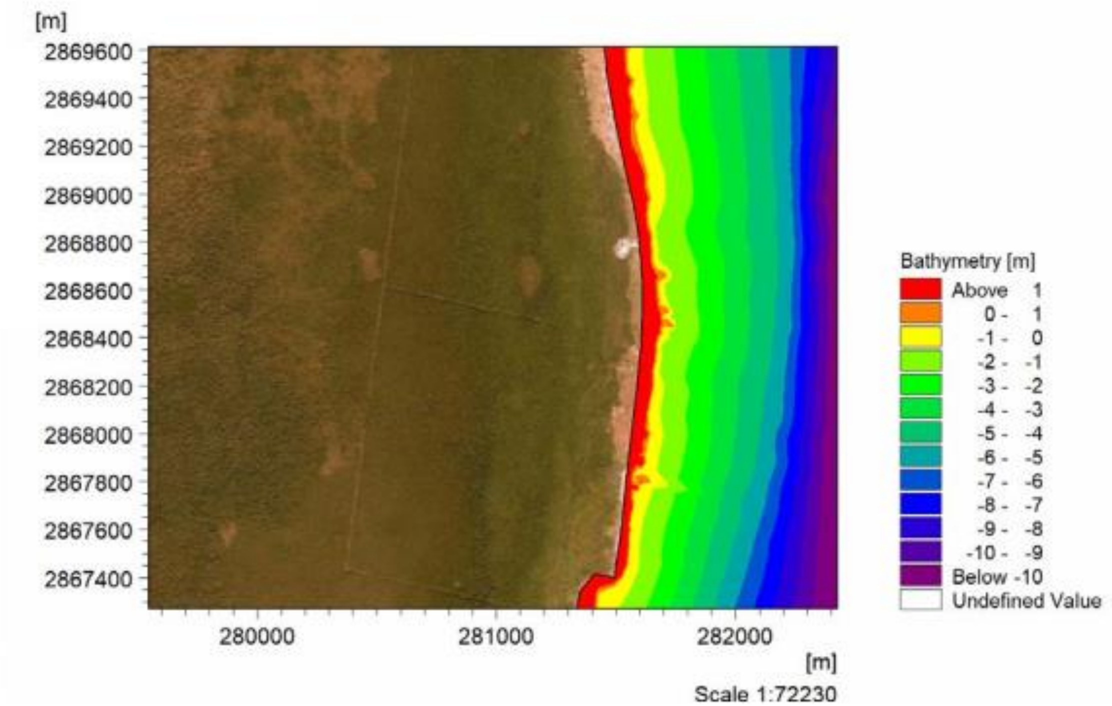


Figure 7.9. High Bank Bay existing bathymetry.

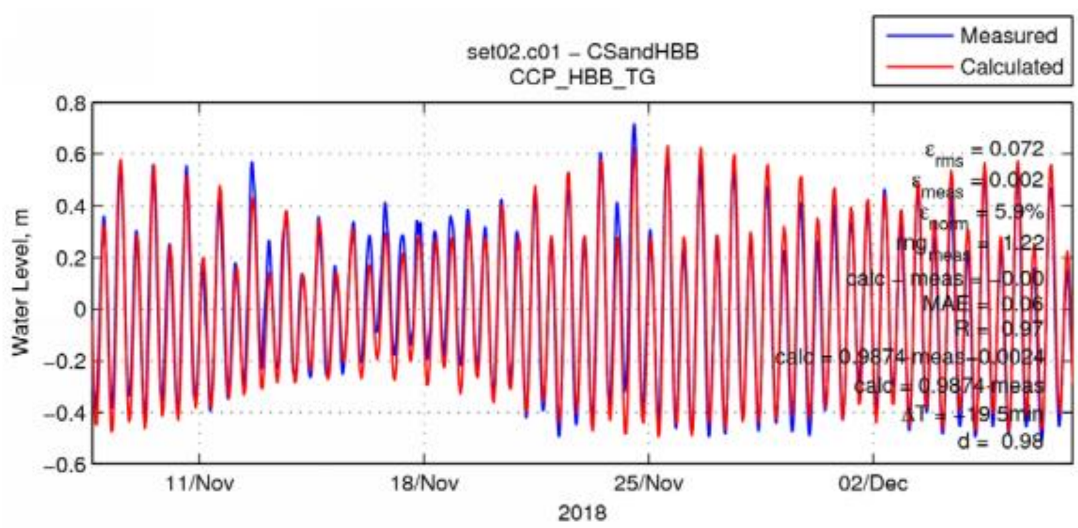


Figure 7.10. HD Model Calibration – High Bank Bay and Conch Sound Point Tide Gauge.

7.3.2.3 Conch Sound Point Bathymetric Results

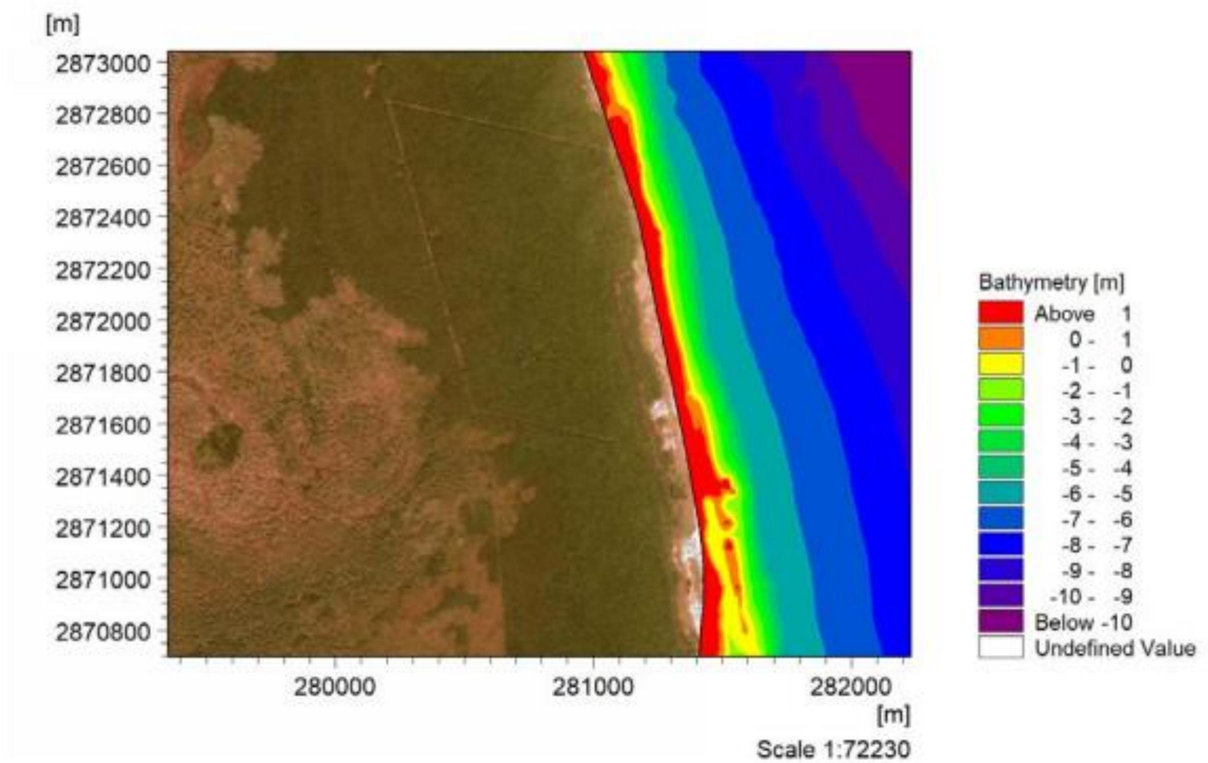


Figure 7.11. Conch Sound Point existing bathymetry.

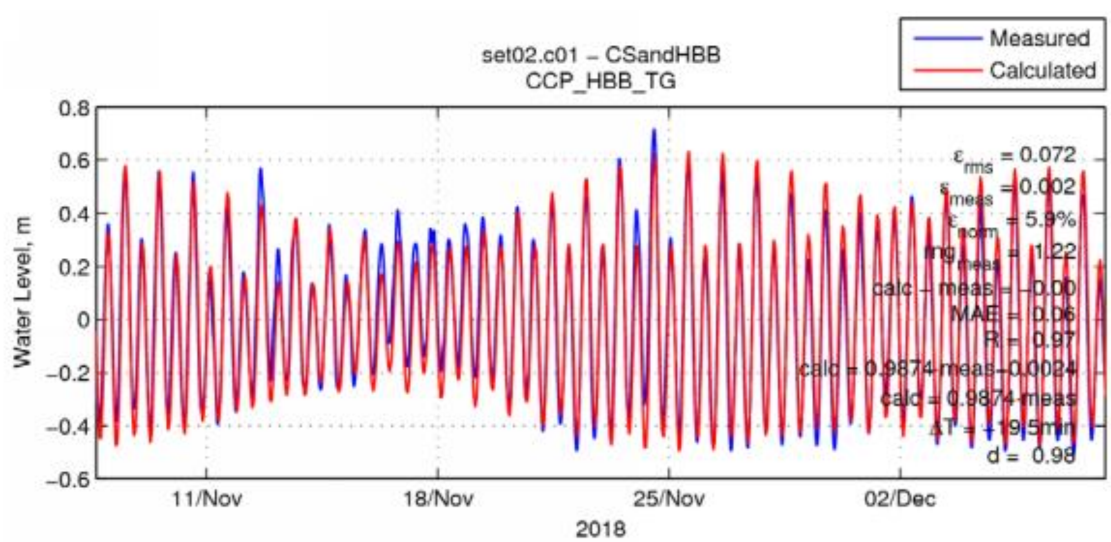


Figure 7.12. HD Model Calibration – High Bank Bay and Conch Sound Point Tide Gauge.

7.3.3 Dredge/Fill Balance

Table 7.1. Dredge and fill balance estimates for Leeward Harbour.

KAKONA - Leeward Harbour					
Harbor Mass Excavation Calculation		**Area (ac)**	**Area (sf)**	**Est. Elevation (ft)**	**Excavated Material (cy)**
S-1 Residential - Beach side Villas		4.00	174,240.00	12.00	77,440.00
S-2 Boutique Hotel		6.00	261,360.00	15.00	145,200.00
S-3 Residential - Townhomes		2.00	87,120.00	10.00	32,266.67
S-4 Harbor Retail / Residential Mix		4.00	174,240.00	10.00	64,533.33
S-5 Harbor Retail / Residential Mix		2.00	87,120.00	7.00	22,586.67
S-6 Harbor Residential Mix		2.00	87,120.00	7.00	22,586.67
S-7 Harbor side Condos		3.50	152,460.00	15.00	84,700.00
S-8 Yacht Club		1.50	65,340.00	14.00	33,880.00
S-9 BOH / Dry Stack		6.74	293,594.40	7.41	80,600.67
Harbor Footprint		17.00		Depth of Harbor 15.00 ft.	
Total Constructed Area		**48.74**	**1,382,594.40**		**~590,000 (with harbour entrance and flushing channel)**

7.4 Coastal Processes

7.4.1 Metocean Discussion

7.4.1.1 General and Offshore Metocean Conditions

The following meteorological and oceanographic conditions were collected to evaluate site specific conditions for South Abaco and to establish design parameters for the proposed Marina at LH and lagoons at CSP and HBB.

The great tidal range in South Abaco is approximately 0.9 m. (2.95 ft.) while the mean tidal range is in the order of 0.7 m. (2.3 ft.). The MHW is approximately 0.4 m. (1.31 ft.) above MSL and the

MLLW is 0.4 m. (1.31 ft.) below MSL. NOAA's 2017 Intermediate Sea Level Rise Scenario projects a future SLT of 0.57 m. (1.87 ft.) in 50 years (2070).

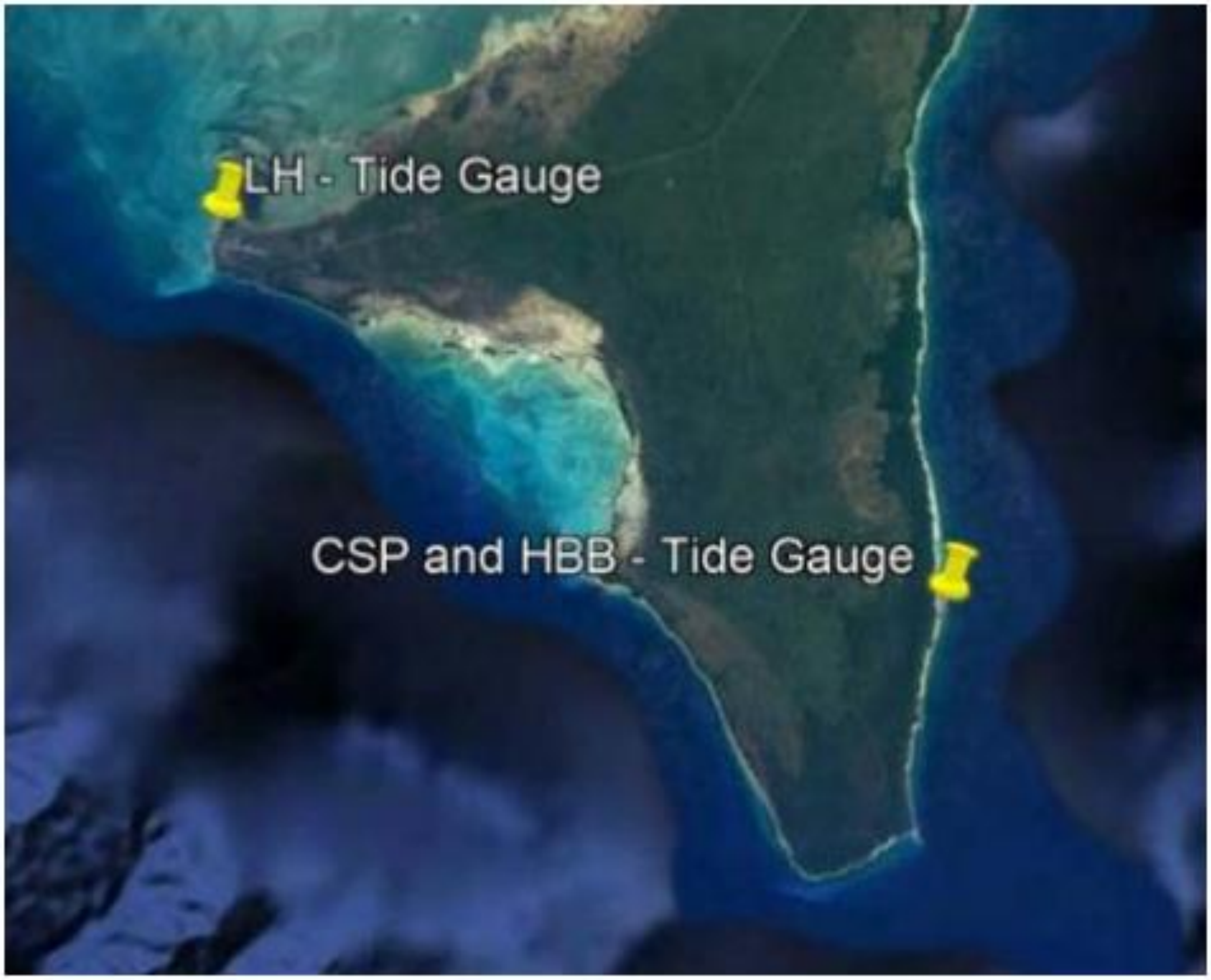
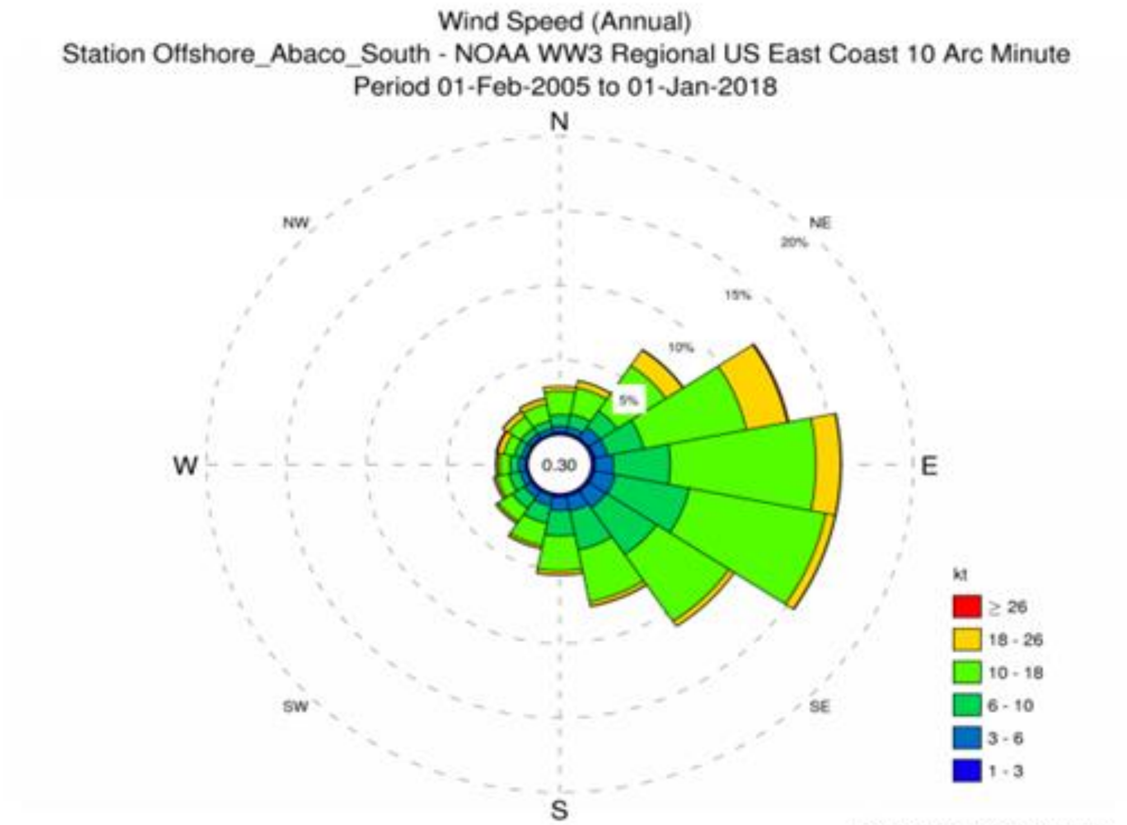


Figure 7.13.Tide gauge placements for Kakona Project, South Abaco.

Figure 7.14. Image of tide gauge at Leeward Harbour.

The prevailing offshore winds east of the Abaco island are from the east-northeast to the south-southeast directions. Stronger winds are from the east-northeast direction. The 1% annual exceedance wind is approximately 25 knots (kt.).



Direction FROM is shown
Center value indicates calms below 1 kt
Total observations 37737, calms 113
No missing observations

Percentage of Occurrence

Wind Speed, kt	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	3.25	3.73	7.26	12.53	15.52	15.52	11.07	7.73	5.44	3.78	2.80	2.20	1.99	2.05	2.30	2.52	99.70
≥ 26				0.10													0.69
18 - 26	0.32	0.46	1.26	2.59	1.54	0.59	0.39	0.30	0.28	0.20	0.17	0.18	0.19	0.41	0.41	0.36	9.63
10 - 18	1.59	1.80	3.65	6.51	9.05	8.66	5.40	3.55	2.33	1.52	1.05	0.76	0.64	0.67	0.94	1.16	49.29
6 - 10	0.77	0.89	1.29	2.31	3.54	4.69	3.77	2.66	1.70	1.18	0.89	0.70	0.53	0.46	0.47	0.51	26.34
3 - 6	0.39	0.43	0.87	0.81	1.14	1.34	1.30	1.00	0.89	0.71	0.51	0.40	0.42	0.32	0.32	0.35	11.21
1 - 3	0.17	0.13	0.14	0.21	0.20	0.20	0.19	0.19	0.21	0.14	0.16	0.11	0.15		0.14	0.10	2.54

Figure 7.15. Annual wind rose of South Abaco (2018).

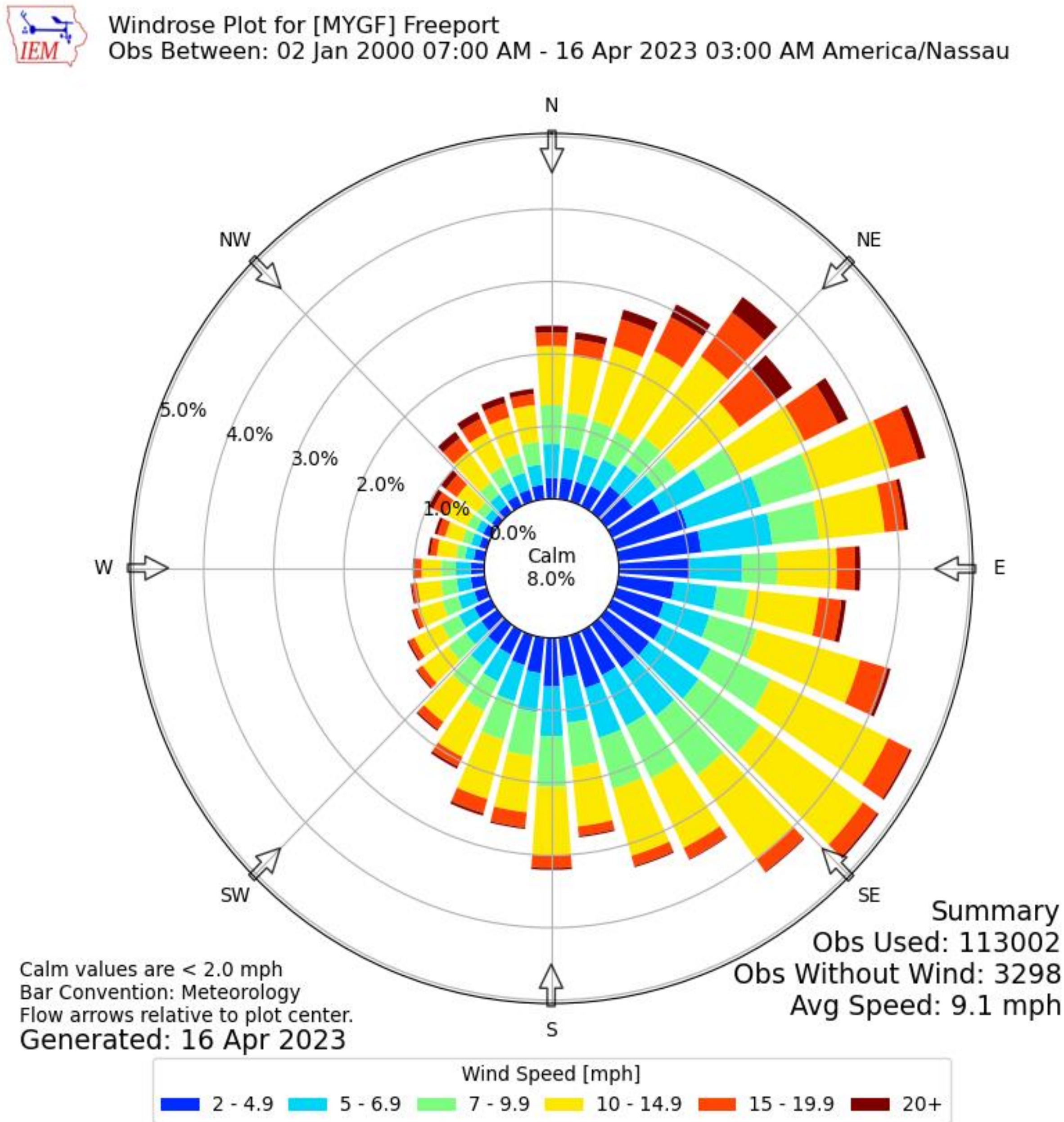


Figure 7.16.Annual wind rose of Freeport, Grand Bahama (2023). There are no recent sources for Abaco. Therefore, the nearest reliable weather station is located in Freeport and this would represent regional wind patterns.

The 1-minute duration design extreme wind speed in the vicinity of the Project varies from approximately 199 kt. to 137 kt. for the 25 to 100-year return periods. The respective extreme central pressure varies from 943 to 918 hPa.

Most of the prevailing offshore waves, east of the Abaco island, range from 1 m. to 2m. (3.28 ft. to 6.56 ft.) with a period between 7 and 9 seconds. The 1% annual exceedance offshore significant wave height is 3.9m (12.8 ft).

The design extreme offshore wave height east of the Abaco Island varies form 11.6 m. to 15.2 m. (38.0 ft to 49.9 ft.) for 25 to 100-year return periods while the corresponding peak wave periods vary from 14.6 s. to 16.8 s.

7.4.1.1.1 Leeward Harbour Metocean Conditions

The marina basin at Leeward Harbour was evaluated for nearshore prevailing winds, extreme water levels and waves, and water quality to support the design of the marina, marina entrance channel and identify preliminary flood elevations at the shoreline. The nearshore transformed prevailing waves are generally from the South-East with significant wave heights near the marine entrance of less than 0.30m (0.98ft). The annual 1% exceedance significant wave height is 1.05 m. (3.44 ft.).

The 100-year storm still water levels are between 2.02 m. (6.64 ft.) and 2.53m (8.31 ft.) above MSL. The 100-year storm maximum significant wave height is 3.21 m. (10.53 ft.) near the marina channel entrance and 1.39 m. (4.55 ft.) near the flushing channel. The combination wind and wave conditions used to develop the flood elevation as a boundary condition and refined using a coastal inundation analysis, final site grading and local building codes.

7.4.1.1.2 High Bank Bay Metocean Conditions

The lagoon at High Bank Bay was evaluated for extreme water levels and overall water quality. The nearshore transformed prevailing waves are generally from ENE and E with a significant wave height of less than 1.5 m. (4.92 ft.) and 1.10 m (3.60 ft.) for High Bank Bay, respectively. The 100-year storm maximum significant wave height at the lagoon entrance is 1.58 m. (5.19 ft.) at High Bank Bay. The 100-year flood elevations near the shoreline range from 3.23 m. (10.61 ft.) to 3.67 m. (12.03 ft.) above MSL.

7.4.1.1.3 Conch Sound Point Metocean Conditions

The lagoon at Conch Sound Point was evaluated for extreme water levels and overall water quality. The nearshore transformed prevailing waves are generally from ENE and E with a significant wave height of less than 1.5 m. (4.92 ft.) and 1.10 m (3.60 ft.) for Conch Sound Point, respectively. The 100-year storm maximum significant wave height at the lagoon entrance is 1.91 m. (6.27 ft.) at Conch Sound Point. The 100-year flood elevations near the shoreline range from 3.23 m. (10.61 ft.) to 3.67 m. (12.03 ft.) above MSL.

7.4.1.2 Leeward Harbour Flushing Analysis

Flushing and water exchange analyses were performed to evaluate marina spill response conditions and overall marina water quality, respectively.

- The flushing analysis was simulated using a 1,200-gallon fuel tank spill inside the basin. The results of the flushing analysis indicate the harbor meets the guidelines provided by the Department of Environmental Planning and Protection (DEPP) formally known as BEST Commissions (concentration reduction to 10% of the original spill in 24 hours).

- The water exchange analysis for the marina was simulated with a non-dimensional concentration of 100 over the entire basin. The results of the overall water exchange analysis showed that 90% of the water in the basin exchange within 5 to 6 days which is consistent with industry guidelines for marinas.

The BW model results for the Base Case show that 1% of the year, the significant wave height inside the basin exceeds 0.32 m. (approx. 1 ft.). The addition of a jetty on the east side of the entrance channel significantly reduces this wave height for the 4, 6 and 8 second waves coming from SE and SSE which are the predominant directions.

The agitation study indicated that an entrance structure (i.e. jetty) was required to reduce heights inside the basin during extreme conditions. The results show that the highest mean wave attenuation factor value for the 12 second extreme waves is of 18% resulting in an average significant wave height of 0.84 m. (2.76 ft.) inside the marina and a maximum significant wave height of 1.4 m. (4.59 ft.). This maximum value is observed near the entrance channel while the rest of the basin experience values closer to the average.

The final configuration of marina basin at Leeward Harbor includes a 49 m. (160 ft.) wide marina entrance channel with a 60 m. (200ft.) jetty along the east side of the entrance channel for wave protection. A flushing channel is provided at the northwest corner of the site to improve water quality in the basin. The final alignment and configuration of the jetty will be evaluated during the final phase of the project to further reduce wave agitation in the basin.

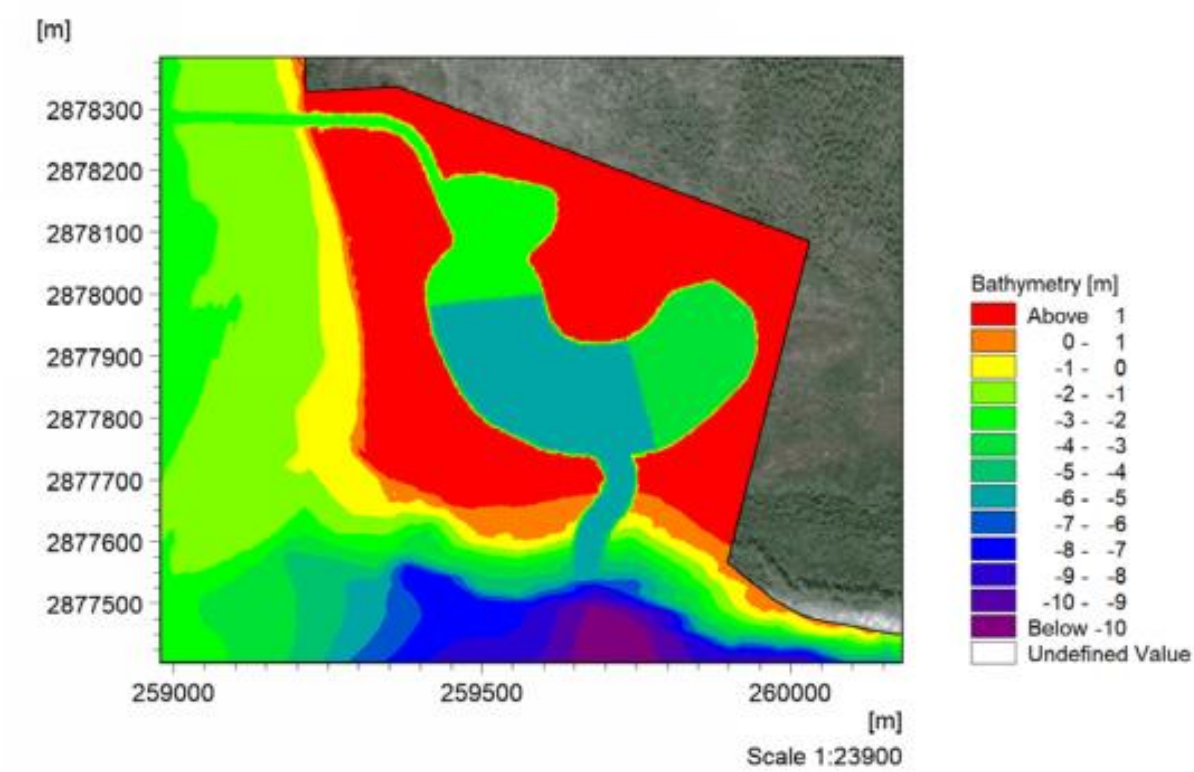


Figure 7.17. Marina at Leeward Harbour bathymetry (m MSL).

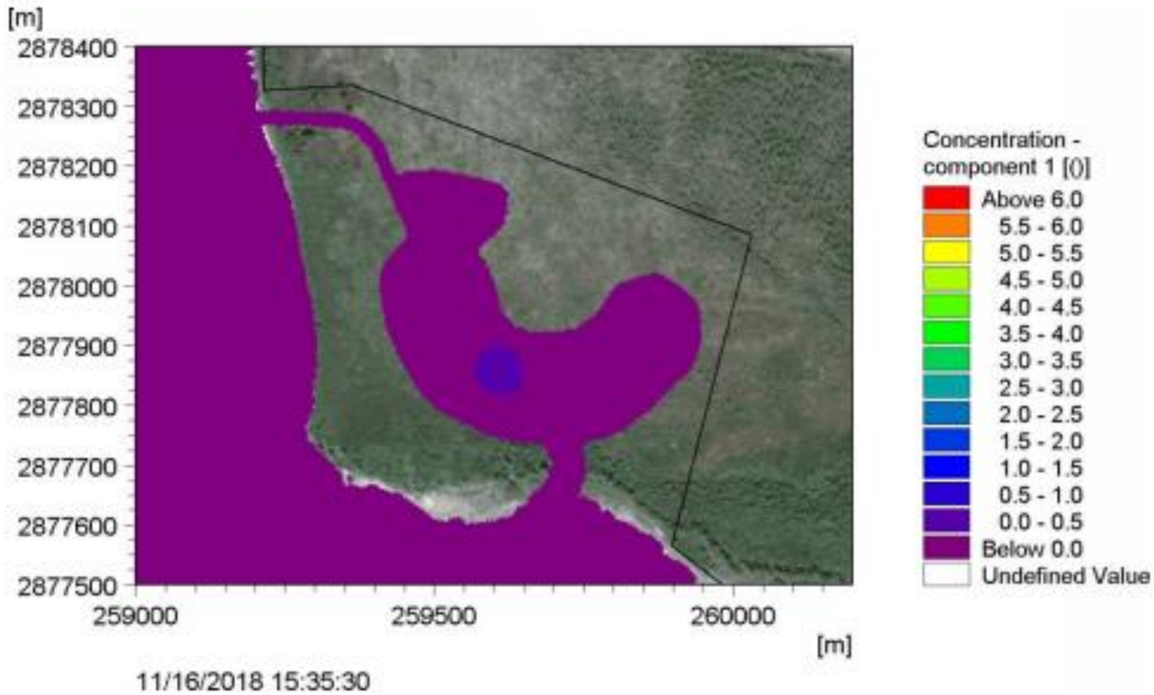


Figure 7.18. Depth average concentration at the end of spill.

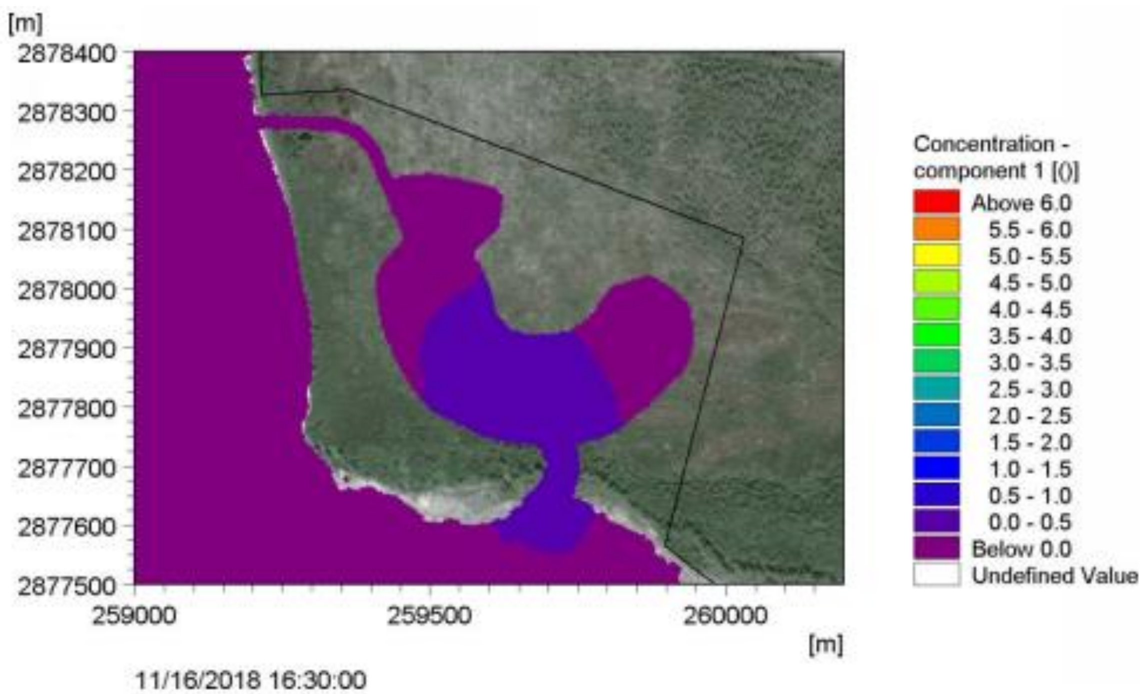


Figure 7.19. Depth average concentration 1 hour after the spill.

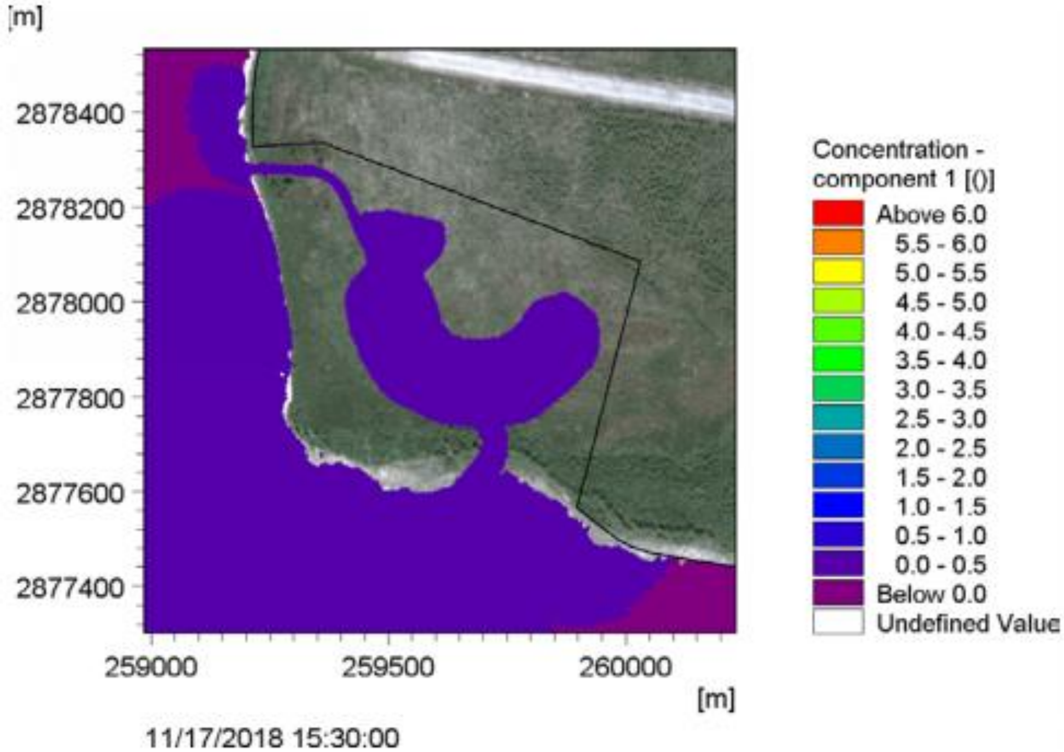


Figure 7.20. Depth average concentration 24 hours after spill.

Leeward Harbour - Storm Surge, Extreme Waves and Flood Elevations

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. The maximum potential storm surge for a particular location depends on a number of different factors. In the northern hemisphere, the surge will be largest in the right-forward part of the storm, while the left-forward part may experience significantly depressed water levels. The worst surge is typically generated from storms located within 80 km of landfall. Based on historical hurricane tracks at the project site, a wider zone of influence of 120 km (65 nautical miles) was selected. Breaking waves also cause water to pile up on the shoreline in a phenomenon known as wave setup. In addition, the crests of waves can be several feet above the still-water elevation.

The initial HD (flushing analysis) and SW (nearshore wave transformation) models considered either a normal tide variation around MSL (former) or a constant water level at MSL (latter). During storm conditions, the water level rises due to pressure setup, wind setup, and wave setup, and since timing of a hurricane is unpredictable, a normal high tide should be considered.

Given that both 25- and 50- year return periods extreme winds correspond to a category 4 hurricane, only the 50 and 100-year return periods were evaluated for the storm surge and extreme waves analysis, which correspond to a category 4 and a category 5 storm respectively.

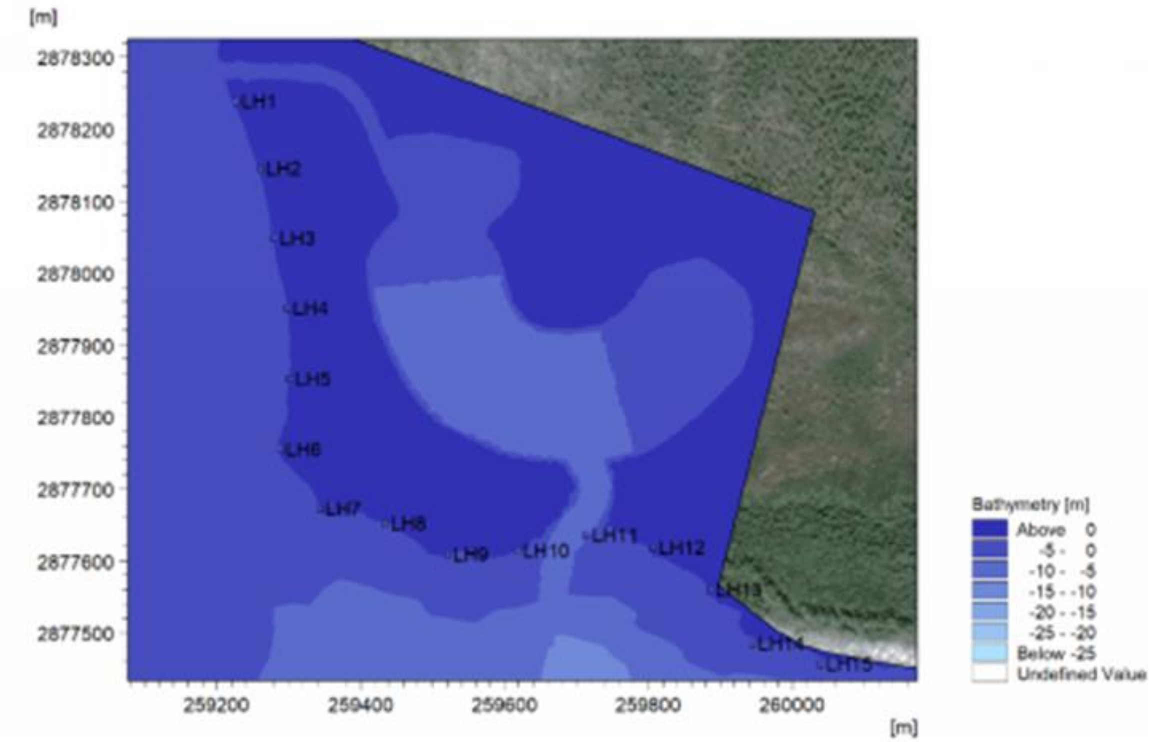


Figure 7.21. Leeward Harbour HD and SW Output Points.

Table 7.2. 50-year Extreme Results- Leeward Harbor.

50-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
LH1	1.24	0.82	1.21	2.86	9.39
LH2	1.24	0.84	1.12	2.86	9.37
LH3	1.24	0.83	1.12	2.79	9.17
LH4	1.24	0.83	1.13	2.76	9.04
LH5	1.24	0.83	1.04	2.66	8.72
LH6	1.24	0.78	0.94	2.68	8.78
LH7	1.24	0.93	1.45	3.18	10.43
LH8	1.24	0.93	2.07	3.63	11.89
LH9	1.24	1.03	1.95	3.63	11.92
LH10	1.24	1.18	1.83	3.70	12.14
LH11	1.24	1.29	3.00	4.62	15.15
LH12	1.24	1.21	1.74	3.67	12.03
LH13	1.24	0.95	1.79	3.44	11.30
LH14	1.24	1.06	2.36	3.95	12.97
LH15	1.24	0.98	3.23	4.48	14.69

Table 7.3. 100-year Extreme Results- Leeward Harbor.

100-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
LH1	1.35	0.91	1.39	3.14	10.30
LH2	1.35	0.93	1.28	3.11	10.22
LH3	1.35	0.94	1.33	3.07	10.06
LH4	1.35	0.95	1.36	3.03	9.94
LH5	1.35	0.85	1.22	2.93	9.61
LH6	1.35	0.89	1.16	2.96	9.73
LH7	1.35	0.82	1.57	3.39	11.11
LH8	1.35	0.82	2.20	3.89	12.76
LH9	1.35	0.87	2.11	3.90	12.79
LH10	1.35	0.96	2.01	4.00	13.12
LH11	1.35	1.07	3.21	4.93	16.18
LH12	1.35	1.06	1.88	3.92	12.88
LH13	1.35	1.03	1.90	3.63	11.92
LH14	1.35	0.91	2.61	4.29	14.06
LH15	1.35	1.13	3.41	4.77	15.66

7.4.1.3 High Bank Bay Flushing Analysis

The flushing for the initially proposed layout of the lagoon (Figure below), where no motorized watercrafts will be present, was evaluated and modifications were recommended in order to improve circulation and eliminate stagnant areas.

The total area of the lagoon was reduced by eliminating “dead spots” and streamlining the land/water boundaries. Additionally, several locations and widths of channels were evaluated. The southern portion of the lagoon at High Bank Bay was eliminated and the three initial proposed channels were enough to provide adequate water exchange.

The final configuration for the lagoon, which is -1.2 m. MLLW, -1.6 m. MSL (4 ft. MLLW, 5.4 ft. MSL) deep, are presented in the Figure below. It also includes three open channels to provide sufficient water circulation through the lagoon.

The water exchange analysis for the lagoon was simulated with a non-dimensional concentration of 100 over the entire water body. The results of the water exchange analysis show that 50% of the water in the lagoons is exchanged in 4 days, and 90% of the water of the lagoon is exchanged in approximately 6 days. This meets the recommended criteria for artificial beaches of swimming lagoons (50% of water exchanged in less than 5-7 days).

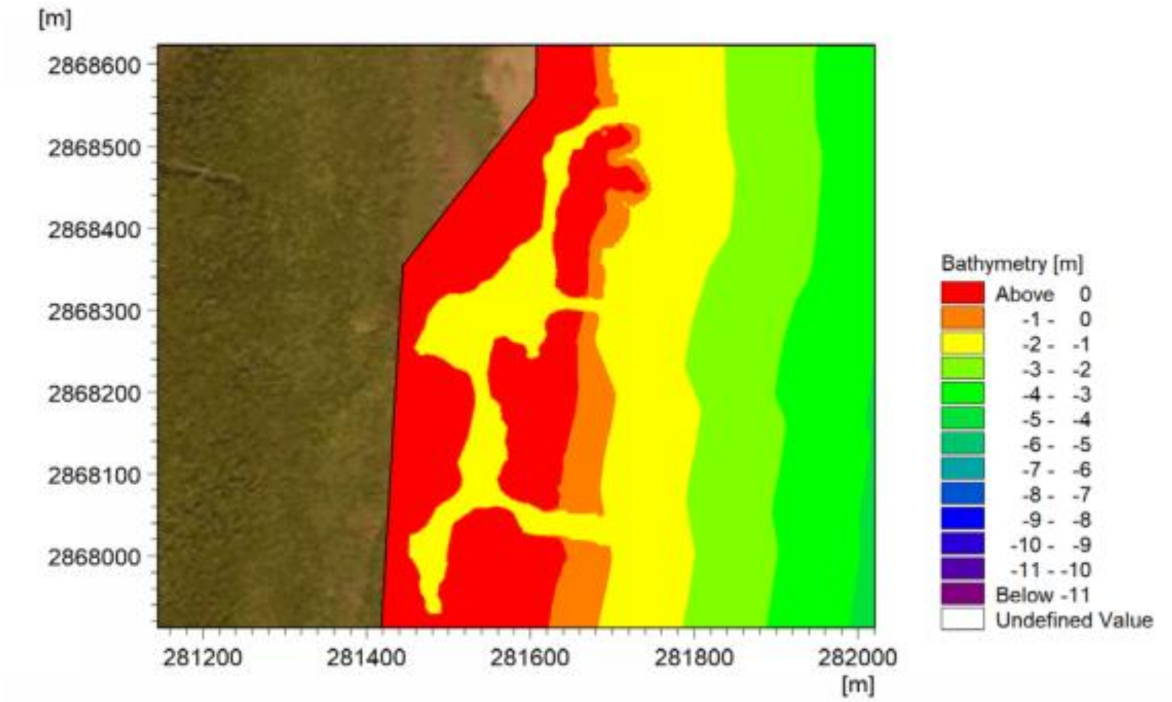


Figure 7.22. Initial Layout for the High Bank Bay lagoon- Bathymetry (m MSL).

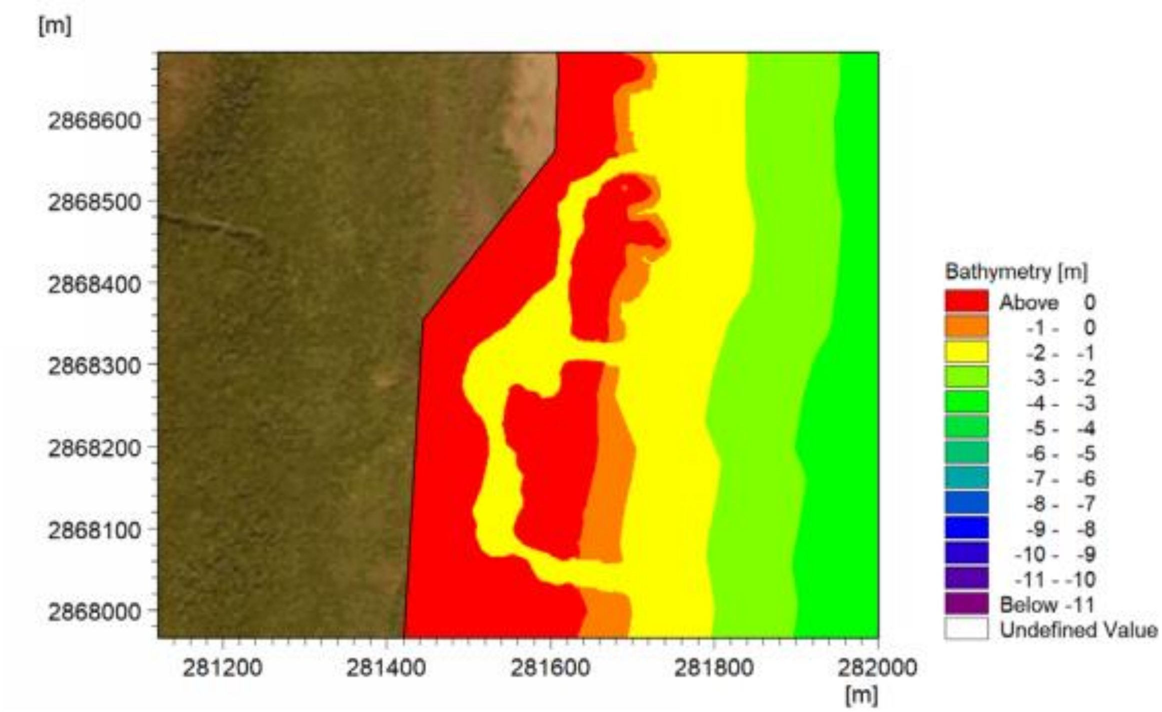


Figure 7.23. Final High Bank Bay lagoon configuration – Bathymetry (m MSL).

The HD/TR coupled model was run with tidal boundaries for the lagoon at High Bank Bay, starting during a neap tide period, with a constant wind of 2 knots from the East. This wind speed is exceeded more than 99% of the time. The decay of substances was not considered in the model in order to simulate only the advection and dispersion process, as the pollutant is assumed to be conservative. The model was run for a period of 11 days.

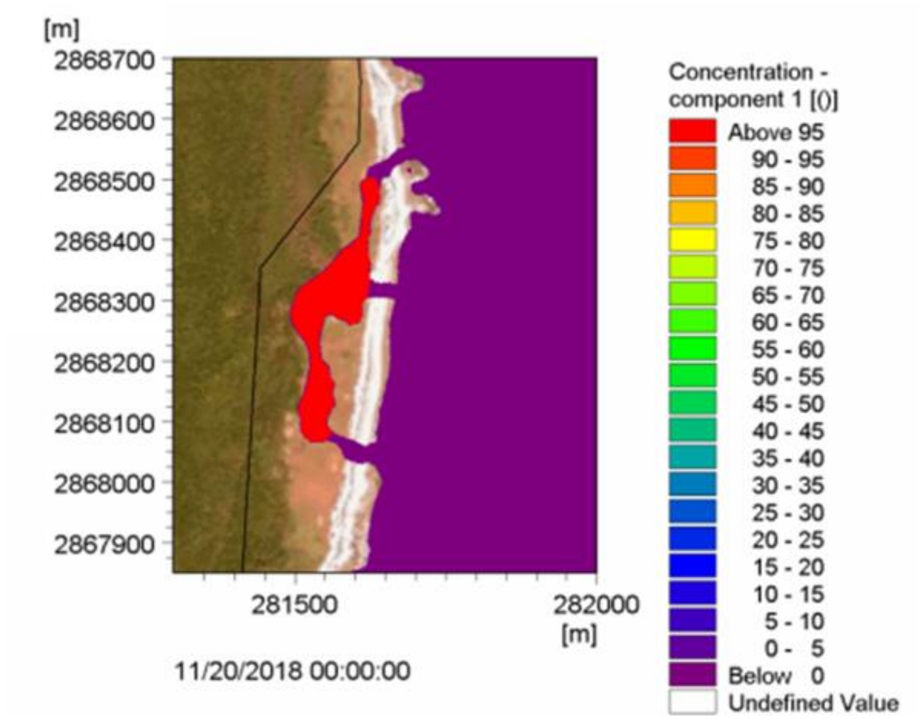


Figure 7.24. Initial condition at High Bank Bay.

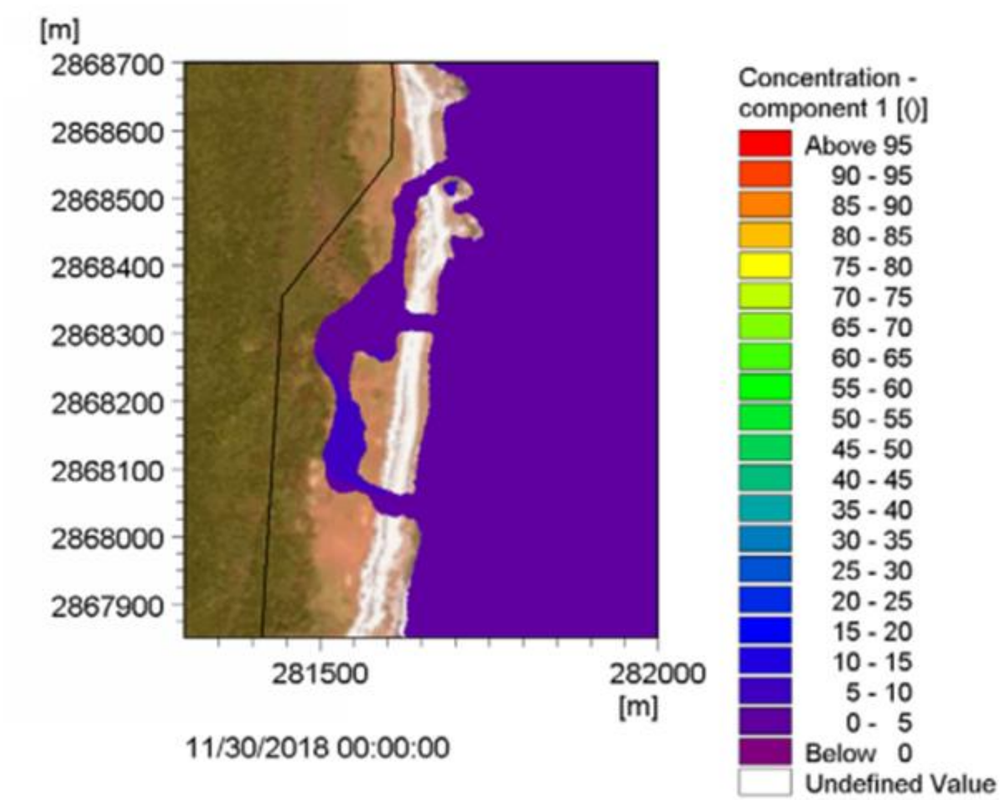


Figure 7.25. High Bank Bay concentrations after 10 days.

High Bank Bay - Storm Surge, Extreme Waves and Flood Elevations

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. The maximum potential storm surge for a particular location depends on a number of different factors. In the northern hemisphere, the surge will be largest in the right-forward part of the storm, while the left-forward part may experience significantly depressed water levels. The worst surf is typically generated from storms located within 80 km. of landfall. Based on historical hurricane tracks at the Project site , a wider zone of influence of 120 km. (65 nautical miles) was selected. Breaking waves also cause water to pile up on the shoreline in a phenomenon known as wave setup. In addition, the crests of waves can be several feet above the still-water elevation.

The initial HD (flushing analysis) and SW (nearshore wave transformation) models considered either a normal tide variation around MSL (former) or a constant water level at MSL (latter). During storm conditions, the water level rises due to pressure setup, wind set up, and wave setup and since timing of a hurricane is unpredictable, a normal high tide should also be considered.

Given that both 25- and 50-year return periods extreme winds correspond to a category 4 hurricane, only the 50 and 100-year return periods were evaluated for the storm surge and extreme waves analysis, which correspond to a category 4 and a category 5 storm respectively.

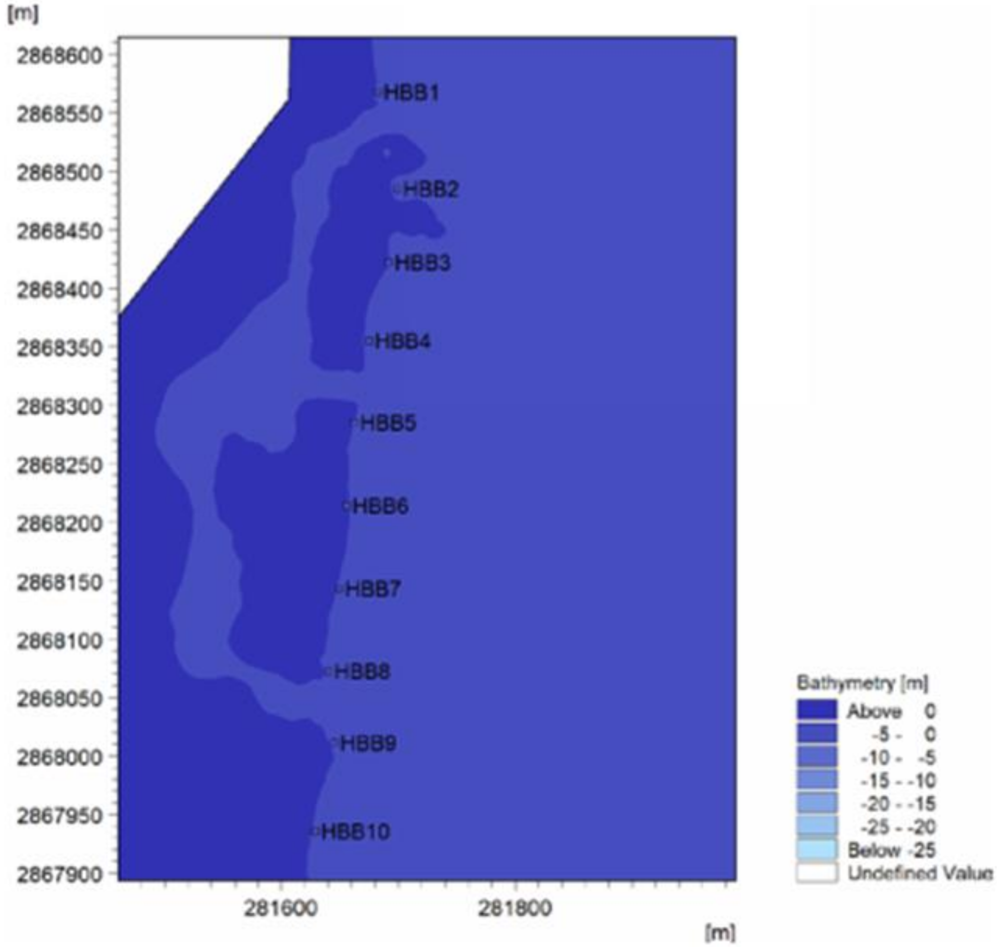


Figure 7.26. High Bank Bay HD and SW Output Points.

Table 7.4. 50-year Extreme Results – High Bank Bay.

50-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
HBB1	1.24	0.97	1.34	3.12	10.22
HBB2	1.24	0.98	1.13	3.01	9.87
HBB3	1.24	0.96	1.37	3.12	10.24
HBB4	1.24	0.96	1.48	3.24	10.64
HBB5	1.24	0.96	1.50	3.21	10.54
HBB6	1.24	0.97	1.34	3.14	10.32
HBB7	1.24	0.97	1.28	3.10	10.18
HBB8	1.24	0.96	1.44	3.20	10.49
HBB9	1.24	0.94	1.35	3.12	10.24
HBB10	1.24	0.97	1.23	3.07	10.07

Table 7.5. 100-year Extreme Results – High Bank Bay.

100-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
HBB1	1.35	1.00	1.43	3.34	10.97
HBB2	1.35	1.01	1.21	3.23	10.61
HBB3	1.35	1.01	1.46	3.35	11.00
HBB4	1.35	1.01	1.58	3.47	11.39
HBB5	1.35	1.01	1.58	3.44	11.29
HBB6	1.35	1.01	1.43	3.37	11.06
HBB7	1.35	1.02	1.37	3.33	10.93
HBB8	1.35	1.01	1.53	3.43	11.26
HBB9	1.35	1.01	1.46	3.36	11.02
HBB10	1.35	0.96	1.32	3.30	10.81

7.4.1.4 Conch Sound Point Flushing Analysis

The total area of the lagoon was reduced by eliminating “dead spots” and streamlining the land/water boundaries. Additionally, several locations and widths of channels were evaluated. At Conch Sound Point, the lagoon was concentrated north of the main channel and an approximately 18.3 m. (60 ft.) wide additional flushing channel was required.

The final configuration for the lagoon, which are -1.2 m. MLLW, -1.6 m MSL (4 ft. MLLW, 5.4 ft. MSL) deep, are presented in the Figure below . It also includes an open channel to the south and a culvert to the north to provide sufficient water circulation through the lagoon.

The water exchange analysis for the lagoon was simulated with a non-dimensional concentration of 100 over the entire water body. The results of the water exchange analysis show that 50% of the water in the lagoons is exchanged in 4 days, and 90% of the water of the lagoon is exchanged in approximately 6 days. This meets the recommended criteria for artificial beaches of swimming lagoons (50% of water exchanged in less than 5-7 days).

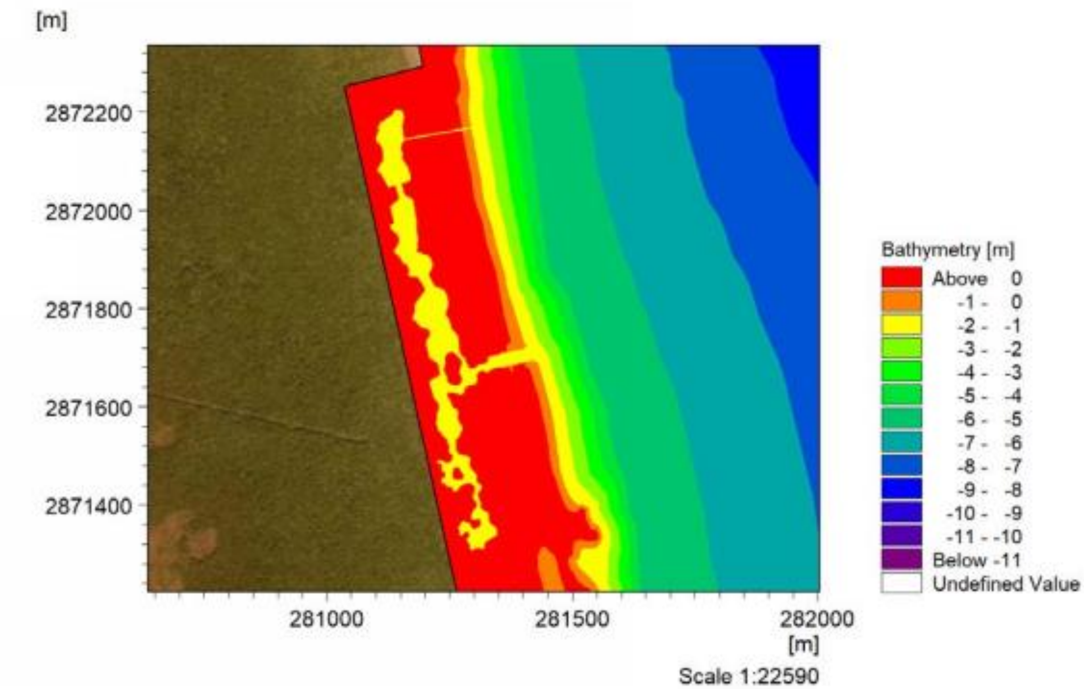


Figure 7.27. Initial Layout for the Conch Sound Point lagoon- Bathymetry (m MSL).

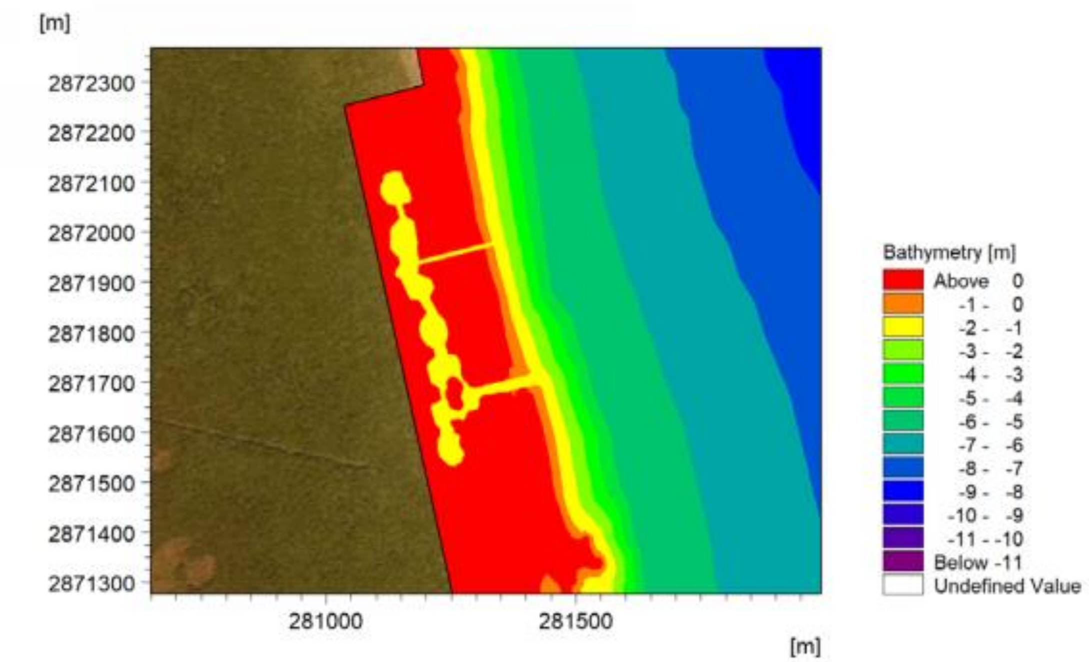


Figure 7.28. Final lagoon configuration- Bathymetry (m MSL).

The HD/TR coupled model was run with tidal boundaries for the lagoon at Conch Sound Point, starting during a neap tide period, with a constatnt wind of 2 knots from the East. This wind speed is exceeded more than 99% of the time. The decay of substances was not considered in the model in order to simulate only the advection and dispersion process, as the pollutant is assumed to be conservative. The model was run for a period of 11 days.

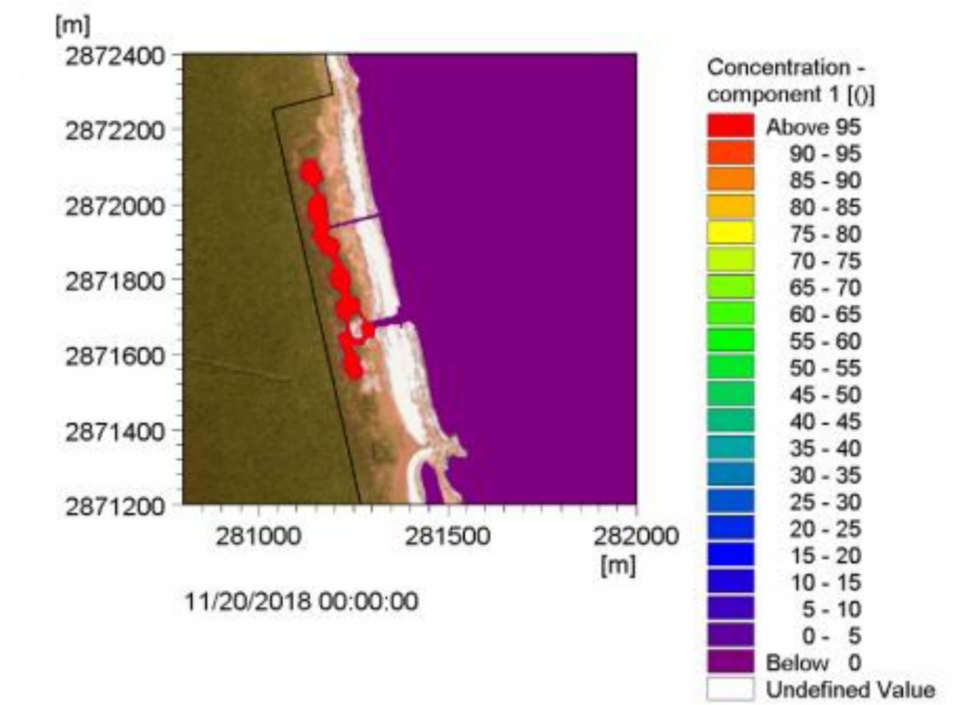


Figure 7.29. Initial condition at Conch Sound Point.

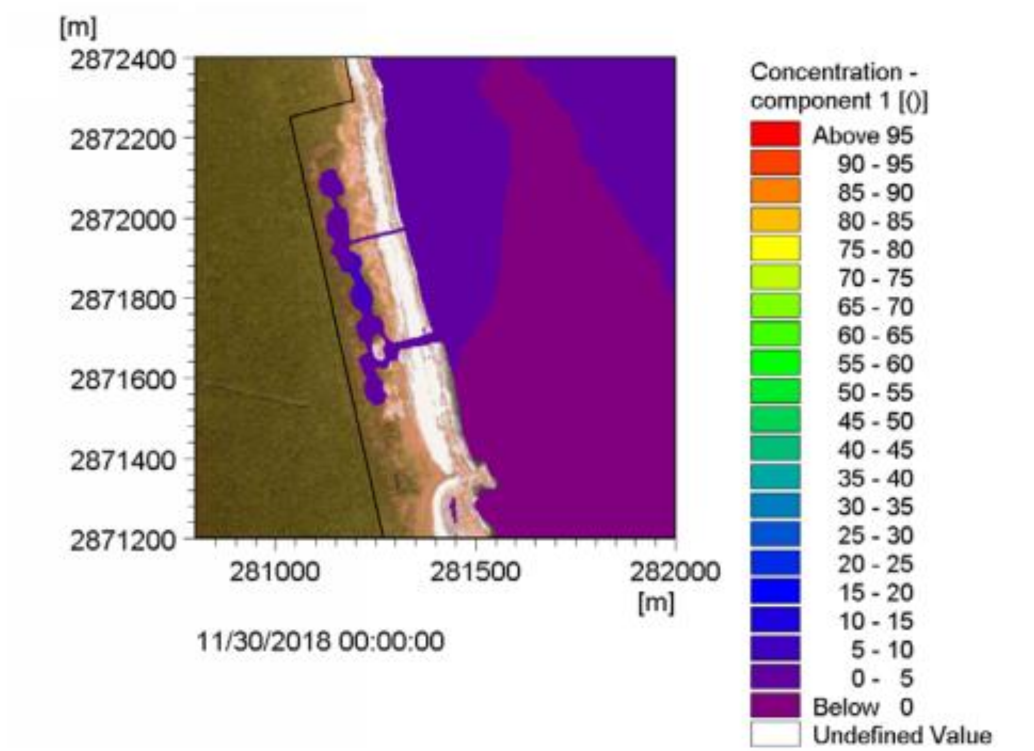


Figure 7.30. Conch Sound Point concentrations after 10 days.

Conch Sound Point - Storm Surge, Extreme Waves and Flood Elevations

Storm surge is an abnoral rise of water genrated by a strom, over and above the predicted astronomical tides. The maximum potential storm surge for a particular location depends on a number of different factors. In the northern hemisphere, the surge will be largest in the right-forward part of the storm, while the left-forward part may experience significantly depressed water levels. The worst surf is typically generated from storms located within 80 km. of landfall. Based on historical hurricane tracks at the Project site , a wider zone of influence of 120 km. (65 nautical miles) was selceted. Breaking waves also cause water to pile up on the shoreline in a phenomenon known as wave setup. In addition, the crests of waves can be several feet above the still-water elevation.

The initial HD (flusing analaysis) and SW (nearshore wave transformation) models considered either a normal tide variation around MSL (former) or a constant water level at MSL (latter). During storm conditions, the water level rises due to pressure setup, wind set up, and wave setup and since timing of a hurricane is unpredicatble, a normal high tide should also be considered.

Given that both 25- and 50-year return periods extreme winds correspond to a category 4 hurricane, only the 50 and 100-year return periods were evaluated for the storm surge and extreme waves analysis, which correspond to a category 4 and a category 5 storm respectively.

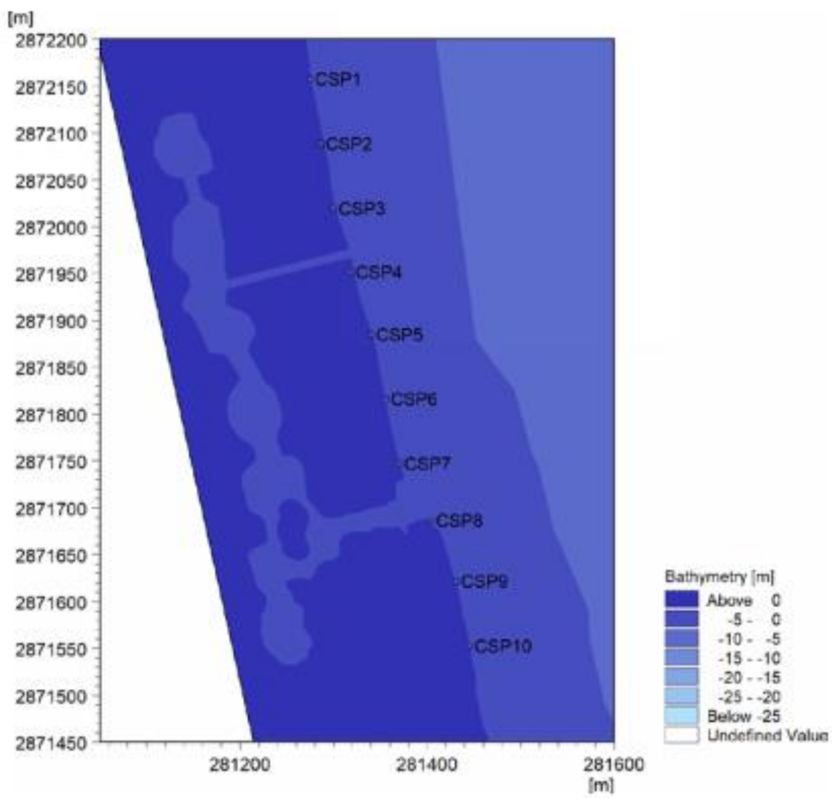


Figure 7.31. Conch Sound Point HD and SW Output Points.

Table 7.6.50-year Extreme Results – Conch Sound Point.

50-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
CSP1	1.24	0.96	1.63	3.34	10.96
CSP2	1.24	0.98	1.44	3.22	10.58
CSP3	1.24	0.97	1.68	3.38	11.10
CSP4	1.24	0.96	1.59	3.31	10.87
CSP5	1.24	0.94	1.74	3.40	11.16
CSP6	1.24	0.96	1.72	3.37	11.04
CSP7	1.24	0.99	1.53	3.30	10.83
CSP8	1.24	0.95	1.75	3.40	11.15
CSP9	1.24	0.95	1.76	3.42	11.23
CSP10	1.24	0.94	1.68	3.33	10.94

Table 7.7. 100-year Extreme Results – Conch Sound Point.

100-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
CSP1	1.35	0.92	1.73	3.57	11.72
CSP2	1.35	0.92	1.59	3.49	11.44
CSP3	1.35	0.95	1.78	3.62	11.86
CSP4	1.35	0.95	1.75	3.58	11.75
CSP5	1.35	0.95	1.90	3.67	12.03
CSP6	1.35	0.90	1.77	3.60	11.81
CSP7	1.35	0.91	1.63	3.53	11.59
CSP8	1.35	0.91	1.91	3.62	11.89
CSP9	1.35	0.91	1.87	3.66	12.00
CSP10	1.35	0.91	1.77	3.52	11.55

7.5 HURRICANE HISTORY

A hurricane is defined by the National Oceanic and Atmospheric Administration (NOAA) as a rotating low-pressure weather system that has organized thunderstorms but no fronts (a boundary separating two air masses of different densities)[2]. The Bahamas experiences heavy storm and hurricane activity through the months of June to November. The official hurricane season runs from June 1-November 30. Throughout The Bahamas, Abaco is one the three Bahamian islands ranked in the top ten most effected cities, islands and countries in the North American Basin[3].

The most recent hurricane to affect Abaco was hurricane Nicole (category 1) in 2022. However, the most memorable and destructive hurricane made landfall on September 1, 2019. Category 5 hurricane Dorian affected the islands of Grand Bahama and Abaco. Dorian's impact caused major damage to property, flooding, death, injuries and mass destruction due to its 48 hour position over the northwestern islands. Currently, Dorian is listed as the strongest hurricane to hit The Bahamas on record.

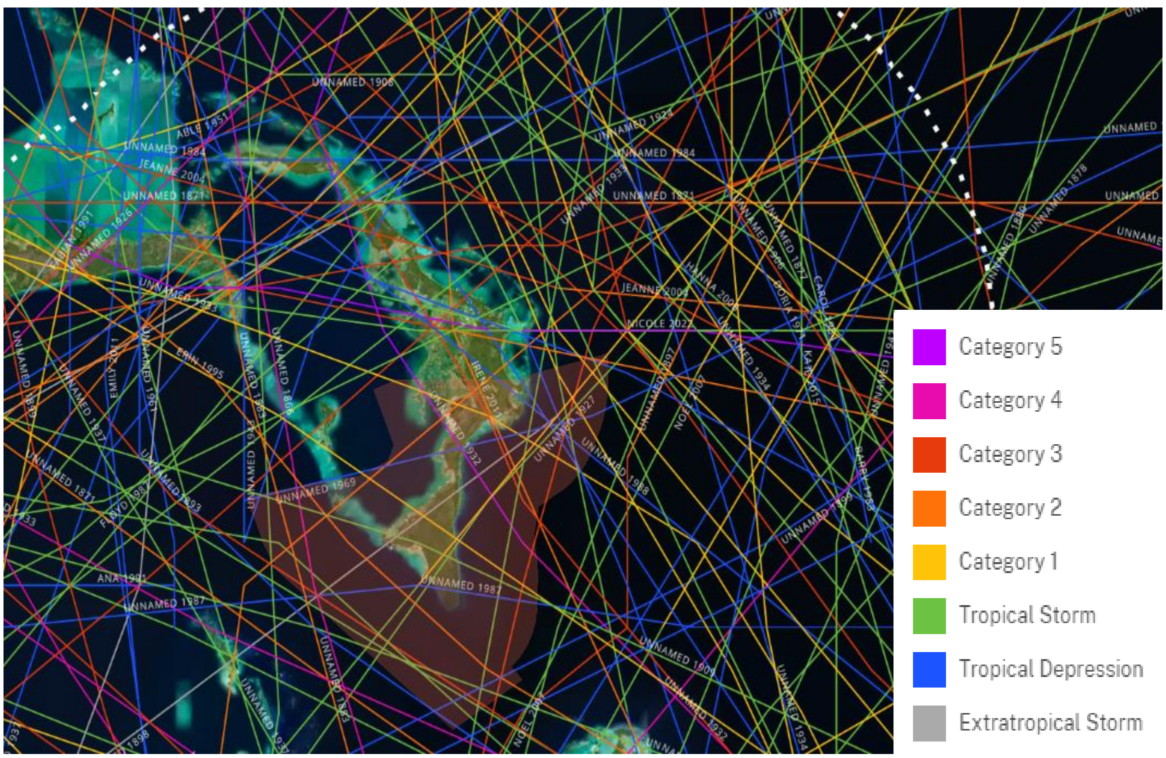


Figure 7.32. Hurricane tracks near Abaco since 1854 (coast.noaa.gov/hurricanes).

[2] NOAA. (January 2023).What is a hurricane? Retrieved from <https://oceanservice.noaa.gov/facts/hurricane.html>

[3] Neely, W. (2009). The great Bahamian hurricanes of 1926. P. 98.

Figure 7.33. Hurricane tracks near the Project site since 1854 (coast.noaa.gov/hurricanes).

Table 7.8. Recent Hurricane History of Abaco.

Year	Event	Storm Category
2004	Francis	2
2004	Jeanne	3
2005	Franklin	Tropical Storm
2005	Katrina	Tropical Storm
2007	Noel	1
2008	Hanna	Tropical Strom
2011	Emily	Tropical Depression
2011	Bret	Tropical Storm
2011	Irene	3
2012	Sandy	3
2015	Kate	1
2016	Matthew	4
2017	Irma	4
2019	Three	Tropical Depression
2019	Dorian	5
2019	Humberto	3
2022	Nicole	1

Table 7.9.Saffir-Simpson Hurricane Categories.

Saffir-Simpson Category	Maximum Sustained Wind Speed		
	mph	km/h	knots
1	74–95	119-153	64–82
2	96–110	154-177	83–95
3	111–129	178–208	96–112
4	130–156	209-251	113–136
5	>157	>252	>137

7.6 Air and Noise Quality

Air and noise data were collected at the three (3) Project sites (LH, HBB and CSP). Methods of data collection include observation, use of a Kestrel Instrument Weather Meter.

7.6.1 Leeward Harbour Air and Noise Quality

The ambient air quality at LH is classified as 'Good'. South Abaco is largely underdeveloped, with miles of coppice forests, pinelands and coastal mangroves between Sandy Point and the nearest settlement of Crossing Rock. In Sandy Point there are no large scale industrial or commercial developments producing emissions impacting air quality in the area. Current sources of air emission in the Sandy Point area include personal and commercial vehicles; fishing boats, mail boats and passenger boats. Also, aircraft use of the Sandy Point airstrip and fires in the surrounding pine forests. Seasonal fires are part of the natural ecology of a healthy pine forest, and periodic fires are known to occur in the pine forests around Sandy Point during the dry periods of the year. The Bahamian pine yards are fire-maintained. They require seasonal prescribed burns to maintain the biodiversity of the pineland ecosystem[4]. Therefore, they depend on fire for their persistence and characteristics. The nearby unmanaged dump located less than a mile east of the airstrip may also result in fires which are intentionally lit to dispose of trash at the 'dump' facility, producing smoke and noxious fumes which may impact the residents of Sandy Point (see Figure below).

Sources of noise in Sandy Point area are transient and originate from passing vehicles, boats, and planes. No consistent sources of noise exist.

[4] Myers, R., D. Wade, and C. Bergh, Fire Management Assessment of the Caribbean Pine (Pinus caribea) Forest Ecosystems on Andros and Abaco Islands, Bahamas. GFI publication no. 2004-1. The Nature Conservancy, Arlington, VA.

Figure 7.34. Satellite image of LH property in relation to local dumpsite.

Table 7.10. Leeward Harbour Climate Measurements with Kestrel Instruments Weather Meter, April 18, 2019.

Date / Time	18/04/2019 11:40	18/04/2019 11:40
Relative Humidity (%)	91.8	90.3
Dew Point(Â°C)	24.9	24.5
Density Altitude(m)	475	467
Relative Air Density(%)	95.5	95.5
Station Pressure(mb)	1,017.90	1,017.80
Psychro Wet Bulb Temperature(Â°C)	25.2	25
Air Speed(mps)	6.3	6.5
Temp.(Â°C)	26.3	26.2
Air Density (kg/m^3)	1.17	1.171
Barometric Pressure(mb)	1,017.90	1,017.70
Wind Chill(Â°C)	26.3	26.1
Heat Stress Index(Â°C)	30.7	30
Delta-T(Â°C)	1.1	1.2
Air Flow(m^3/s)	0.6	0.6

7.6.2 High Bank Bay Air and Noise Quality

The ambient air quality at HBB is classified as 'Good', as South Abaco is largely underdeveloped, with miles of coppice forests, pinelands and coastal mangroves between HBB and the nearest settlement of Crossing Rock. In South Abaco, there are no large scale industrial or commercial developments producing emissions impacting air quality in the area. Currently, there are no direct sources of air emission in the area. Similar to the LH site, seasonal fires are part of the natural ecology of a healthy pine forest, and periodic fires are known to occur in the pine forests during the dry periods.

There are no consistent sources of noise that exist within or surrounding the HBB site. This area is considered to be void of noise pollution within the terrestrial habitats and its surrounding communities.

Table 7.11. High Bank Bay Climate Measurements with Kestrel Instruments Weather Meter, April 17, 2019.

Date / Time		17/04/2019 9:43	17/04/2019 9:44	17/04/2019 9:44
Humidity Ratio	g/kg	13.32	12.23	12.13
Relative Humidity	%	65.7	62.9	63.5
Dew Point	Â°C	18.6	17.2	17.1
Density Altitude	m	385	355	343
Relative Air Density	%	96.3	96.6	96.7
Station Pressure	mb	1,019.90	1,019.90	1,019.90
Psychro Wet Bulb Temperature	Â°C	20.8	19.7	19.5
Air Speed	mps	3	5.7	6.4
Temp.	Â°C	25.4	24.8	24.5
Air Density	kg/m^3	1.18	1.183	1.185
Barometric Pressure	mb	1,019.90	1,019.90	1,019.90
Wind Chill	Â°C	25.4	24.7	24.4
Heat Stress Index	Â°C	26.1	24.8	24.6
Delta-T	Â°C	4.7	5.1	5
Air Flow	m^3/s	0.3	0.5	0.6

7.6.3 Conch Sound Point Air and Noise Quality

The ambient air quality in CSP is classified as ‘Good’, as South Abaco is largely underdeveloped, with miles of coppice forests, pinelands and coastal mangroves between CSP and the nearest settlement of Crossing Rock, similar to HBB. Also similar to the LH and HBB sites, seasonal fires are part of the natural ecology of a healthy pine forest, and periodic fires are known to occur in the pine forests around Sandy Point during the dry periods of the year.

Sources of noise in CSP area are transient and originate from passing boats and planes. No consistent sources of noise exist.

Table 7.12. Conch Sound Point Climate Measurements with Kestrel Instruments Weather Meter, April 16, 2019.

Date / Time	**16/04/2019 11:23**	**16/04/2019 11:23**
Humidity Ratio(g/kg)	18.17	19.04
Relative Humidity (%)	82.8	85.2
Dew Point(Â°C)	23.4	24.2
Density Altitude(m)	495	506
Relative Air Density(%)	95.3	95.2
Station Pressure(mb)	1,015.80	1,016.20
Psychro Wet Bulb Temperature(Â°C)	24.3	24.9
Air Speed(mps)	5.5	6.2
Temp.(Â°C)	26.6	26.9
Air Density (kg/m^3)	1.167	1.166
Barometric Pressure(mb)	1,015.70	1,016.20
Wind Chill(Â°C)	26.6	26.8
Heat Stress Index(Â°C)	30.1	30.9
Delta-T(Â°C)	2.3	2
Air Flow(m^3/s)	0.5	0.6

7.7 WATER QUALITY

Water quality measurements were taken of surface water bodies at all three (3) locations using a Horiba U52G water quality meter in 2019. Parameters measured during water body sampling include temperature, pH, oxidation reduction potential, electrical conductivity, turbidity, dissolved oxygen, total dissolved solids, salinity, depth and GPS location. Additional water quality measurements were taken on May 9, 2023, in the marine environment located near the proposed flushing and entrance channels at the LH site and analyzed at KLG Investments Limited for biological and chemical testing use. Due to the Project details associated with the CSP and HBB sites (no dredging activity, but minor excavation), marine water quality samples were not collected and tested. Parameters measured during water body sampling include pH, coliform bacteria, turbidity, dissolved oxygen, total dissolved solids, nitrate, iron, and salinity (see Tables below in Section 7.6.1). KLG Investments Limited Results included in Appendix I.

Water temperature is a measure of the average amount of thermal energy available in a body of water, a result of kinetic energy of water molecules. Temperature is an important parameter impacting the ecology of a water body, as it influences other water quality parameters. Temperature changes have been known to influence the metabolism and behavior of marine fauna, as well as the photosynthetic and growth rate of marina flora. As temperature increases, the dissolved oxygen holding capacity of a water body decreases and the electrical conductivity increases.

Electrical conductivity and total dissolved solids are related to the salinity of a water body. The electrical conductivity relates to the concentration of ions from inorganic matter and salts. Total dissolved solids (TDS) represent the total of dissolved material in a body of water. Salinity is the measurement of the amount of dissolved salts in a body of water which equates the water's ability to conduct electricity. The average salinity of a marine habitat is measured at 35 parts per thousand (‰). These parameters act as an indicator of any possible changes in the water quality within an aquatic environment, which may indicate signs of contamination. Therefore, affecting the development of aquatic organisms.

Turbidity is a term used to describe the passage of light through a body of water. This parameter measures suspended particles in a body of water including inorganic and organic matter. Its units of measurement are Nephelometric Turbidity Units (NTU). The association with turbidity and water quality aids in identifying suitable conditions for aquatic organisms to thrive. For instance, clarity within the water column allows light to penetrate algae and other primary producers that support complex food webs.

Measurements of pH indicate the relative alkalinity or acidity of a water sample. The device measures the potential difference of free Hydrogen ions (H+) and is expressed as a number between 1-14; 1-6 being acidic, 7 neutral, and 8-14 alkaline. The pH is equal to −log10c, where c is the hydrogen ion concentration in moles per liter. The pH of a body of water has a direct impact on resident biology, impacting the ability for organisms to regulate life-sustaining processes dependent on the exchange of ions with the water and respiration. The ideal pH range for aquatic organisms has been suggested as 6-9, although algae, fish and other extremophiles have been known to colonize extremely acidic and alkaline conditions where other life would not thrive. Ocean water has a pH range of 5-9, with a pH of 7 representing ideal conditions for marine life.

The oxidation reduction potential is a measure of the state of equilibrium between the oxidants and reductants that coexist in a solution, which determines its ability to release or accept electrons during chemical reactions.

Dissolved oxygen represents the amount of atmospheric oxygen dissolved throughout a body of water. The EPA water quality criteria states that the dissolved oxygen should not fall below 4.0ml due to its negative effect on aquatic organisms and mortality rate (O'Brien, 2008[5]).

[5] O'Brien, P. (2008). Interpretation guidance for marine dissolved oxygen (DO) standard. Retrieved From: http://www.dec.ny.gov/docs/water_pdf/togs116.pdf

7.7.1 Leeward Harbour Water Quality Results

7.7.1.1 LH 2023 Location and Results

Figure 7.35. Water quality sample collection points for KLG samples collected on May 9, 2023.

Table 7.13. Water quality sample 1.

LAB TEST	RESULTS	E.P.A STANDARDS Desirable Level	W.H.O. STANDARDS Maximum Permissible Level
Bacteria			
COLIFORM/100 ML	***135/**100ml	NONE	NONE
FECAL COLIFORM/100 ML	0/100ml	NONE	NONE
NON-COLIFORM	0/100ml		
*L 1-50 COLONIES OF BACTERIA			
*M 51-200 COLONIES OF BACTERIA			
*TNTC-TOO NUMEROUS TO COUNT			
Chemical			
pH	7.8	6.5 – 8.5	6.5 – 8.5
TOTAL DISSOLVED SOLIDS-PPM (TDS)	***24,200ppm**	500	1,200
SODIUM CHLORIDE (SALINITY)-PPM	***13,800ppm**	250	<600
TOTAL HARDNESS-PPM	***1,036ppm**	100	<200
NITRATE-PPM	0.5pm	10	10
IRON-PPM	0.02ppm	0.3	0.5
APPEARANCE	Clear	CLEAR	CLEAR
ODOR	None	NONE	NONE
CHLORINE RESIDUAL-PPM *IBWA	NIL	*0.1	4.0
TURBIDITY-FNU	3FNU	5.0	5.0
NOTE: **W.H.O.** - WORLD HEALTH ORGANIZATION			
NOTE: **E.P.A.**-ENVIRONMENTAL PROTECTION AGENCY			

Table 7.14. Water quality sample 2.

LAB TEST	RESULTS	E.P.A STANDARDS Desirable Level	W.H.O. STANDARDS Maximum Permissible Level
Bacteria			
COLIFORM/100 ML	***10/**100ml	NONE	NONE
FECAL COLIFORM/100 ML	0/100ml	NONE	NONE
NON-COLIFORM	0/100ml		
*L 1-50 COLONIES OF BACTERIA			
*M 51-200 COLONIES OF BACTERIA			
*TNTC-TOO NUMEROUS TO COUNT			
Chemical			
pH	7.7	6.5 – 8.5	6.5 – 8.5
TOTAL DISSOLVED SOLIDS-PPM (TDS)	***24,300ppm**	500	1,200
SODIUM CHLORIDE (SALINITY)-PPM	***12,000ppm**	250	<600
TOTAL HARDNESS-PPM	***856ppm**	100	<200
NITRATE-PPM	0.2pm	10	10
IRON-PPM	0.00ppm	0.3	0.5
APPEARANCE	Clear	CLEAR	CLEAR
ODOR	None	NONE	NONE
CHLORINE RESIDUAL-PPM *IBWA	NIL	*0.1	4.0
TURBIDITY-FNU	0FNU	5.0	5.0
NOTE: **W.H.O.** - WORLD HEALTH ORGANIZATION			
NOTE: **E.P.A.**-ENVIRONMENTAL PROTECTION AGENCY			

7.7.1.2 LH 2023 Water Quality Discussion

It is noted that the standards for other parameters in this test are in reference to consumption.

Sample 1 and Sample 2 (marine habitat) contain numerous amounts of fecal coliform bacteria (disease causing bacteria) which is found in the gut and feces of warm-blooded animals. The source of the bacteria is uncertain. Although, it is noted that wild hogs visit the LH area. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and/or animal waste[6]. Which can also indicate that pathogens, disease-producing bacteria or viruses can exist in this environment due to the presence of fecal material. This is a potential health risk for individuals exposed to this water. High levels of coliform bacteria can affect marine organisms and their habitat by depleting oxygen levels in the marine water and affecting pH. Which can potentially prohibit ecosystem services and reduce biodiversity.

Turbidity levels at 0 and 3 NTU are considered acceptable for environmental standards. Average ocean pH is at a reading of 8.1 which means that the water is basic or alkaline[7]. Sample results show pH of 7.7 and 7.8 which shows signs of decrease in pH due to an increase in the ocean's carbon dioxide absorption. Thus, potentially creating an acidic marine environment if pH continues to decrease. Acidic marine environments have an impact on calcium carbonate structures such as shells, exoskeletons and skeletons of marine organisms. Which means an impact on commercially important species (i.e., Spiny Lobster, Queen Conch, Crab, etc.).

Salinity levels at Sample 1 equate to 13,800 ppm (13.8‰) and Sample 2 equate to 12,000 ppm (12‰) which indicates the presence of brackish water. Brackish water is a broad term used to describe water that is more saline than freshwater but less saline than true marine environments[8]. Brackish water, generally defined as water with TDS content between that of freshwater (≤500 mg l−1 TDS) and seawater (33 000–48 000 mg l−1 TDS)[9]. Sample 1 recorded TDS at 24,200 ppm (24,172.39 mg/L) and Sample 2 recorded TDS at 24,300 ppm (24,272.28 mg/L). Some marine species are unable to tolerate characteristics of brackish water such as sea stars and sea cucumbers. These organisms are unable to tolerate low salinity levels. Altering the conductivity of the environment by increasing or decreasing salt levels will negatively affect the metabolic abilities of the organisms. [10]

According to the United States Environmental Protection Agency (EPA), the state of Florida has criteria values for nitrate which should not exceed 10.0 mg/L[11]. Nitrate levels up to 10mg/L are acceptable for marine organisms and reef organisms. Levels under 0.4 mg/L are considered too low and can affect the rate of production for primary producers as this compound is required for

[6] KnowYourH2O. (2020). Fecal coliform bacteria in water. Retrieved from <https://www.knowyourh2o.com/outdoor-4/fecal-coliform-bacteria-in-water>

[7] NOAA. (2020). Ocean acidification. Retrieved from <https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification#:~:text=The%20ocean's%20average%20pH%20is,the%20ocean%20becomes%20more%20acidic.>

[8] Sandrin, T.R., Dowd, S.E., Herman, D.C., and Maier, R.N. (2009). Chapter 6 - Aquatic Environments. *Environmental Microbiology (Second Edition*),Pages 103-122,

[9] Gray, S., Semiat, R., Duke, M., Rahardianto, A., and Cohen, Y. (2011). 4.04 - Seawater Use and Desalination Technology. *Treatise on Water Science, Volume 4,* Pages 73-109.

[10] Fondriest Environmental, Inc. (2014). Conductivity, Salinity and Total Dissolved Solids. *Fundamentals of Environmental Measurements*. Retrieved from <https://www.fondriest.com/environmental-measurements/parameters/water-quality/conductivity-salinity-tds/>.

[11] United States Environmental Protection Agency. (1980). Water quality standards criteria summaries, a compilation of state/federal criteria :
Nitrogen-ammonia/nitrate/nitrite. Retrieved from
<https://nepis.epa.gov/Exe/ZyPDF.cgi/9101S991.PDF?Dockey=9101S991.PDF>

photosynthesis. Sample 2 shows signs of low nitrates at 0.2ppm (0.199mg/L). Sample 1 shows acceptable levels at 0.5ppm (0.499 mg/L).

7.7.1.3 LH 2019 Sample Collection and Results

Table 7.15. *Water quality measurements of wetland east of LH property*

Site	Leeward Harbour - Adjacent Wetland					
Description of Water Body	Approximately 30.5 acres of surface water due east of the LH site. No above ground connectivity to open ocean. Water levels fluctuate with rain and drought periods throughout the year. Active bird community, small to medium sized fish in wetland, suspected Tarpon.					
GPS	25 59 49 N, 77 23 30 W					
Date	April 18, 2019					
Data #	39	38	37	36	35	34
Time	9:30am	9:28am	9:25am	9:24am	9:21am	9:20am
Temp (°C)	26.77	26.83	27.29	27.44	27.96	27.76
pH	8.09	8.11	8.28	8.29	8.39	8.4
pHmV (mV)	-77	-78	-89	-89	-95	-96
ORP (mV)	-38	-20	121	126	116	116
Cond (mS/cm)	48.8	48	47.9	48	48.5	48.7
Turbidity (NTU)	6.5	6.5	3.6	4.6	4.5	2.9
DO (mg/L)	3.37	6.73	5.13	5.38	6.18	7
TDS (g/L)	29.8	29.3	29.2	29.3	29.6	29.7
Salinity (ppt)	31.82	31.24	31.22	31.18	31.69	31.8
SG (Sigma t)	20.5	20.1	19.9	19.9	20.1	20.2
Depth (m)	0.15	0.25	0.3	0.3	0.3	0.3

Figure 7.36. *Aerial image of sample point*

Figure 7.37. Image of sample point.

Table 7.16. *Water quality measurements of onsite permanently flooded wetland*

Site	**Leeward Harbour - Permanently Flooded Wetland**			
Description of Water Body	Freshwater wetland body surrounded by *R. mangle* and *Typha* along its margins.			
GPS	26 00 14 N, 77 24 16 W			
Date	April 15, 2019			
Data #	15	14	13	12
Time	12:28pm	12:27pm	12:25pm	12:24pm
Temp (°C)	33.07	35.31	33.07	36.9
pH	8.41	8.39	8.28	8.4
pHmV (mV)	-98	-98	-90	-99
ORP (mV)	48	-10	54	-38
Cond (mS/cm)	3.27	15.3	12.1	15.6
Turbidity (NTU)	38.9	258	43.7	20.1
DO (mg/L)	11.12	8.05	8.32	7.03
TDS (g/L)	2.24	9.47	7.52	9.69
Salinity (ppt)	1.64	8.83	6.92	9.04
SG (Sigma t)	0	0.7	0	0.3
Depth (m)	0.05	0.1	0.15	0.25

Figure 7.38. Water quality sample point.

Figure 7.39. Image of sample point.

7.7.1.4 LH 2019 Water Quality Discussion

Average sample temperature in this sample location were recorded at 94.30ºF, pH at 8.37, turbidity at 90 NTU, salinity at 6.61 ppt and dissolved oxygen at 8.63mg/L. These results indicate that the sample area is a considerably healthy freshwater environment due to standard levels of dissolved oxygen and pH, as well as the low salinity levels. High temperatures indicate the lack of flushing and stagnant nature susceptible to evaporation. Although this is considered a freshwater habit, it is not recommended for direct consumption of recreation due to high levels of turbidity.

7.7.2 High Bank Bay Water Quality Results

Table 7.17. High Bank Bay water quality readings.

Site	**High Bank Bay - Mangrove Overwash**		
Description of Water Body	Low lying area behind primary dune system at HBB. Dominated by Black Mangrove in mucky soils		
GPS	25°55'5.05"N, 77°10'52.75"W		
Date	April 16, 2019		
Data #	23	22	21
Time	10:20 a.m.	10:19 a.m.	10:17 a.m.
Temp (°C)	27.7	27.58	27.55
pH	8.87	8.54	8.55
pHmV (mV)	-124	-104	-105
ORP (mV)	-3	-21	-150
Cond (mS/cm)	23.9	54.7	34.8
Turbidity (NTU)	758	111	0
DO (mg/L)	8.09	9.75	5.03
TDS (g/L)	14.9	32.8	21.1
Salinity (ppt)	14.48	36.23	21.88
SG (Sigma t)	7.3	23.6	12.9
Depth (m)	0.15	0.15	0.1

Figure 7.40. Water quality sample point at HBB.

7.7.2.1 HBB 2019 Water Quality Discussion

The average sample temperature in this sample location was recorded at 81.70ºF, pH at 8.65, turbidity at 289.67 NTU, salinity at 24.19 ppt and dissolved oxygen at 7.63mg/L. These results indicate that the sample area is a considerably healthy brackish water environment due to standard levels of dissolved oxygen, temperature and pH, as well as the low salinity levels. High levels of turbidity may be due to wave activity and wave over wash increasing sedimentation and nutrients in the sample area mixed in with soil/mud materials.

7.7.3 Conch Sound Point Water Quality Results

Table 7.18. Conch Sound Point water quality readings.

Site	Conch Sound Point - Mangrove Overwash				
Description of Water Body	Stagnant Wetland located in overwash area behind the primary dune system. Continuous along east coastline of South Abaco, standing water in some area, soil wet and muck, dominated by black mangroves and *Conocarpus erectus*. Rainy season causes accumulation of water in these areas. Heavy evidence of wild hog use wallowing and movement				
GPS	25 56 48 N, 77 11 04 W				
Date	April 16 2019				
Data #	28	27	26	25	24
Time	10:34am	10:33am	10:32am	10:31am	10:31am
Temp (°C)	29.24	29.37	29.89	30.68	28.59
pH	6.75	6.42	6.6	7.84	8.31
pHmV (mV)	3	22	12	-63	-91
ORP (mV)	-176	-187	-184	-200	-158
Cond (mS/cm)	1.51	0	0	17.1	1
Turbidity (NTU)	124	315	74.8	121	113
DO (mg/L)	9.45	9.65	9.41	4.39	5.53
TDS (g/L)	0.797	0	0	10.6	0.772
Salinity (ppt)	0.74	0	0	9.89	0.47
Depth (m)	0.05	0.05	0.1	0.1	0.1

Figure 7.41. Water quality sampling point at CSP.

7.7.3.1 CSP 2019 Water Quality Discussion

The average sample temperature in this sample location was recorded at 77.99ºF, pH at 7.18, turbidity at 149.56 NTU, salinity at 2.22ppt and dissolved oxygen at 7.29mg/L. These results indicate that the sample area is a considerably healthy brackish water environment due to standard levels of dissolved oxygen, temperature and pH, as well as the low salinity levels. Due to low levels of salinity it is possible that rainwater is at the surface and included in the sample. High levels of turbidity may be due to wave activity and wave over wash increasing sedimentation and nutrients in the sample area.

7.8 Fresh Water Resources

Surface water bodies cover less than 2% of the island of Abaco and include blue holes, man-made lakes, and ponds. Abaco Island possesses good freshwater resources from the Lucayan Limestone aquifer lenses. Very large to large quantities of water are available from four (4) relatively large freshwater lenses: (a) Normans Castle, (b) Marsh Harbour – Lake City, (c) Lake City – Crossing Rocks, and (d) Crossing Rocks – Hole in the Wall. The area between Crossing Rocks and Hole in the Wall contains a thick (12 – 18 m) and extensive freshwater lens that may produce yields greater than 2.5 L/s (40 gpm) which covers approximately 33% of the total island area and is suitable for hand pumps. It is important to note that hurricanes and severe storm activity can cause damage to the freshwater lens on the island of Abaco[12].

Expected surface groundwater resources on and near the Project site are shown in the following Figures from the US Army Corps of Engineers report. The map below indicates that groundwater

[12] US Army Corps of Engineers. (2004). Water resources assessment of The Bahamas. Retrieved from <BAHAMAS1WRA.pdf (army.mil)>

resources are "Moderate to Enormous" at approximately 0-20ft. of the surface within South Abaco. The Project sites at LH, HBB and CSP are located in areas that have unsuitable to small quantities of freshwater from shallow, fine-grained, well-sorted Holocene sandy aquafers.

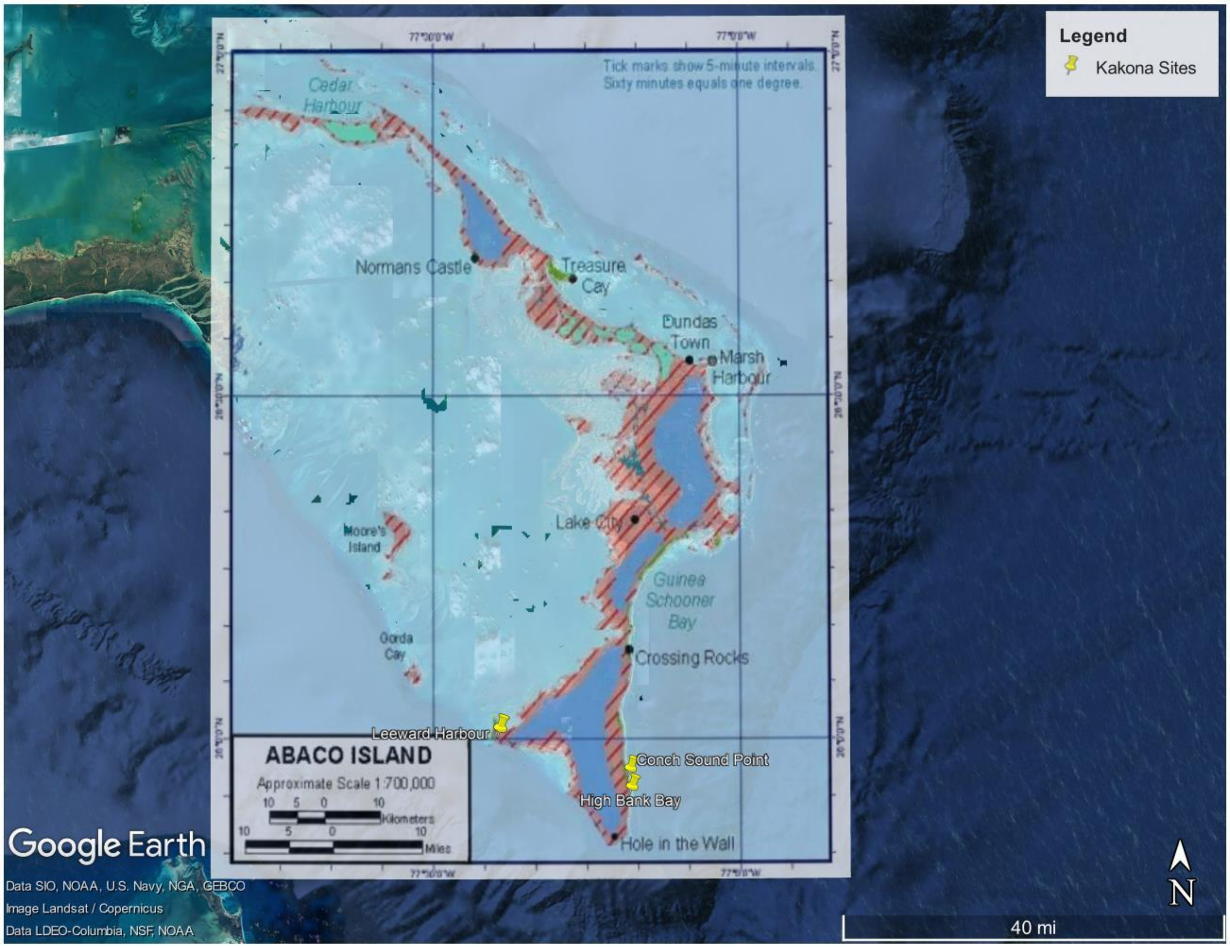


Figure 7.42. Ground water resources of Abaco completed by US Army Corp.

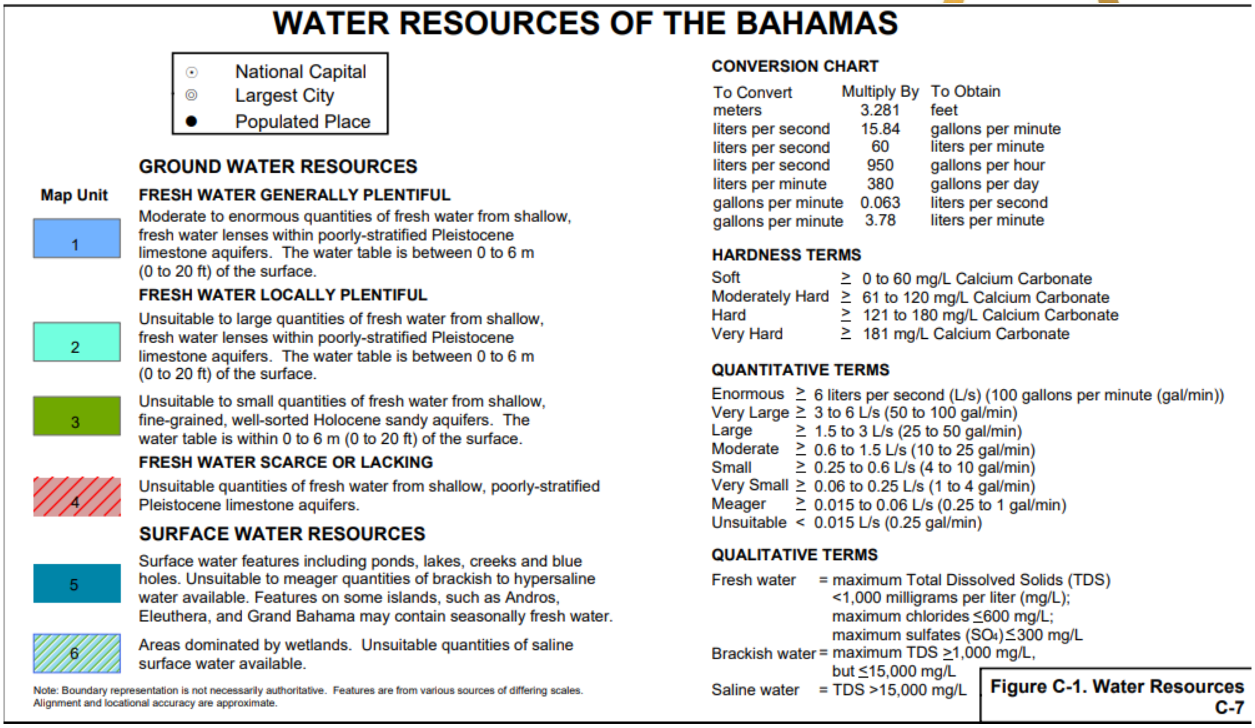


Figure 7.43. Legend for the above Water Resources map.

7.8.1 Leeward Harbour Hydrology and Hydrogeology

The LH property serves as a watershed area for standing bodies of surface waters in the immediate areas of the site. One such body of surface water lies immediately east of the LH property, with its expanding boundaries encroaching onto the property during rainy seasons and flooding events. As this wetland is served by rainfall alone, during the drier months evapotranspiration exceeds recharge of this wetland, resulting in decreased volumes and increased salinity of the pond. The wetter months of the year introduces fresh water into the system, creating a brackish environment as opposed to hypersaline.

Figure 7.44. Permanently flooded wetlands on site and adjacent to Leeward Harbour property.

Figure 7.45. Satellite image of wetland fluctuations, April 2005.

Figure 7.46. Satellite image of wetland fluctuations, December 2014.

Figure 7.47.Satellite image of wetland fluctuations, November 2015.

Figure 7.48. Satellite image of wetland fluctuations, October 2017.

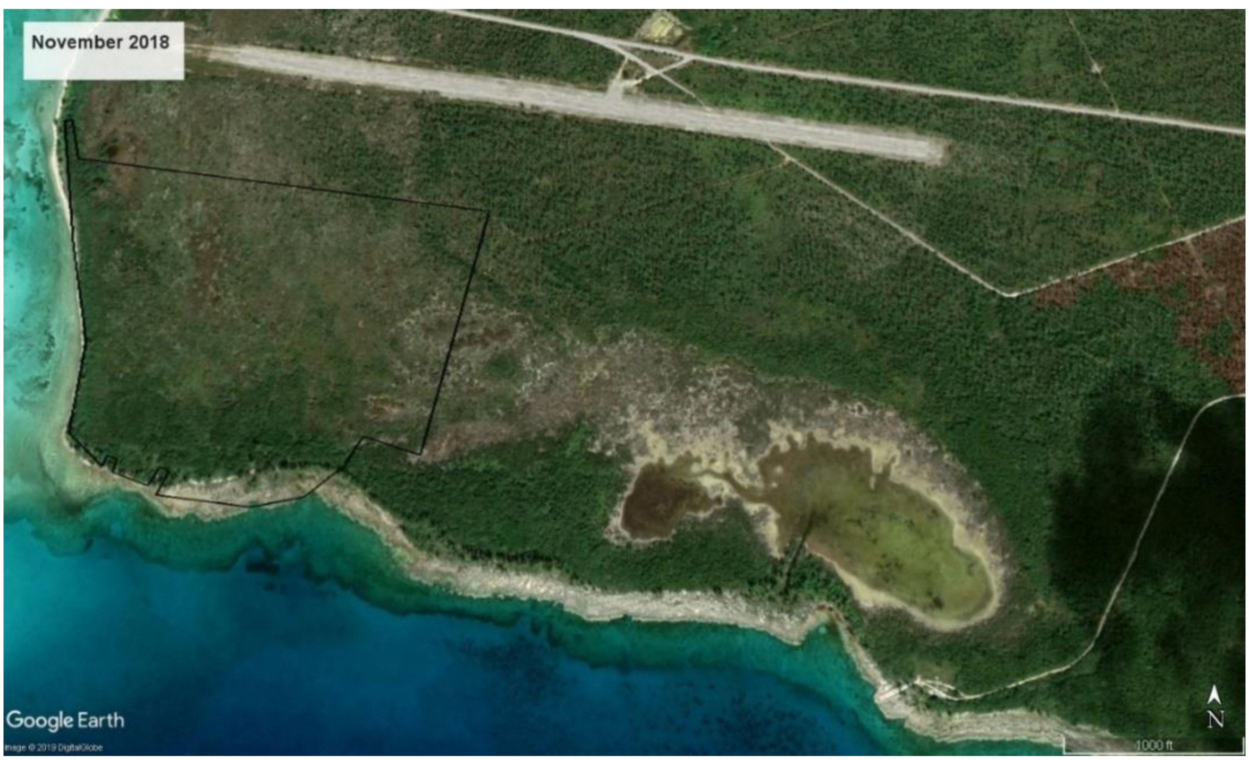


Figure 7.49.Satellite image of wetland fluctuations, November 2018.

7.8.2 High Bank Bay Hydrology and Hydrogeology

Mangrove Forests

The low-lying areas behind the primary dune systems accumulate water during rainfall and over wash during high storm surges. This habitat runs parallel to the coastline, with a damp mucky substrate along its perimeters and some standing brackish water within the interior of the mangrove system. The dominant vegetation along the perimeter of the wetlands are *Conocarpus erectus, Coccoloba uvifera, Hymenocallis arenicola, Laguncularia racemosa, Canavalia rosea, Metopium toxiferum, Sideroxylon americanum* and *Scaevola taccada.* The wetter interior areas of the wetlands are dominated by the Black Mangrove (*Avicennia germinans*).

Figure 7.50. Boundary between sandy dune community and Mangrove forests at HBB.

Figure 7.51. Mangrove wetland at HBB, Conocarpus erectus in foreground.

Figure 7.52. Avicennia germinans dominating mangrove wetland interior.

Figure 7.53. Black Mangrove growing along perimeter of mangrove wetland.

7.8.3 Conch Sound Point Hydrology and Hydrogeology

Mangrove Forests

The low-lying areas behind the primary dune systems accumulate water during rainfall and over wash during high storm surges. This habitat runs parallel to the coastline, with a damp mucky substrate along its perimeters and some standing brackish water within the interior of the mangrove system. The dominant vegetation along the perimeter of the wetlands are *Conocarpus erectus, Coccoloba uvifera, Hymenocallis arenicola, Laguncularia racemosa, Canavalia rosea, Metopium toxiferum, Sideroxylon americanum* and *Scaevola taccada.* The wetter interior areas of the wetlands are dominated by the Black Mangrove (*Avicennia germinans*).

Figure 7.54. Mangrove wetland at CSP.

Figure 7.55. Red and Black Mangroves in wetland at CSP.

Figure 7.56. Red and Black Mangroves in wetland at CSP.

Figure 7.57. Ephemeral wetland at CSP.

Figure 7.58. Ephemeral wetland at CSP.

7.9 TERRESTRIAL RESOURCE SURVEY

7.9.1 Botanical Survey Methodology

Botanical surveys were conducted at all three (3) sites to determine vegetation types, structure and diversity. Walking releve surveys were conducted to generate comprehensive botanical lists for the sites and to delineate terrestrial habitat and their transition zones. Plots were established at random points throughout the site to determine dominant species for vegetation types. Botanical ID's were assigned to specific epithet where possible in the field, and desktop studies conducted to confirm flora identity using The Flora of the Bahama Archipelago (1979) and The Catalogue of Seed Plants of the West Indies (2012). Updated nomenclature was assigned according to the most recent APGIV (2016) publication. Classifications of vegetation types were assigned according to the International Classification of Ecological Communities' Guide to Caribbean Vegetation Types (Areces-Mallea et al., 1999)[13] and the Flora of the West Indies (Rodríguez et al., 2007)[14].

7.9.2 Protected Plant Survey Methodology

Resource sampling was conducted from May 3rd to May 13th, 2023, and June 19th to June 24, 2023. To determine the density of protected plant species within each site, vegetation plots were used. Each plot was 66ft^2 or 0.1-acre and was randomly placed throughout the site. All protected plant species and the number of individuals of each species observed within each plot were recorded. The total number of each protected species in all plots was calculated and the average number was recorded. This number was then multiplied by 10 to determine the average number of individuals per acre. Finally, the average number of individuals per acre was multiplied by the total acreage of the site. Additional calculations were also made to estimate the number of protected plants that were going to be removed from the site during construction and development.

Results

The total number of protected plants was extrapolated from forty-six (46), 0.1-acre plots randomly distributed within 974.28 acres of vegetation across the three sites (High Bank Bay, Conch Sound Point and Leeward Harbour). The estimates show that 221,038 protected trees and shrubs reside within the three sites. Of the total acreage, 549.55 acres will be cleared for construction and development which accounts for a loss of 124,678 protected plants across the three sites. This number consists of *17,203 Gum Elemi (Bursera simaruba), 11,108 Silver Thatch Palm (Cocothrinax argentata), 3040 Joe Wood (Jacquinia keyensis), 5028 Black Mangrove (Avicennia germinans), 117 Thatch Palm (Leucothrinax morrisii), 27010 Buttonwood (Conocarpus erectus), 4779 Narrow-leafed Blolly (Guapira discolor), 12,664 Wild Cinnamon (Canella winterana), 5,963 Three-finger (Thouinia discolor), 17,188 West Indian Mahogany (Sweetenia mahogany), 1637 Paradise Tree (Simaruba glauca), 13,330 Caribbean Pine (Pinus caribaea bahamensis), 5262*

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[13] Areces-Mallea AE, Weakley AS, Li X, Sayre RG, Parrish JD, Tipton CV, Boucher T (1999) A guide to Caribbean vegetation types: preliminary classification system and descriptions. Nature Conservancy, Washington.

[14] Acevedo-Rodríguez, P., & Strong, M. T. (2007). Flora of the West Indies. National Museum of Natural History, The Smithsonian Institution, Washington, DC. Published in the Internet: http://persoon.si. edu/antilles/westindies/index.htm.

Cat's Tongue (Varronia bahamensis), 234 Horseflesh (Lysiloma sabicu), and 117 Red Cedar (Juniperus barbadensis).

7.9.2.1 ***Vegetation Type/ Habitat Type***

7.9.2.1.1 Leeward Harbour Vegetation Type/ Habitat Type

Leeward Harbour (LH) consisted of a few plant communities including scrub coppice, mixed wetlands, pinelands and mangrove forests. The general height of the plant community was 2m-4m in most areas, reaching up to 12m in pineland dominated sections of the site. The southern and western boundary lines were rocky and sandy shoreline respectively. The dense, scrubby, mixed wetland community in the interior of the site made maneuvering through the area difficult.

Pine Woodland

Pine forests dominate the areas around the LH site, however the *Pinus caribea var. bahamensis* dominant vegetation does not extend throughout the site. Pine dominated woodlands occupy the northwestern area of the LH site, transitioning to a shrubland devoid of *Pinus caribea var. bahamensis* in the canopy. The individuals of *Pinus caribea var. bahamensis* in the woodlands are on average 6-8 m. tall, and do not form a closed canopy. The pinelands grow in a thin soil layer overlaying a pitted limestone surface which collects moist soil in its pockets. In areas where the pitted limestone is exposed, vegetation only grows out of pits with sufficient soil and moisture to support the vegetation there. The understory of the Pine Woodland is on average 1-2 m. tall, supporting a diversity of species, however mostly dominated by *Metopium toxiferum* and *Cassytha filiformis*. Other species occurring in the understory of the Pine Woodlands include *Byrsonima lucida* (Guana Berry), *Lantana involucrate* (White Sage), *Vachellia choriophylla* (Cinnecord), *Smilax havanensis* (Razor Vine), *Morinda royoc* (Rhubarb), *Ardisia escallanoides* (Marlberry), *Varronia bahamensis* (Cat's Tongue, endemic), *Pithecellobium keyense* (Ram's Horn), *Tabebuia bahamensis* (Five Finger), *Corchorus hirsutus* (Wooly Buggar), *Coccothrinax argentata* (Silver Thatch Palm), *Pteridium aquilinum* (Bracken Fern), *Sideroxylon salicifolium* (Willow Bustic), *Dichromena floridanum*, *Coccoloba diversifolia* (Pigeon Plum), *Erithalis fruticosa* (Black Torch), *Swietenia mahagoni* (Mahogany, protected), *Trema lamarckianum* (Pain in Back), *Ipomoea indica* (Morning Glory), *Thouinia discolor* (Quicksilver Bush, endemic) and *Cladium jamaicense* (Sawgrass).

Figure 7.59. Habitat map depicting Pine Woodlands at Leeward Harbour (brown highlighted area).

Figure 7.60. Pinus caribea var. bahamensis.

Coastal Coppice & Shrubland

The southern boundary of LH features the higher elevation and drier areas of the property. Standing water does not occur in these areas, and the substrate is sandy loam soil with a defined leaf litter layer and scattered rocks on the forest floor. The canopy in coastal coppice ranges from 10-15 ft. at its highest, dominated by *Vachellia choriophylla* (Cinnecord), *Pithecellobium keyense* (Ram's Horn) and *Coccoloba uvifera* (Seagrape). Portions of the coastal copies and shrublands along the south eastern corner of the property are dominated by *Coccoloba uviera*, forming a monoculture thicket along the coastline. Other species commonly found in the coastal coppice and shrubland include *Sideroxylon americanum* (Milk Berry), *Busera simaruba* (Gum Elemi), *Chrysobalanus icaco* (CocoPlum), *Agave sisiliana* (Sisal), and *Maytenus phyllanthoides*.

Figure 7.61. Habitat map depicting coastal coppice and shrubland vegetation at Leeward Harbour (blue highlighted area).

Figure 7.62. Coastal coppice & shrublands at Leeward Harbour.

Rocky Shore

The southern shoreline of the property features an extensive rocky shoreline habitat subject to the high energy waves, wind, salt spray, and heat stress common to of this type of exposed coastal environment. The flora in this habitat are stunted and prostrate in many cases due to these environmental factors. Transitioning from the coastal coppice seaward, the substrate of the rocky shoreline habitat changes from predominantly sandy with exposed Pleistocene limestone to only exposed dogtooth limestone devoid of any collecting sediment other than rocks and boulders. Dominating this landscape is the bonsai like shrub *Rachicallis Americana* (Sandfly Bush), *Ambrosia hispida* (Bay Geranium), *Fimbristylis spathacea*, *Conocarpus erectus* (Button Wood), *Borrichia arborescens* (Sea Ox Eye Daisy), *Scaevola taccada* (Hawaiian Sea Lettuce, invasive), and *Blutaparon vermiculare* (Saltweed).

Figure 7.63. Habitat map depicting rocky shoreline at Leeward Harbour (highlighted in grey).

Figure 7.64. Rocky shore habitat at Leeward Harbour.

Figure 7.65. Rocky shore habitat at Leeward Harbour

The splash and intertidal zones on the rocky shoreline are devoid of sandy substrate, with tolerant species established in shallow pools which have collected clay-like sediment. Species colonizing this habitat are *Rhizophora mangle* (Red Mangrove), *Avicennia germinans* (Black Mangrove) and *Sesuvium portulacastrum* (Sea Purslane).

Figure 7.66. Black mangrove (Avicienna germinans) growing in intertidal zone at Leeward Harbour

Sand Strand and Dune Community

The western shoreline of the property features an established sand strand and dune community in areas above the high tide line and below the upland mangrove wetlands parallel to the shoreline. The elevation in this habitat ranges from approximately 2-6 ft. asl. The higher regions of the dune are dominated in some areas by the invasive *Casuarina equisetifolia* (Australian Beefwood) and *Scaevola taccada* (Hawaiian Sea Lettuce). Evidence of coastal erosion can be observed along the dune in areas colonized by invasive species.

Outside of areas dominated by invasives, the sand dune community is dominated by *Ambrosia hispida* (Bay Geranium), *Uniola paniculata* (Sea Oats), *Canavalia rosea* (Beach Pea), *Casasia clusiifolia* (Seven Year Apple), *Tournefortia gnaphalodes* (Bay Lavendar) and *Hymenocallis arenicola* (Spider Lily).

Figure 7.67. Habitat Map depicting Sandy-Dune Communities at Leeward Harbour (highlighted in yellow).

Figure 7.68. Sandy-Dune community at Leeward Harbour.

Figure 7.69. Sandy-Dune community at Leeward Harbour.

Table 7.19.Terrestrial flora observed at Leeward Harbour.

Terrestrial Flora				
Family	**Genus**	**Species**	**Common Name**	**Habitat**[15]
Agavaceae	*Agave*	*sisiliana*	Sisal	cs/cc
Asteraceae	*Ambrosia*	*hispida*	Bay Geranium	sd
Schizaceae	*Anemia*	*adiantifolia*		pw
Primulaceae	*Ardisia*	*escallanioides*	Marlberry	pw/ew
Acanthaceae	*Avicennia*	*germinans*	Black Mangrove	mn/rs
Asteraceae	*Borrichia*	*arborescens*	Sea Ox-Eye Daisy	rs
Burseraceae	*Bursera*	*simaruba*	Gum Elemi	cc
Malpighiaceae	*Byrsonima*	*lucida*	Guana Berry	pw
Fabaceae	*Caesalpinia*	*bonduc*	Nicker bean	sd/cs/ew
Fabaceae	*Canavalia*	*rosea*	Beach Pea	sd
Fabaceae	*Cassia*	*bahamensis*	Bahama Senna	pw/ew
Lauraceae	*Cassytha*	*filiformis*	Love Vine	pw/ew
Casuarinaceae	*Casuarina*	*equisetifolia*	Australian Beefwood	sd/ew
Chrysobalanaceae	*Chrysobalanus*	*icaco*	Coco Plum	pw/ew
Cyperaceae	*Cladium*	*jamaicense*	Sawgrass	pw/ew
Polygonaceae	*Coccoloba*	*uvifera*	Sea Grape	cs/cc
Polygonaceae	*Coccoloba*	*diversifolia*	Pigeon Plum	pw/cc/ew
Arecaceae	*Coccothrinax*	*argentata*	Silver Thatch Palm	pw/ew
Combretaceae	*Conocarpus*	*erectus*	Button Wood	mn/ew/cs/rs
Malvaceae	*Corchorus*	*hirsutus*	Wooly Bugger	pw
Orchidaceae	*Encyclia*	*sp.*		pw
Rubiaceae	*Erithalis*	*fruticosa*	Black Torch	pw
Rubiaceae	*Ernodea*	*littoralis*		pw/ew
Cyperaceae	*Fimbristylis*	*sp.*		rs
Liliaceae	*Hymenocallis*	*arenicola*	Spider Lily	sd
Convolvulaceae	*Ipomoea*	*indica*	Morning Glory	pw
Convolvulaceae	*Ipomoea*	*microdactyla*		pw
Combretaceae	*Laguncularia*	*racemosa*	White Mangrove	mn
Verbenaceae	*Lantana*	*involucrata*	White Sage	pw
Sapotaceae	*Manilkara*	*bahamensis*	Wild Dilly	cc
Anacardiaceae	*Metopium*	*toxiferum*	Poison Wood	pw/ew
Rubiaceae	*Morinda*	*royoc*		pw/ew
Pinaceae	*Pinus*	*caribea var. bahamensis*		pw
Fabaceae	*Pithecellobium*	*keyense*	Ram's Horn	pw/ew

[15] Pine Woodland – pw, Coastal Coppice – cc, Mangrove – mn, Coastal Shrubland – cs, Rocky Shore – rs, Ephemeral Wetland – ew, Sandy Dune– sd,

Dennstaedtiaceae	*Pteridium*	*aquilinum*	Bracken Fern	pw
Rubiaceae	*Rhachicallis*	*americana*	Wild Thyme	rs
Rhizophoraceae	*Rhizophora*	*mangle*	Red Mangrove	mn/rs
Cyperaceae	*Rynchospora*	*floridensis*		pw
Goodeniaceae	*Scaevola*	*taccada*	Hawaiian Lettuce	sd/rs
Aizoaceae	*Sesuvium*	*sp.*		rs
Sapotaceae	*Sideroxylon*	*americanum*	Wild Saffron	cs/cc
Sapindaceae	*Sideroxylon*	*salicifolium*	Willow Bustic	pw
Smilacaceae	*Smilax*	*havanensis*	Razor Vine	pw
Solanaceae	*Solanum*	*bahamense*	Canker berry	sd/ew
Scrophulariaceae	*Stemodia*	*maritima*	Obeah Bush	pw/ew
Meliaceae	*Swietenia*	*mahagoni*	Caribbean Mahogany	pw/ew
Bignoniaceae	*Tabebuia*	*bahamensis*	Five Finger	pw/ew
Sapindaceae	*Thouinia*	*discolor*	Naked-wood	pw
Cannabacaeae	*Trema*	*lamarckianum*	Pain in back	pw
Typhaceae	*Typha*	*domingensis*	Cattail	ew
Fabaceae	*Vachellia*	*choriophylla*	Cinnecord	pw/ew/cs
Boraginaceae	*Varronia*	*bahamensis*	Cat's Tongue	pw/ew

7.9.2.1.2 High Bank Bay Vegetation Type/ Habitat Type

High Bank Bay – the habitats of High Bank Bay (HBB) consisted of dune, coppice, mix pine and coppice (along the western border) wetland. Canopy height ranged from 1m to >10 m. Dominant plants withing the community were Pigeon Plum, Poisonwood, False Mastic, and Lancewood. The interior coppice was tall and mature with a high canopy. This observation may be due in part to the foraging behavior of feral hogs in the site. Near the borders, the vegetation was dense and hard to maneuver through. Karst formations were observed within the site as well as "hides", previously cleared areas used by bird hunters.

Wetland plants such as buttonwood line sections of the eastern border behind the beach dune. Wetlands were also observed in the interior of High Bank Bay in the south and central sections of the site.

Rocky Shoreline

A series of rocky projections emerge in the near shore environments and scatter the sandy coastline at HBB. The offshore projections are the remnants of Pleistocene dunes which have eroded under the forces of wind and wave action over time. These rocky habitats reach up to 15-20 ft. asl., and small communities of coastal shrubs grow atop these rocks, including *Borrichia arborscens, Hymenocallis arenicola, Tournefortia gnaphalodes, Sesuvim portulacasturm* and *Ambrosia hispida.*

Rocky shorelines at HBB are confined to the southern coastal areas of the property, and these habitats are exposed dogtooth limestone with minimal sediment and plant cover. Species in this habitat include *Sesuvium portulacastrum, Suriana maritima* and *Tournefortia gnaphalodes.*

Figure 7.70. Rocky shore outcroppings at HBB

Figure 7.71. Rocky shore outcropping with salt tolerant vegetation.

Figure 7.72. Tournefortia gnaphalodes, Sesuvium portulacasturm and Borrichia arborescens growing atop rocky outcropping at HBB

Figure 7.73. Hymenocallis arenicola colonizing rocky outcropping at HBB.

Figure 7.74. Hymenocallis arenicola colonizing rocky outcropping at HBB.

Figure 7.75. Rocky shoreline habitat at HBB

Figure 7.76. Rocky shoreline habitat with Sesuvium portulacasturm

Figure 7.77. Eroded rocky shore habitat

Sandy Dune and Coastal Shrub Communities

The shorelines of HBB are high energy systems with intact sandy dunes interspersed with rocky shoreline habitats. The dunes reach heights up to 40 ft. asl. and support a well-established community of low growing salt tolerant species which functions to maintain the integrity of the dune. Along the high-water mark, in the intertidal zones, coastal species such as *Ipomeoa pes caprae, Scaveola taccada, Tournefortia gnaphalodes, Suriana maritima and Uniola paniculata.*

Above the high watermark, a dense ground cover of Sea Oats (*Uniola paniculata)* extends over the dune crest into the valleys behind, accompanied by other salt tolerant species such as

Ambrosia hispida, Cassytha filiformis, Crossopetlaum rhacoma, Ipomoea pes caprae, Cordia sebestena, Suriana maritima, Lantana involucrata, Pilosocereus polygonous, Optunita stricta, Corchorus hirsutus and Cenchrus incertus. Bay Geranium (Ambrosia hispida) forms an extensive ground cover between the dune crest and the low-lying mangrove areas behind the dunes.

Figure 7.78. Sandy dune community at HBB with invasive Scaevola taccada in foreground and Uniola paniculata covering dune ridges

Figure 7.79. Sandy Dune habitat at HBB

Figure 7.80. Sandy Dune habitat at HBB

Figure 7.81. Canavalia rosea (Beach Pea)

Figure 7.82. Opuntia stricta growing in Sea Oats (Uniola paniculata) with Ambrosia hispida.

Figure 7.83. Extensive ground cover of Uniola paniculata and Ambrosia hispida in the coastal shrubland habitat.

Figure 7.84. Coastal shrubland habitat at HBB

Coastal Coppice

Further inland from the coastal shrubland and sandy dune communities, the coastal coppice begins to form as the land elevation increases towards the high ridges on the property. The ocean winds and salt spray have stunted all vegetation on the windward side of the ridges, including the coppice species. The coppice shrublands and coppice and shaped by these forces, created many stout, mutli-stemmed dense communities of plants. Hardwood coppice species typically growing to 25ft tall in an interior coppice are bent and stunted to no higher than 4ft in this habitat. Dominating the windward coastal coppice is *Sideroxylon americanum,* also including *Coccoloba diversifolia, Jacquinia keyensis, Erithalis fruticosa, Guapira discolor (Endemic), Manilkara bahamensis, Canella winteriana, Passiflora cuprae, Bourreria succulenta, Pilosocereus polygonus, Metopium toxiferum, Jacquemontia havanensis, Cyperus glomerulus, Eugenia axillaris, Cestru bahamense. Randia aculeata and Opuntia strica.*

Figure 7.85. Coastal coppice habitat at HBB.

Figure 7.86. Coastal Coppice species Coccothinax argentata and Simarouba glauca

Figure 7.87. Drypetes laterifolia in the coastal coppice habitat at HBB

Dry Broadleaf Interior Coppice

Once behind the crest of the high Pleistocene ridges on the property, the coppice species are more sheltered and grow as taller individuals with less horizontal stems and a more defined understory. The canopy in these forests reach up to 20-25ft and are formed in dark humus rich soil with significant leaf litter. Loose limestone boulders scatter the forest floor, and solution holes, pits and banana holes are common.

Dominant in these interior coppice forests are *Metopium toxiferum* and *Bursera simaruba,* also growing alongside *Eugenia axillaris, Coccoloba diversifolia, Sideroxylon foetidissimum, Swietenia mahagoni (protected), Thouinia discolor (endemic), Tabebuia bahamensis, Hibiscus rosa-sinensis, Drypetes laterifolia,Ateramnus lucidus, Erithalis fruticosa, Bourreria succulenta, Ardisia escallanoides, Guapira obtusata, Psychotria nervosa, Phyllanthus epiphyllanthus, Coaeslanpinia bonduc, Simarouba glauca, Vachellia choriopylla, Exothea paniculata, Ocotea coriaceum, Tournefortia volibulis, Guettarda scabra, Erithalis diffusa, Randia aculeate, Lasciacis divaricata and Tournefortia volibulis.*

Figure 7.88. Broadleaf Coppice habitat at HBB

Figure 7.89. Broadleaf Coppice habitat at HBB

Figure 7.90. Dominant Coccoloba diversifolia in broadleaf coppice habitat at HBB

Figure 7.91 Broadleaf Coppice habitat at HBB

Figure 7.92 Broadleaf Coppice habitat at HBB

Figure 7.93. Broadleaf Coppice habitat at HBB

Figure 7.94. Broadleaf Coppice habitat at HBB

Figure 7.95. Forest floor substrate in the broadleaf coppice habitat at HBB

Figure 7.96. Endemic Thouinia discolor

Pine Woodland

West of the interior broadleaf coppice forests are vast expanses of Pine woodlands typical of the Abaco landscape. The coppice forests gradually transition from a Poisonwood and Gum Elemi dominated canopy to singular individuals to *Pinus caribea* amongst a shrubby understory of *Vachellia choriophylla, Pteridium aquilinum, Passiflora bahamensis, Ernodea littoralis, Cassytha filiformis, Smilax havanensis, Byrsonima lucida, Lantana involucrata, Chiococca parviflora, Jacquemontia havanensis* and *Cassia lucayanum.*

Figure 7.97. Pinus spaling in the transition zone between the boradleaf coppice and pine woodland habitats at HBB

Figure 7.98. Understory shrubs in the Pine woodland transition zone at HBB

Figure 7.99. Pineland species Tetrazygia bicolor

Figure 7.100. Pinus caribea var. bahamensis dominating the woodland canopy

Figure 7.101. Pinus caribea var. bahamensis dominating the woodland canopy

Figure 7.102. Pinus caribea var. bahamensis dominating the woodland canopy

Figure 7.103. High Bank Bay terrestrial habitat map

Table 7.20. High Bank Bay Terrestrial Flora Species List.

Terrestrial Flora				
Family	**Genus**	**Species**	**Common Name**	**Habitat**[16]
Poaceae	*Uniola*	*paniculata*	Sea Oats	SD/CS
Asteraceae	*Ambrosia*	*hispida*	Bay Geranium	SD/CS
Surianaceae	*Suriana*	*maritima*	Bay Cedar	SD/CS
Convolvulaceae	*Ipomoea*	*pes-capraea*	Railroad Vine	SD/CS
Boraginaceae	*Tournafortia*	*gnaphalodes*	Bay Lavendar	SD/CS
Goodeniaceae	*Scaevola*	*taccada*	Hawaiian Lettuce	SD/CS
Euphorbiaceae	*Euphorbia*	*mesembryanthemifolia*	Coast Spurge	SD/CS
Lauraceae	*Cassytha*	*filiformis*	Love Vine	SD/CS/CC/PW
Combretaceae	*Conocarpus*	*erectus*	Button Wood	CS/MN
Polygonaceae	*Coccoloba*	*uvifera*	Sea Grape	SD/CS
Liliaceae	*Hymenocallis*	*arenicola*	Spider Lily	SD/CS
Acanthaceae	*Avicennia*	*germinans*	Black Mangrove	MN
Combretaceae	*Laguncularia*	*racemosa*	White Mangrove	MN
Fabaceae	*Canavalia*	*rosea*	Beach Pea	SD/CS
Anacardiaceae	*Metopium*	*toxiferum*	Poison Wood	CC/CP/PW
Boraginaceae	*Cordia*	*sebestena*	Geiger tree	SD/CS/CC
Cactaceae	*Pilocereus*	*polygonus*	Millspaugh's Dildo	SD/CS/CC
Sapotaceae	*Sideroxylon*	*americanum*	Wild Saffron	CS/CC/MN
Poaceae	*Cenchrus*	*incertus*	Sand Bur	SD/CS
Verbenaceae	*Lantana*	*involucrata*	White Sage	SD/CS
Malvaceae	*Corchorus*	*hirsutus*	Wooly Bugger	CS
Polygonaceae	*Coccoloba*	*diversifolia*	Pigeon Plum	CC/CP/PW
Primulaceae	*Jacquinia*	*keyensis*	Joewood	CS/CC
Rubiaceae	*Erithalis*	*fruticosa*	Black Torch	CS/CC
Nyctaginaceae	*Guapira*	*discolor*	Narrow Leaf Blolly	CC/CP
Sapotaceae	*Manilkara*	*bahamensis*	Wild Dilly	CP
Canellaceae	*Canella*	*winteriiana*	Cinnamon Bark	CP
Passifloraceae	*Passiflora*	*bahamensis*		PW
Asteraceae	*Chromolaena*	*lucayanum*		CS
Boraginaceae	*Bourreria*	*succulenta*	Strong Back	CP
Convolvulaceae	*Jacquemontia*	*cayensis*		CS/CC
Cyperaceae	*Cyperus*	*sp.*		MN
Myrtaceae	*Eugenia*	*axillaris*	Stopper	CC/CP
Solanaceae	*Cestrum*	*bahamense*		CS
Rubiaceae	*Randia*	*aculeata*	Box Briar	CC/CP

[16] Sand Dune – SD, Pine Woodland – PW, Coastal Coppice – CC, Mangrove – MN, Coastal Shrubland – CS, Coppice – CP

Cactaceae	*Opuntia*	*stricta*	Prickly Pear	SD/CS/CC
Asteraceae	*Gundlachia*	*corymbosa*	Horse bush	CS/CC
Arecaceae	*Coccothrinax*	*argentata*	Silver Thatch Palm	CS/CC
Burseraceae	*Bursera*	*simaruba*	Gum Elemi	CP/PW
Simaroubaceae	*Simarouba*	*glauca*	Paradise Tree	CC/CP
Fabaceae	*Vachellia*	*choriophylla*	Cinnecord	CS/CP/PW
Malvaceae	*Hibiscus*	*clypeatus L. subsp. Membranaceus*	Bahama Hibiscus	CC/CP
	Malvaviscus	*arboreus*	Salva's Malvaviscus	CP/PW
Putranjivaceae	*Drypetes*	*diversifolia*	Whitewood	CC/CP
Sapotaceae	*Sideroxylon*	*foetidssimum*	Mastic Tree	CP
Euphorbiaceae	*Ateramnus*	*lucidus*	Crabwood	CC/CP
Apocynaceae	*Angadenia*	*berteroi*	Lice Root	SD/CS/CC
Picramniaceae	*Alvaradoa*	*amorphoides*		CP
Bignoniaceae	*Tabebuia*	*bahamensis*	Five Finger	CP/PW
Primulaceae	*Ardisia*	*escallanioides*	Marlberry	CP/PW
Passifloraceae	*Passiflora*	*cupraea*	Devil's Pumpkin	CC/CP
Nyctaginaceae	*Guapira*	*obtusata*	Broad leaf Bolly	CC/CP
Convolvulaceae	*Jacquemontia*	*havanensis*		CS/CC
Rubiaceae	*Psychotria*	*nervosa*	Wild Coffee	CP
Sapindaceae	*Thouinia*	*discolor*	Naked-wood	CP/PW
Boraginaceae	*Tournafortia*	*volubilis*	Soldier Vine	CP
Poaceae	*Lasciacis*	*divaricata*	Wild Cane	CP
Lamiaceae	*Petitia*	*domingensis*	Bastard stopper	PW
Lauraceae	*Ocotea*	*coriaceae*	Sweet Torchwood	CP
Sapindaceae	*Exothea*	*paniculata*	Butterbough	CP
Rubiaceae	*Guettarda*	*scabra*	Velvet Seed	CP
Asteraceae	*Salmea*	*petrobioides*	Shanks	CS/CC
Rubiaceae	*Morinda*	*royoc*		PW
Rubiaceae	*Chiococca*	*parviflora*	Pineland Snowberry	PW
Rhamnaceae	*Reynosia*	*septentrionalis*	Darling Plum	CC
Cannabaceae	*Trema*	*lamarckianum*	Pain in back	CP
Meliaceae	*Swietenia*	*mahagoni*	Caribbean Mahogany	CP/PW
Euphorbiaceae	*Croton*	*lucidus*	Fire Bush	CP
Melastomataceae	*Tetrazygia*	*bicolor*		PW
Dennstaedtiaceae	*Pteridium*	*aquilinum*	Bracken Fern	PW
Pinaceae	*Pinus*	*caribea var. bahamensis*		PW
Euphorbiaceae	*Savia*	*bahamensis*	Maiden Bush	CS/CC
Euphorbiaceae	*Philanthus*	*epiphilanthus*	Sword Bush	CP
Fabaceae	*Caesalpinia*	*bonduc*	Nicker bean	CC/CP

7.9.2.1.3 Conch Sound Point Vegetation Type/ Habitat Type

Conch Sound Point contained a similar vegetation profile as HBB with mixed pineland habitat on the western border and coppice forest being the dominant plant community. Karst formations were observed within the site. Wetlands dominated by buttonwood were found along sections of the property's eastern boundary, behind the eastern shore sand dunes.

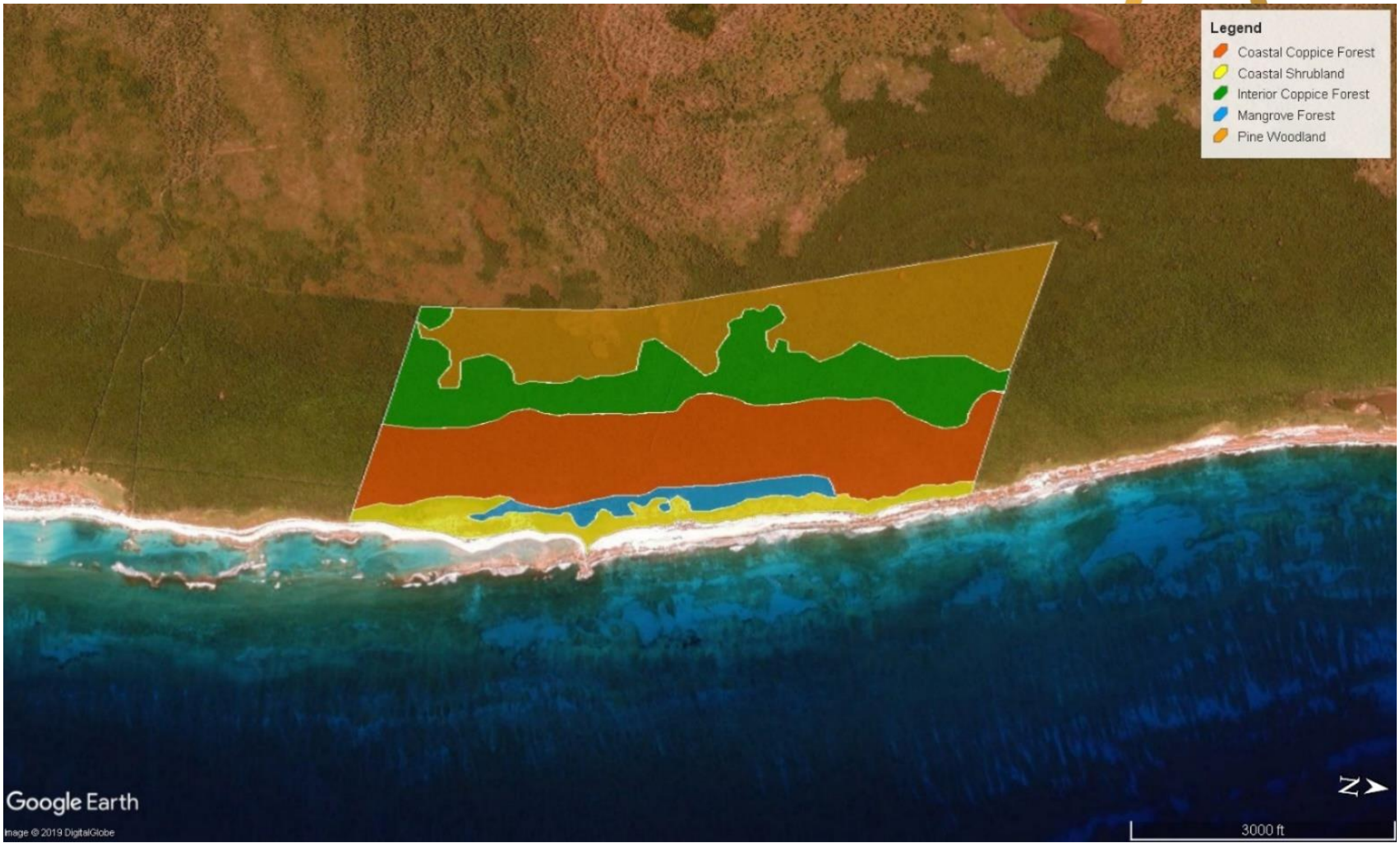

Figure 7.104. Terrestrial habitat Map of CSP

Pine Woodland

West of the interior broadleaf coppice forests are vast expanses of Pine woodlands typical of the Abaco landscape. The coppice forests gradually transitions from a Poisonwood and Gum Elemi dominated canopy to singular individuals to *Pinus caribea* amongst a shrubby understory of *Coccothrinax argentata, Thouinia discolor, Vachellia choriophylla, Pteridium aquilinum, Passiflora bahamensis, Ernodea littoralis, Cassytha filiformis, Smilax havanensis, Byrsonima lucida, Lantana involucrata, Chiococca parviflora, Jacquemontia havanensis* and *Cassia lucayanum.*

Figure 7.105. Pine woodland habitat at CSP

Figure 7.106. Pine woodland habitat at CSP

Figure 7.107. Pinus caribea var. bahamensis trunk

Dry Broadleaf Interior Coppice

Once behind the crest of the high Pleistocene ridges on the property, the coppice species are more sheltered and grow as taller individuals with less horizontal stems and a more defined understory. The canopy in these forests reach up to 20-25ft. and are formed in dark humus rich soil with significant leaf litter. Loose limestone boulders scatter the forest floor, and solution holes, pits and banana holes are common.

Dominant in these interior coppice forests are *Metopium toxiferum* and *Bursera simaruba,* also growing alongside *Eugenia axillaris, Coccoloba diversifolia, Sideroxylon foetidissimum, Swietenia mahagoni (protected), Thouinia discolor (endemic), Tabebuia bahamensis, Hibiscus rosa-sinensis, Drypetes laterifolia,Ateramnus lucidus, Erithalis fruticosa, Bourreria succulenta, Ardisia escallanoides, Guapira obtusata, Psychotria nervosa, Phyllanthus epiphyllanthus, Coaeslanpinia bonduc, Simarouba glauca, Vachellia choriopylla, Exothea paniculata, Ocotea coriaceum, Tournefortia volibulis, Guettarda scabra, Erithalis diffusa, Randia aculeate, Lasciacis divaricata* and *Tournefortia volibulis.*

Figure 7.108. Dry broadleaf interior coppice habitat at CSP.

Figure 7.109. Dry broadleaf interior coppice habitat at CSP.

Figure 7.110. Metopium toxiferum in interior coppice habitat at CSP.

Coastal Coppice

Further inland from the coastal shrubland and sandy dune communities, the coastal coppice begins to form as the land elevation increases towards the high ridges on the property. The ocean winds and salts pray have stunted all vegetation on the windward side of the ridges, including the coppice species. The coppice shrublands and coppice shaped by these forces, created many stouts, mutli-stemmed dense communities of plants. Hardwood coppice species typically growing to 25ft tall in an interior coppice are bent and stunted to no higher than 4ft in this habitat. Dominating the windward coastal coppice is *Sideroxylon americanum,* also including *Coccoloba diversifolia, Jacquinia keyensis, Erithalis fruticosa, Guapira discolor (Endemic), Manilkara bahamensis, Canella winteriana, Passiflora cuprae, Bourreria succulenta, Pilosocereus polygonus, Metopium toxiferum, Jacquemontia havanensis, Cyperus glomerulus, Eugenia axillaris, Cestru bahamense. Randia aculeata* and *Opuntia strica.*

Figure 7.111. Coastal coppice habitat at CSP.

Figure 7.112. Coastal coppice habitat at CSP.

Coastal Shrubland & Sand Dune Community

The shorelines of CSP are high energy systems with intact sandy dunes interspersed with rocky shoreline habitats. The dunes reach heights up to 40ft asl and support a well-established community of low growing salt tolerant species which functioni to maintain the integrity of the dune. Along the high-water mark, in the intertidal zones, coastal species such as *Ipomeoa pes caprae, Scaveola taccada, Tournefortia gnaphalodes, Suriana maritima and Uniola paniculata.*

Above the high watermark, a dense ground cover of Sea Oats (*Uniola paniculata)* extends over the dune crest into the valleys behind, accompanied by other salt tolerant species such as *Ambrosia hispida, Cassytha filiformis, Crossopetlaum rhacoma, Ipomoea pes caprae, Cordia sebestena, Suriana maritima, Lantana involucrata, Pilosocereus polygonous, Optunita stricta, Corchorus hirsutus* and *Cenchrus incertus.* Bay Geranium (Ambrosia hispida) forms an extensive ground cover between the dune crest and the low-lying mangrove areas behind the dunes.

Figure 7.113. Coastal shrubland and dune community at CSP.

Figure 7.114*. Coastal shrubland and dune community at CSP*

Figure 7.115. Coastal shrubland and dune community at CSP

Figure 7.116. Coastal shrubland and dune community at CSP

Rocky Shore

A series of rocky projections emerge in the near shore environments and scatter the sandy coastline at CSP. The offshore projections are the remnants of Pleistocene dunes which have eroded under the forces of wind and wave action over time. These rocky habitats reach up to 15-20ft asl, and small communities of coastal shrubs grow atop these rocks, including *Borrichia arborscens, Hymenocallis arenicola, Tournefortia gnaphalodes, Sesuvim portulacasturm* and *Ambrosia hispida.*

Figure 7.117. Rocky shore habitat at CSP

Figure 7.118. Rocky shore habitat at CSP

Table 7.21. Conch Sound Point botanical species list.

Flora			
Family	**Genus**	**Species**	**Common Name**
Picramniaceae	*Alvaradoa*	*amorphoides*	
Asteraceae	*Ambrosia*	*hispida*	Bay Geranium
Apocynaceae	*Angadenia*	*berteroi*	Lice Root
Primulaceae	*Ardisia*	*escallanioides*	Marlberry
Euphorbiaceae	*Ateramnus*	*lucidus*	Crabwood
Acanthaceae	*Avicennia*	*germinans*	Black Mangrove
Boraginaceae	*Bourreria*	*succulenta*	Strong Back
Burseraceae	*Bursera*	*simaruba*	Gum Elemi
Fabaceae	*Caesalpinia*	*bonduc*	Nicker bean
Fabaceae	*Canavalia*	*rosea*	Beach Pea
Canellaceae	*Canella*	*winteriiana*	Cinnamon Bark
Lauraceae	*Cassytha*	*filiformis*	Love Vine
Poaceae	*Cenchrus*	*incertus*	Sand Bur
Solanaceae	*Cestrum*	*bahamense*	
Rubiaceae	*Chiococca*	*parviflora*	Pineland Snowberry
Asteraceae	*Chromolaena*	*lucayanum*	
Polygonaceae	*Coccoloba*	*uvifera*	Sea Grape
Polygonaceae	*Coccoloba*	*diversifolia*	Pigeon Plum
Arecaceae	*Coccothrinax*	*argentata*	Silver Thatch Palm
Combretaceae	*Conocarpus*	*erectus*	Button Wood
Malvaceae	*Corchorus*	*hirsutus*	Wooly Bugger
Boraginaceae	*Cordia*	*sebestena*	Geiger tree
Euphorbiaceae	*Croton*	*lucidus*	Fire Bush
Cyperaceae	*Cyperus*	*sp.*	
Putranjivaceae	*Drypetes*	*diversifolia*	Whitewood
Rubiaceae	*Erithalis*	*fruticosa*	Black Torch
Myrtaceae	*Eugenia*	*axillaris*	Stopper
Euphorbiaceae	*Euphorbia*	*mesembryanthemifolia*	Coast Spurge
Sapindaceae	*Exothea*	*paniculata*	Butterbough
Nyctaginaceae	*Guapira*	*discolor*	Narrow Leaf blolly
Nyctaginaceae	*Guapira*	*obtusata*	Broad leaf bolly
Rubiaceae	*Guettarda*	*scabra*	Velvet Seed

Asteraceae	*Gundlachia*	*corymbosa*	Horse bush
Malvaceae	*Hibiscus*	*clypeatus L. subsp. Membranaceus*	Bahama Hibiscus
Liliaceae	*Hymenocallis*	*arenicola*	Spider Lily
Convolvulaceae	*Ipomoea*	*pes-capraea*	Railroad Vine
Convolvulaceae	*Jacquemontia*	*cayensis*	
Convolvulaceae	*Jacquemontia*	*havanensis*	
Primulaceae	*Jacquinia*	*keyensis*	Joewood
Combretaceae	*Laguncularia*	*racemosa*	White Mangrove
Verbenaceae	*Lantana*	*involucrata*	White Sage
Poaceae	*Lasciacis*	*divaricata*	Wild Cane
	Malvaviscus	*arboreus*	Salva's Malvaviscus
Sapotaceae	*Manilkara*	*bahamensis*	Wild Dilly
Anacardiaceae	*Metopium*	*toxiferum*	Poison Wood
Rubiaceae	*Morinda*	*royoc*	
Lauraceae	*Ocotea*	*coriaceae*	Sweet Torchwood
Cactaceae	*Opuntia*	*stricta*	Prickly Pear
Passifloraceae	*Passiflora*	*bahamensis*	
Passifloraceae	*Passiflora*	*cupraea*	Devil's Pumpkin
Lamiaceae	*Petitia*	*domingensis*	Bastard stopper
Euphorbiaceae	*Philanthus*	*epiphilanthus*	Sword Bush
Cactaceae	*Pilocereus*	*polygonus*	Millspaugh's Dildo
Pinaceae	*Pinus*	*caribea var. bahamensis*	
Rubiaceae	*Psychotria*	*nervosa*	Wild Coffee
Dennstaedtiaceae	*Pteridium*	*aquilinum*	Bracken Fern
Rubiaceae	*Randia*	*aculeata*	Box Briar
Rhamnaceae	*Reynosia*	*septentrionalis*	Darling Plum
Asteraceae	*Salmea*	*petrobioides*	Shanks
Euphorbiaceae	*Savia*	*bahamensis*	Maiden Bush
Goodeniaceae	*Scaevola*	*taccada*	Hawaiian Lettuce
Sapotaceae	*Sideroxylon*	*americanum*	Wild Saffron
Sapotaceae	*Sideroxylon*	*foetidssimum*	Mastic Tree
Simaroubaceae	*Simarouba*	*glauca*	Paradise Tree
Surianaceae	*Suriana*	*maritima*	Bay Cedar
Meliaceae	*Swietenia*	*mahagoni*	Caribbean Mahogany
Bignoniaceae	*Tabebuia*	*bahamensis*	Five Finger

Melastomataceae	*Tetrazygia*	*bicolor*	
Sapindaceae	*Thouinia*	*discolor*	Naked-wood
Boraginaceae	*Tournafortia*	*gnaphalodes*	Bay Lavendar
Boraginaceae	*Tournafortia*	*volubilis*	Soldier Vine
Cannabacaeae	*Trema*	*lamarckianum*	Pain in back
Poaceae	*Uniola*	*paniculata*	Sea Oats
Fabaceae	*Vachellia*	*choriophylla*	Cinnecord
Casuarinaceae	*Casuarina*	*equisetifolia*	Australian Pine
Goodeniaceae	*Scaevola*	*plumieri*	Inkberry
Rhamnaceae	*Colubrina*	*arborescens*	Snakeroot
Asteraceae	*Iva*	*imbricata*	Beach Iva
Convolvulaceae	*Ipomoea*	*microdactyla*	Wild Potato
Fabaceae	*Sophora*	*tomentosa*	Sea Pod Necklace
Myrtaceae	*Psidium*	*longipes*	Sweet Margaret

7.9.2.2 Faunal Survey Methodology

Avian Surveys

Distance Sampling was used to determine avian species' richness within the site. Points were separated at 200m from each other and were conducted by two observers. Observers recorded all species flying around the site for 10 minutes at each point and measured the perpendicular distance of each species using a Bushnell Fusion 10x42 Binoculars with built in range finders, and Vortex 8x42 Binoculars. Walking transects were also used in addition to point counts surveys and all species seen or heard were recorded

Non-Avian surveys

Walking transects were done to develop an inventory of all non-avian species within the sites. All species seen or heard were recorded. Because both the HBB and CSP sites were in the same area and were similar in plant community and structure, we combined the species list across both sites.

7.9.2.3 Faunal Survey Results

7.9.2.3.1 Leeward Harbour Faunal Survey Results

Avian

Avian species diversity was high at the LH site, with 35 species recorded during the survey period. Of these, 10 species were species of concern, one species (the Bahama Swallow) was endangered, and one species (the Chimney Swift) was listed as Vulnerable (see table 7.19). Hummingbirds were common to abundant within the site and both the Bahama Woodstar and Cuban Emerald seen.

Arthropods were the most seen non-avian animals within the site. The presence of feral hog footprints, scat, and depressions in grassy areas of the site indicate they were actively using the site as a foraging and resting ground. Lizards such as Bahama Brown anoles and Saw-scaled Curlytails were present, but these species were not as conspicuous as in other places visited on Abaco.

Table 7.19. Avian species seen at Leeward Harbour site.

Common	*Scientific*	*IUCN Status*	*Species of Concern*
Bahama Swallow	*Tachycineta cyannoviridis*	*EN*	*Yes*
Bahama Woodstar	*Nesophlox evelynae*	*LC*	*No*
Bahama Yellowthroat	*Geothlypis rostrata tanneri*	*LC*	*Yes*
Bananaquit	*Coereba flaveola bahamensis*	*LC*	*No*
Barn Swallow	*Hirundo rustica*	*LC*	*No*
Belted Kingfisher	*Megaceryle alcyon*	*LC*	*Yes*
Black and White Warbler	*Mniotilta varia*	*LC*	*No*
Black-faced Grassquit	*Melanospiza bicolor*	*LC*	*No*
Black-whiskered Vireo	*Vireo altiloquus*	*LC*	*No*
Blue gray Gnatcatcher	*Polioptila caerulea*	*LC*	*No*
Bobolink	*Dolichonyx oryzivorus*	*LC*	*Yes*
Brown Pelican	*Pelecanus occidentalis*	*LC*	*Yes*
Cape May Warbler	*Setophaga tigrina*	*LC*	*Yes*
Chimney Swift	*Chaetura pelagica*	*VU*	*Yes*
Cuban Emerald	*Riccordia riccordi*	*LC*	*No*
Cuban Pewee	*Contopus caribaeus bahamensis*	*LC*	*No*
Grey Kingbird	*Tyrannus dominicus*	*LC*	*No*
Hairy Woodpecker	*Leuconotopicus villosus*	*LC*	*No*
LaSagras Flycatcher	*Myiarchus sagrae*	*LC*	*No*
Northern Mockingbird	*Mimus polyglottus*	*LC*	*No*
Northern Parula	*Setophaga americana*	*LC*	*No*

Palm Warbler	*Setophaga palmarum*	*LC*	*No*
Pine Warbler	*Setophaga pinus*	*LC*	*No*
Red legged Thrush	*Turdus plumbeus plumbeus*	*LC*	*No*
Red-winged Blackbird	*Agelaius phoeniceus*	*LC*	*No*
Solitary Sandpiper	*Tringa solitaria*	*LC*	*No*
Spotted Sandpiper	*Actitis macularius*	*LC*	*No*
Thick-billed Vireo	*Vireo crassirostris crassirostris*	*LC*	*No*
Turkey Vulture	*Cathartes aura*	*LC*	*No*
Upland Sandpiper	*Bartramia longicauda*	*LC*	*No*
West Indian Woodpecker	*Melanerpes supercilliaris blakei*	*LC*	*Yes*
Western Sandpiper	*Calidris mauri*	*LC*	*No*
Western Spindalis	*Spindalis zena townsendi*	*LC*	*Yes*
Wilson's Plover	*Charadrius wilsoni*	*LC*	*Yes*
Yellow-billed Cuckoo	*Coccyzus minor*	*LC*	*No*

Figure 7.119 Bahama Woodstar hummingbird, a species endemic to the Lucayan Archipelago.

Figure 7.120 A Red-legged Thrush, an endemic Bahamian subspecies.

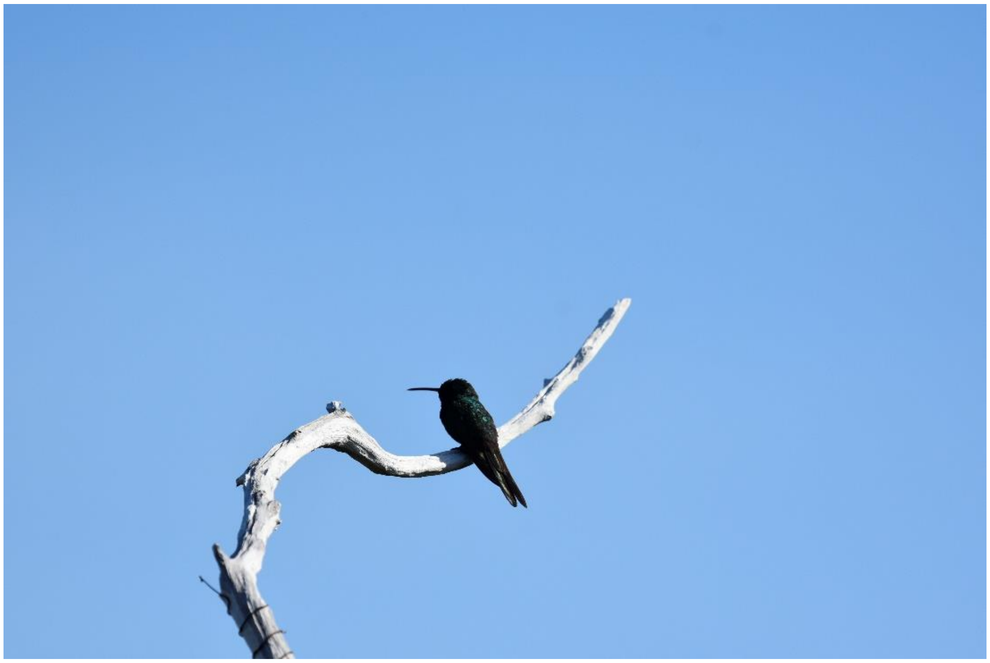

Figure 7.121. A male Cuban Emerald.

Figure 7.122. A Northern Waterthrush.

Table 7.20. Non-Avian species seen at Leeward Harbour site.

Common Name	Scientific Name	IUCN Status
Peanut Snail	*Cerion*	*N/A*
Saw-scaled Curlytail	*Leiocephalus carinatus amouri*	*LC*
Common Paperwasp	*Polistes exclamans*	*N/A*
American Bird Grasshopper	*Schistocerca americana*	*N/A*
Soldier Crab	*Coenobita clypeatus*	*N/A*
Feral Hog	*Sus scrofa*	*LC*
Bahama Brown Anole	*Norops sagrei ordinatus*	*LC*
Polydamas Swallowtail	*Battus polydamas lucayus*	*LC*

7.9.2.3.2 High Bank Bay and Conch Sound Faunal Survey Results

Avian

A total of 49 species of birds were seen in and around the High Bank Bay and Conch Sound Point sites. Of these, 13 species are listed as species of High Concern and three species are listed as Near Threatened by the International Union for the Conservation of Nature (IUCN). Endemic subspecies and economically important species such as the Abaco Parrot, White-crowned Pigeon and West Indian Woodpecker were observed foraging, roosting and possibly nesting within the site.

Figure 7.123. Some species of birds seen in HPP and CSP sites: Tope left-Abaco Parrot, Top right- Bahama Yellowthroat, Bottom Left- Spotted Sandpiper, Bottom Right- Solitary Sandpiper.

Non-Avian

Both HBB and CSP had a wealth of diversity including Cuban Tree Frogs, Brown speckled Geckolets, Bahama Brown Anoles, various species of arthropods and invasive mammals such as raccoons and feral hogs. The Cuban funnel web spider was found in both sites but appeared to be more common in the HBB site. This species is range restricted, being found only on the islands of Cuba and the Lucayan Archipelago.

Table 7.21. Avian species seen at High Bank Bay and Conch Sound Point site.

Common	*Scientific*	*IUCN Status*	Species of Concern
American Oystercatcher	*Haematopus palliatus*	*LC*	Yes
American Redstart	*Setophaga ruticilla*	*LC*	No
Bahama Mockingbird	*Mimus gundlachii*	*LC*	No
Abaco (Bahama) Parrot	*Amazona leucocephala bahamensis/ abacoensis*	*NT*	Yes
Bahama Warbler	*Setophaga flavescens*	*EN*	Yes
Bahama Woodstar	*Nesophlox evelynae*	*LC*	No
Bahama Yellowthroat	*Geothlypis rostrata tanneri*	*LC*	Yes
Barn Swallow	*Hirundo rustica*	*LC*	No
Black and White Warbler	*Mniotilta varia*	*LC*	No
Black-throated Blue Warbler	*Setophaga caerulescens*	*LC*	No
Black-throated Green Warbler	*Setophaga virens*	*LC*	No
Black-whiskered Vireo	*Vireo altiloquus*	*LC*	No
Blue-gray Gnatcatcher	*Polioptila caerulea*	*LC*	No
Cape May Warbler	*Setophaga tigrina*	*LC*	Yes
Chuck-wills Widow	*Antrostomus carolinensis*	*NT*	Yes
Common Ground Dove	*Columbina passerina*	*LC*	No
Common Yellowthroat	*Geothlypis trichas*	*LC*	No
Cuban Emerald	*Riccordia ricordii*	*LC*	No
Great Egret	*Egretta alba*	*LC*	No
Greater- Antillean Bullfinch	*Melopyrrha violacea*	*LC*	No
Green Heron	*Butroides virescens bahamensis*	*LC*	No
Hairy Woodpecker	*Leuconotopicus villosus*	*LC*	No
Key West Quail Dove	*Geotrygon chrysia*	*LC*	No
LaSagra's Flycatcher	*Myarchus sagrae*	*LC*	No
Laughing Gull	*Leucophaeus atricilla*	*LC*	No
Least Sandpiper	*Calidris minutilla*	*LC*	No
Least Tern	*Sternula antillarum*	*LC*	No

Loggerhead Kingbird	*Tyrannus caudifasciatus bahamensis*	*LC*	No
Mangrove Cuckoo	*Coccyzus minor*	*LC*	Yes
Northern Parula	*Setophaga americana*	*LC*	No
Northern Waterthrush	*Parkesia noveboracensis*	*LC*	No
Olive-capped Warbler	*Setophaga pityophila*	*LC*	Yes
Osprey	*Pandion hileatus*	*LC*	No
Ovenbird	*Seiurus aurocapilla*	*LC*	No
Palm Warbler	*Setophaga palmarum*	*LC*	No
Pine Warbler	*Setophaga pinus*	*LC*	No
Red legged Thrush	*Turdus plumbeus plumbeus*	*LC*	No
Royal Tern	*Thalasseus maximus*	*LC*	No
Smooth-billed Ani	*Crotophaga ani*	*LC*	No
Solitary Sandpiper	*Tringa solitaria*	*LC*	No
Spotted Sandpiper	*Actitis macularius*	*LC*	No
Thick-billed Vireo	*Vireo crassirostris crassirostris*	*LC*	No
Turkey Vulture	*Cathartes aura*	*LC*	No
West Indian Woodpecker	*Melanerpes supercilliaris*	*LC*	Yes
White-crowned Pigeon	*Patagioenas leucocephala*	*NT*	Yes
White-tailed Tropicbird	*Phaethon lepturus*	*LC*	Yes
Wilson's Plover	*Charadrius wilsoni*	*LC*	Yes
Yellow-billed Cuckoo	*Coccyzus americanus*	*LC*	Yes
Zenaida Dove	*Zenaida aurita*	*LC*	No

Table 7.22. Non-Avian species seen at High Bank Bay and Conch Sound Point site.

Common Name	Scientific Name	IUCN Status
American Bird Grasshopper	*Schistocerca americana*	*N/A*
Atala Hairstreak	*Eumaeus atala*	*N/A*
Bahama Brown Anole	*Norops sagrei ordinatus*	*LC*
Bahamian Cicada*	*Diceroprocta bonhotei*	*N/A*
Banana Spider	*Nephilia clavipes*	*LC*
Brown-speckled Geckolet	*Sphaerodactlyus notatus peltastes*	*LC*
Common Paperwasp	*Polistes exclamans*	*N/A*
Cuban Funnelweb Spider	*Ischnothele longicauda*	*N/A*
Cuban Treefrog	*Osteopilus septentrionalis*	*LC*
Eastern Pondhawk	*Erythemis simplicicollis*	*N/A*
European Honeybee	*Apis mellifera*	*N/A*
Feral Hog	*Sus scrofa*	*LC*
Florida Duskywing	*Ephyriades brunnea*	*N/A*
Gulf Fritilary	*Dione vanillae*	*N/A*
Micrathena sp.	*Micrathena sp.*	*N/A*
Polydamas Swallowtail	*Battus polydamas lucayus*	*N/A*
Raccoon	*Procyon loctor*	*LC*
Tent Web Spider	*Cytophora citricola*	*N/A*
Trashline Spider	*Cyclosa turbinata*	*N/A*
White Micrathena	*Micrathena mitrata*	*N/A*

7.9.3 Species of Cultural and Economic Importance

The Abaco Parrot (a sub species of the Cuban Parrot) is a range restricted, single island endemic subspecies whose population is primarily concentrated only in South Abaco. The Cuban Parrot is listed as Near Threatened by the International Union for the Conservation of Nature (IUCN). Research on this parrot population indicate that is genetically distinct from other Cuban Parrot populations, including the Inagua Parrot populations, leading some scientists to regard it as its own unique subspecies (*Amazona leucocephala abacoensis*). Parrots were heard and observed throughout the HBB and CSP sites both roosting and foraging. West Indian Woodpeckers, also a range restricted species, being found only on the islands of Abaco and San Salvador. Abaco has a distinct subspecies (*Melanerpes superciliaris blakei*) that is endemic to the island. Although it is frequently seen in some residential areas, it is found primarily in coppice forests or mixed coppice, unlike the Hairy Woodpecker which primarily inhabits the pinelands. West Indian Woodpeckers were found throughout all three sites.

White-crowned Pigeon

Poisonwood was common to all three sites and was especially common in High Bank Bay, indicating the presence of White-crowned Pigeons. The White-crowned Pigeon is a Near Threatened species native to The Bahamas, South Florida, the Greater Antilles, and parts of the Lesser Antilles. This species is also regarded as one of the most important game birds in The Bahamas.

7.9.4 Human Influence

7.9.4.1 Leeward Harbour Human Influence

There were no signs of human activity within the site, but people were seen fishing and harvesting conch near the western sandy shore of the site.

7.9.4.2 High Bank Bay Human Influence

The presence of Hunters "hides", the many feral hogs (an invasive species) within the site and the abundant debris along the eastern shoreline of the site were clear indicators of human activity within and around the site. Historic human artifacts were also found near the southeastern boundary of HBB.

7.9.4.3 Conch Sound Point Human Influence

As with High Bank Bay, Hunter "hides", human debris washed up on shore, feral hog fecal remains and signs of ATV activity have been observed. ATV tracks have been seen on the shoreline heading north and on one occasion, a visitor to the site was seen with an ATV on the back of his pickup truck.

7.9.5 Habitat Utilization and Food Sources for Native Sources

Parrots and other species use the coppice to forage, during the breeding and non-breeding season and feed on a variety of fruits including West Indian Mahagony, Gum Elemi, Mastic, Poisonwood, Pigeon plum, and many others. White-crowned Pigeons also feed on many of the same plant species as Abaco Parrots and the abundance of poisonwood throughout the site highlights the importance of this poisonous plant species as a major food source. Cavity nesting species such as the West Indian Woodpecker use dead trees to make holes for their nests.

7.9.6 Caves and Blue Holes

7.9.6.1 Leeward Harbour Caves and Blue Holes

No caves or blue holes exist on the LH site. Karst formations occurring on the site are restricted to shallow holes and depressions in the exposed limestone substrate, some collecting water during rainfall and/or supporting species such as *Cladium jamaicense* or *Typha domingensis* in the wet mud accumulating within the depressions.

7.9.6.2 High Bank Bay Caves and Blue Holes

Karst formations of various sizes were seen within the High Bank Bay site. Some contained freshwater and are presumed to be important water resources for the abundant feral hogs occupying the site. No caves or blue holes were seen within the marine survey area. Karst formations occurring on the site are restricted to shallow holes and depressions in the exposed limestone substrate, some collecting water during rainfall.

7.9.6.3 Conch Sound Point Caves and Blue Holes

No caves or blue holes were seen within the marine survey area. Karst formations of various sizes depths were seen throughout the site. occurring on the site are restricted to shallow holes and depressions in the exposed limestone substrate, some collecting water during rainfall.

7.10 MARINE RESOURCE SURVEY

Historically, the islands of Grand Bahama and Abaco were connected due to lower sea levels, during the last ice age which ended approximately 10,000 years ago. Today, the waters spanning between Abaco and Grand Bahama are known as the Little Bahama Bank. A shallower, warmer area of ocean when compared to the deep dark, and colder Atlantic Ocean to the east of Abaco. Furthermore, it is noted that coral reefs account for approximately 1,231 sq. miles of territory within The Bahamas.

7.10.1 Leeward Harbour Marine Survey Methodology

The original Benthic surveys were performed at Leeward Harbour on October 10th and 11th, 2018 between the hours of 12:15 p.m. to 3:58 p.m., November 6th and 7th, 2018 between the hours of 12:10 p.m. to 4:12 p.m. and December 18th, 2018, between the hours of 2:05 p.m. to 3:20 p.m. via manta tow and roving techniques. The manta tow technique involves an observer (snorkel diver) attached to a manta board while the diver is towed behind a boat by a 17-meter rope. The diver makes a visual assessment of the existing habitat, organisms, coral reef structures or other notable features while recording data. The benthic survey occurred along the entire shoreline of the proposed site, as well as 1,000 ft. from the shoreline into the sublittoral and pelagic zone (Figure 58). This motion was repeated until the diver arrived at the starting point of the survey, several meters from the boundary shoreline of the proposed site. Furthermore, roving surveys using snorkel equipment were completed within the survey area by swimming parallel and perpendicular to the shore. Fish species were recorded and assigned one of four abundance categories based on their species count within the area (Single = 1, Few = 2 - 11, Many = 11-100, and Abundant = > 100).

Updated marine surveys performed at Leeward Harbour on May 8th and 9th 2023, via manta tow and snorkel survey. The manta tow technique involves an observer (snorkel diver) being towed behind a boat by holding onto a rope. The diver makes a visual assessment of the existing habitat, organisms, coral reef structures or other notable features while taking photos for later assessment. The surveys were similar to the previous surveys completed in 2018. These updated surveys took place to confirm if there were any changes to the general marine habitat. Between 2018 to 2023 a major hurricane, Dorian, had taken place and the surveys were conducted to see if there was damage to the ecosystem and corals within the site.

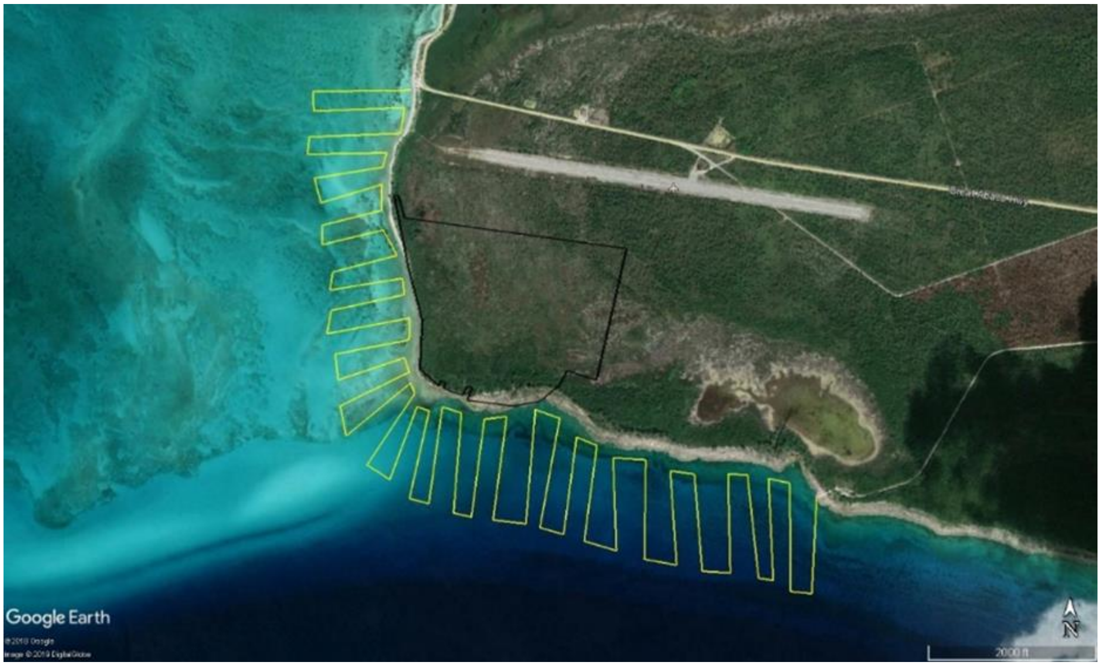

Figure 7.124. Map of benthic survey area at Leeward Harbour depicting survey route. (2018)

Figure 7.125. Map of benthic survey area at Leeward Harbour depicting survey route. (2023)

7.10.1.1 Leeward Harbour Benthic Habitat Description

The benthic habitat at Leeward Harbour is unique, as it is geographically positioned within the shallow waters of the Little Bahama Bank to the west and the deeper waters to the south which are characterized by continental margins. Its surrounding marine habitat consists of various marine habitats such as patch reef systems, hard bottom, sandy bottom, seagrass beds and the rocky intertidal zone.

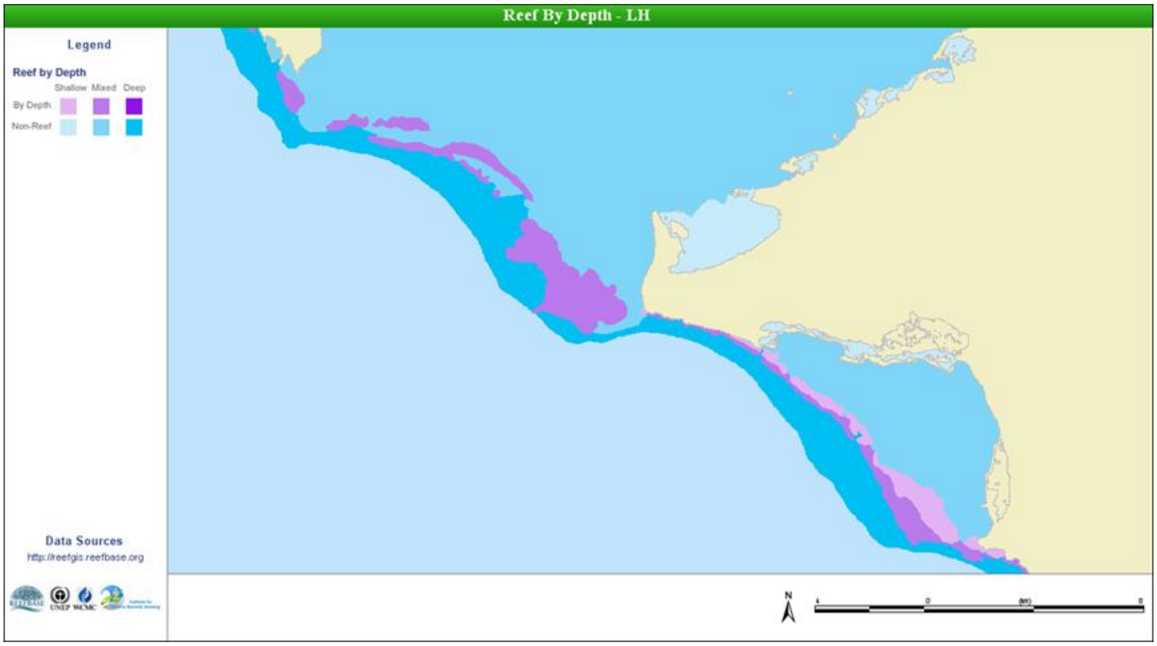

Figure 7.126 Depth of coral reef systems located northwest and southwest of Leeward Harbour.

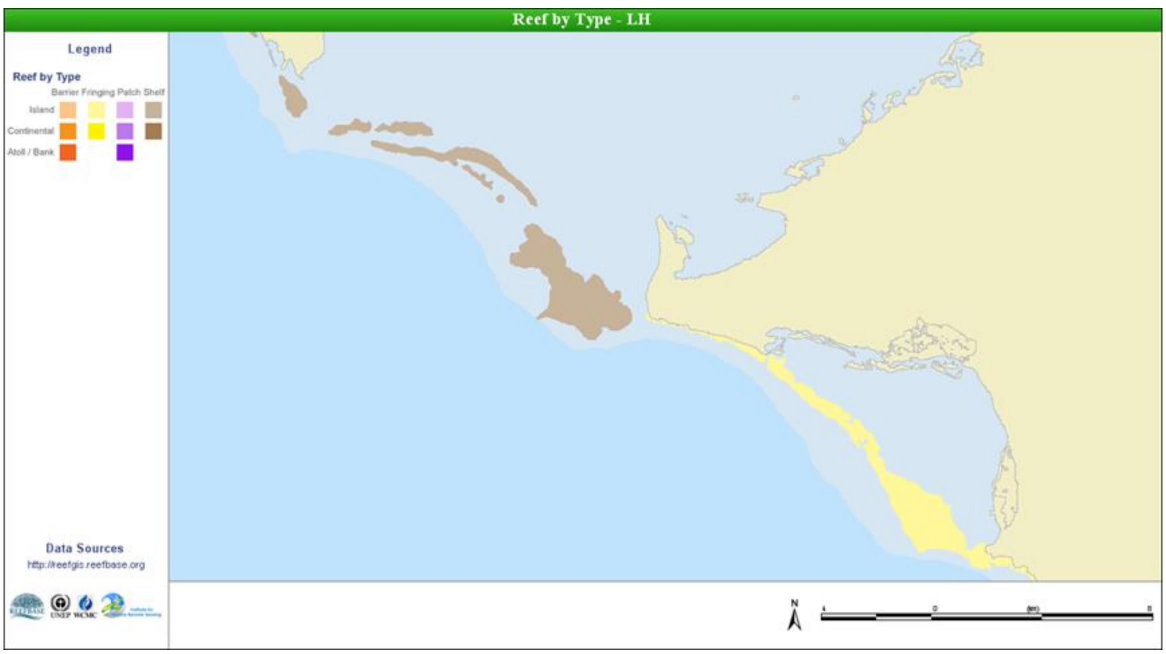

Figure 7.127 Reef type located northwest and southeast of the Leeward Harbour benthic area.

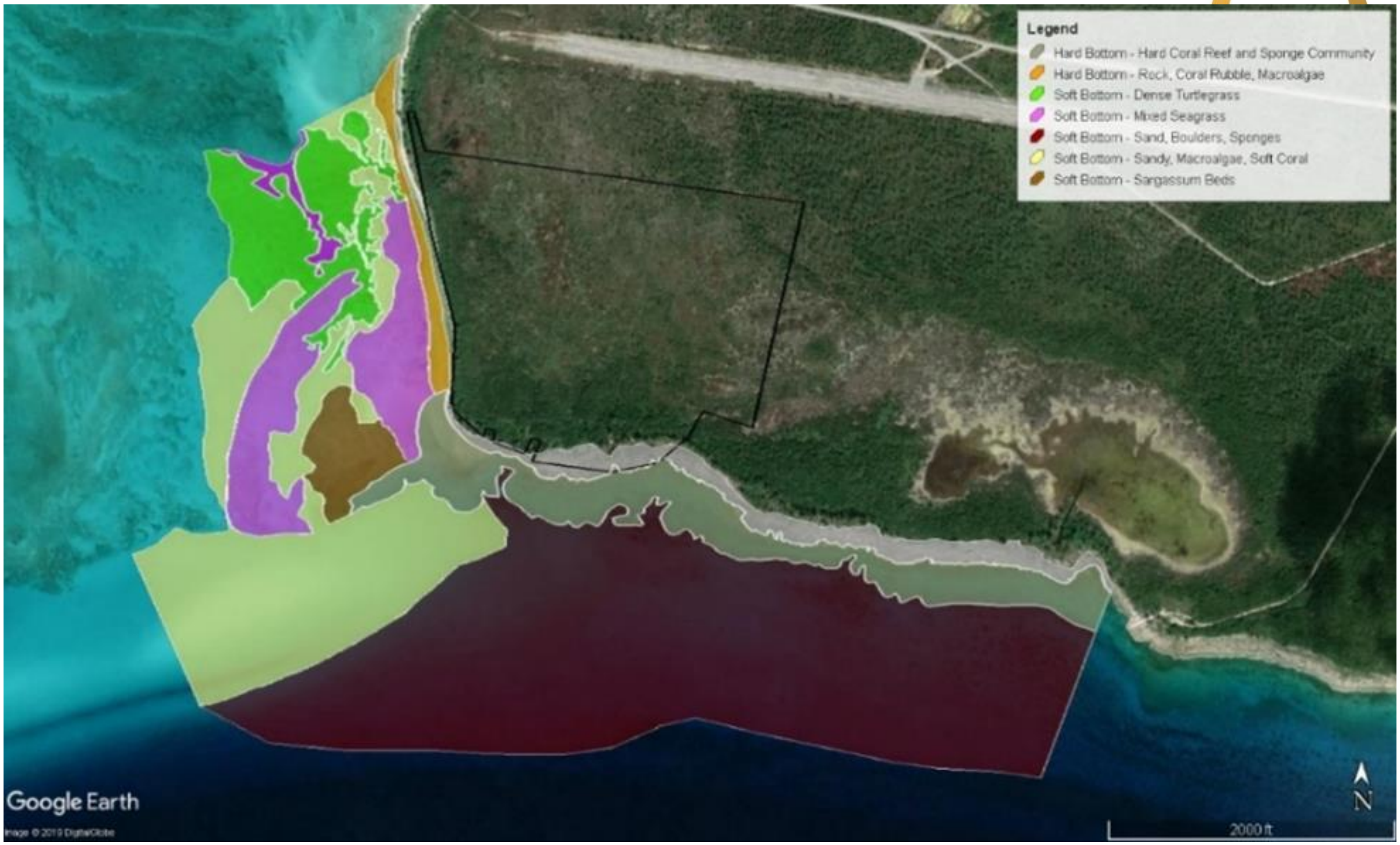

Figure 7.128 Leeward Harbour Marine Habitat Map.

It was found that the marine habitat had not changed significantly since the previous surveys conducted in 2018. However, there were signs of bleaching and damage to the hard coral found including the possible presence of Stony Coral Tissue Loss Disease (SCTLD). During surveying GPS points were taken in the approximate area of where each sign of disease and bleaching was sited and marked in the figure below.

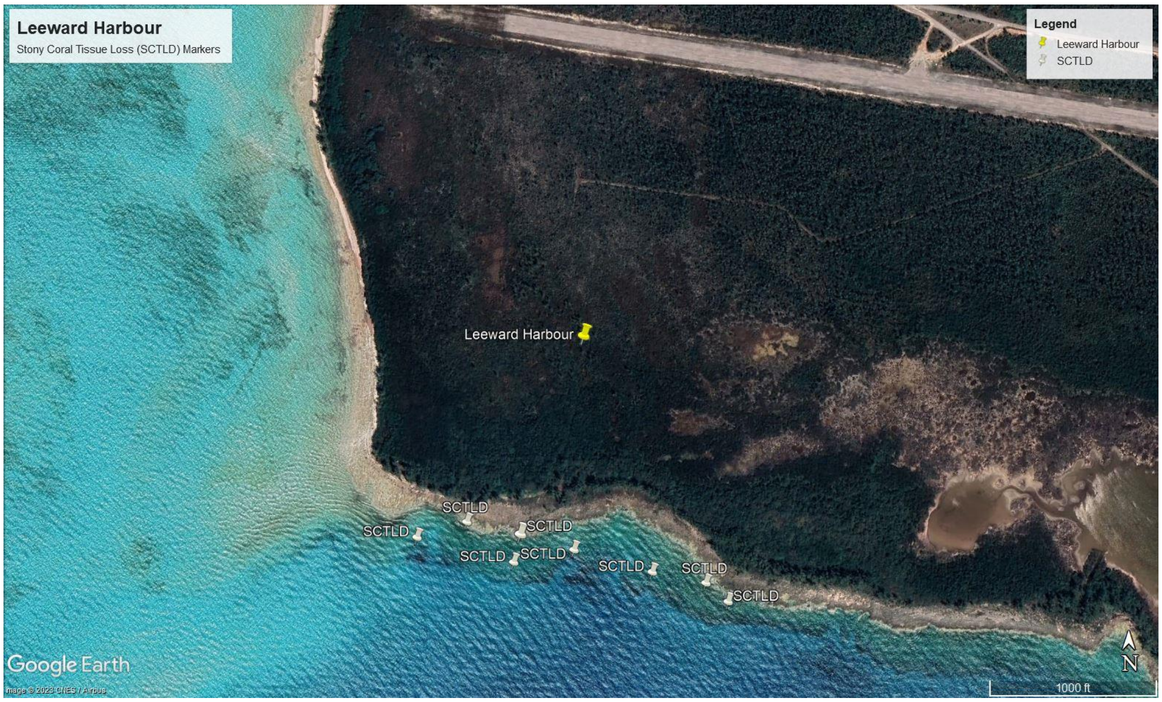

Figure 7.129 Bleaching and possible presence of SCTLD points (2023).

Figure 7.130 Examples of Bleached and Diseased Coral (2023).

Patch Reefs

Patch reef systems were observed within the southeast coastal habitat within Leeward Harbour. These systems are composed of rock formations which house well-formed coral species. Numerous patch reefs are located within this survey area; inclusive of coral species such as *Gorgonia flabellum, Acropora cervicornis, Acropora palmata, Millepora complanata* and *Diploria clivosa.* Some patch reef systems showed signs of distress such as discoloration, as well as complete coral deterioration and death.

Figure 7.131. Juvenile Yellowtail Damselfish feeding from the Elkhorn coral, School of Bermuda Chub among Elkhorn Coral (2018).

Figure 7.132 Stressed and deceased Elkhorn Coral (2018).

Hard Bottom Habitat

This habitat consists of algae covered subaquatic limestone rock formations within the littoral zone. Large connecting rock and coral reef structures cover this habitat. Numerous algae and coral species cover the rock formations in this habitat inclusive of; *Acropora palmata, Gorgonia flabellum, Galaxaura spp. and Lithothamnion spp.* Various fish and epifauna species were observed within this habitat; inclusive of *Echinometra lucunter, Stichodactyla helianthus, Notaulax occidentalis, Microspathodon chrysurus* and *Abudefduf taurus.*

Figure 7.133 Algal turf inclusive of Tubular Thicket, Venus Sea Fan and Elkhorn Coral, Hard bottom habitat coverage (2018).

Figure 7.134 Venus Sea Fan coral attached to hard bottom (2018).

Seagrass Habitat

Located within the sandy bottom habitat, the seagrass beds observed consists of a mixture of Turtle Grass (*Thalassia testudinum*) and Manatee Grass (*Syringodium filiforme*). This extensive habitat covers a large portion of the littoral zone within this shallow water habitat. It is surrounded by various algae species such as *Sargassum fluitans*, *Udotea sp.* and *Penicillus capitatus.* A large school of juvenile *Sardinella aurita* was observed swimming above and throughout the densely populated seagrass habitat. A considerable amount of accumulated discarded Queen Conch shells (*Strombus gigas*) were observed within and near the sea grass habitats.

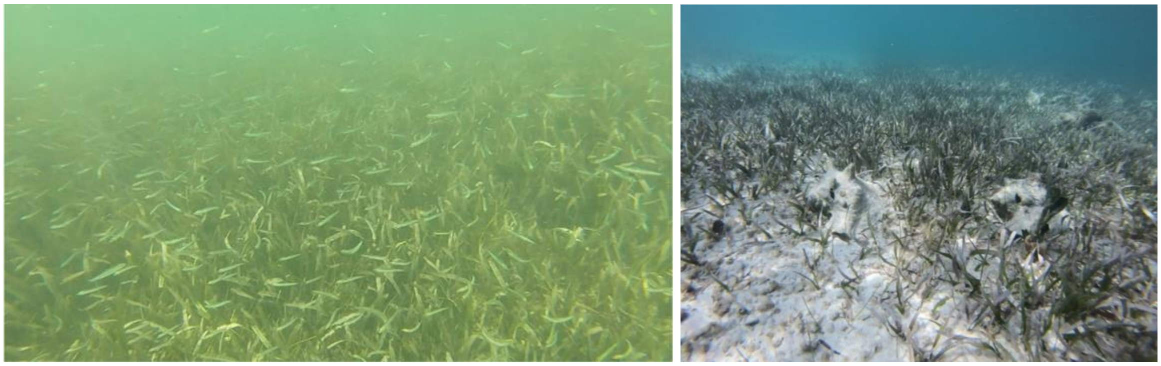

Figure 7.135 Densely populated seagrass bed with Manatee Grass, Turtle Grass and Round Sardinella, Queen conch remains in seagrass bed (2018).

Figure 7.136 Seagrass habitat within the Leeward Harbour shallow water habitat (2018).

Rocky Intertidal Zone

The rocky intertidal zone is situated along the north and southeastern coastline of Leeward Harbour. The littoral zone along the northern coastline consists of flat limestone formations which produce tidal pools during tidal fluctuations. This area is mostly covered by water within the foreshore. Some species were observed within this habitat such as *Nerita versicolor*. Few Black Mangrove (*Avicennia germinans*) trees were observed within this area. Some pieces of exposed communications cable lie along the shoreline of this habitat. This cable is partially covered with cement which has worn away over time.


Figure 7.137 Toothed Nerite attached to limestone in the rocky intertidal zone, Littoral and sublittoral zone at Leeward Harbour (2018).


Figure 7.138 Black Mangrove among the rocky intertidal zone, Exposed cable (2018).

Figure 7.139 Exposed limestone rock formations within the littoral zone at low tide (2018).

7.10.2 High Bank Bay Marine Survey Methodology

Benthic surveys were completed on April 18, 2019, between the hours of 12:37 p.m. and 1:30 p.m. at low tide. This survey area consists of the northern boundary of High Bank Bay Beach and extends approximately 1-mile toward the southern boundary of the beach (see Figure below). The purpose of the investigation was to record the presence and abundance of marine flora, epifauna and fauna species, as well as assess benthic bottom types and cover. Using snorkel equipment, divers performed a roving survey by swimming parallel and perpendicular to the shore. This method was selected to gain an accurate representation of the marine environment. All observed marine species were recorded. More specifically, fish species were recorded and assigned by one of four abundance categories based on their total species count within the area (Single = 1, Few = 2 - 11, Many = 11- 100, and Abundant = > 100).

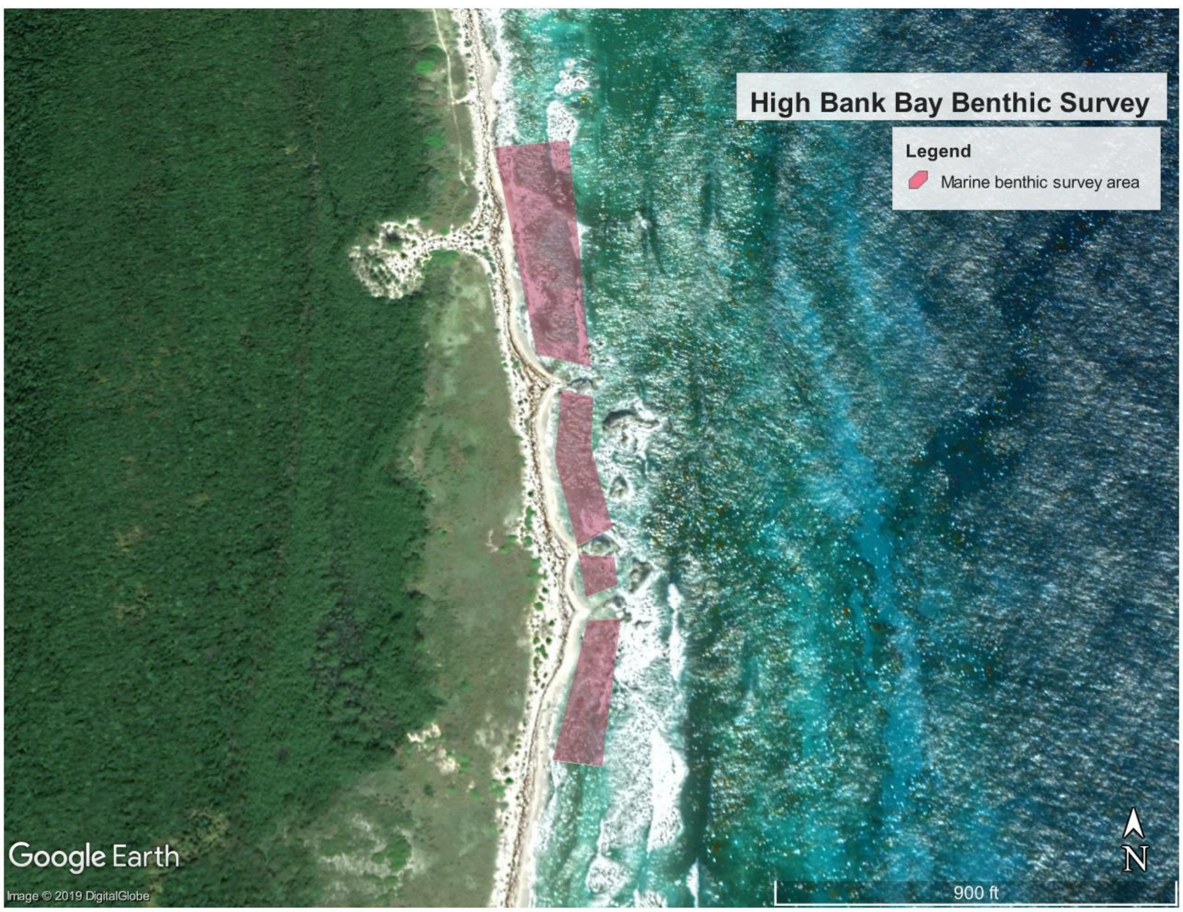

Figure 7.140 High Bank Bay Benthic survey map.

7.10.2.1 High Bank Bay Benthic Habitat Description

The High Bank Bay benthic area is located along the eastern coast of South Abaco surrounded by the deep waters of the Atlantic Ocean. Its benthic habitat is a mixture of hard bottom, beach zone and rock intertidal zone.

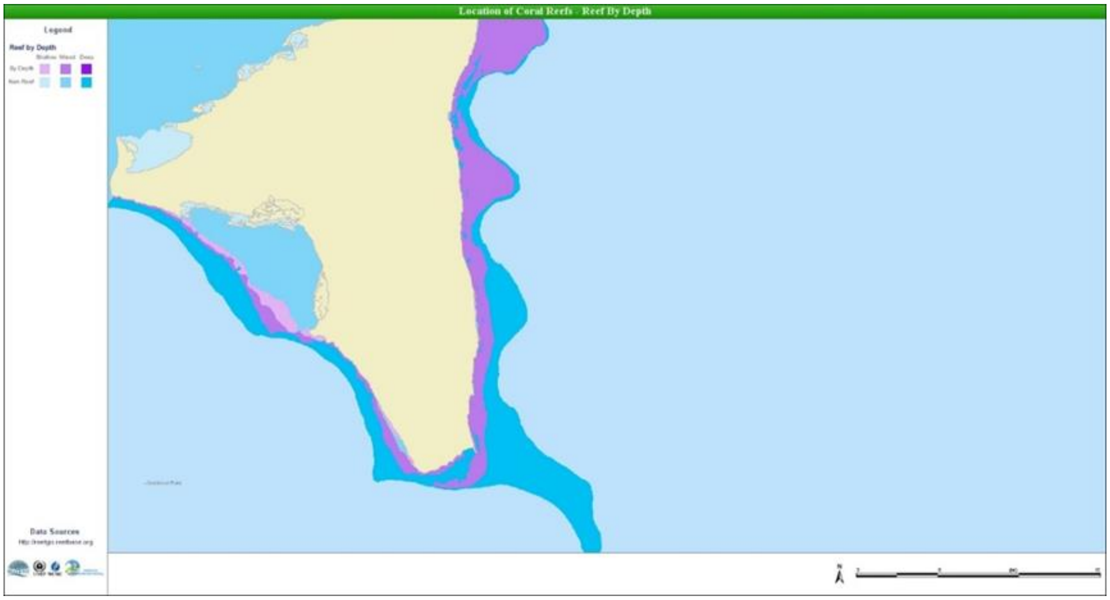

Figure 7.141 Depth of coral reef system located near High Bank Bay.

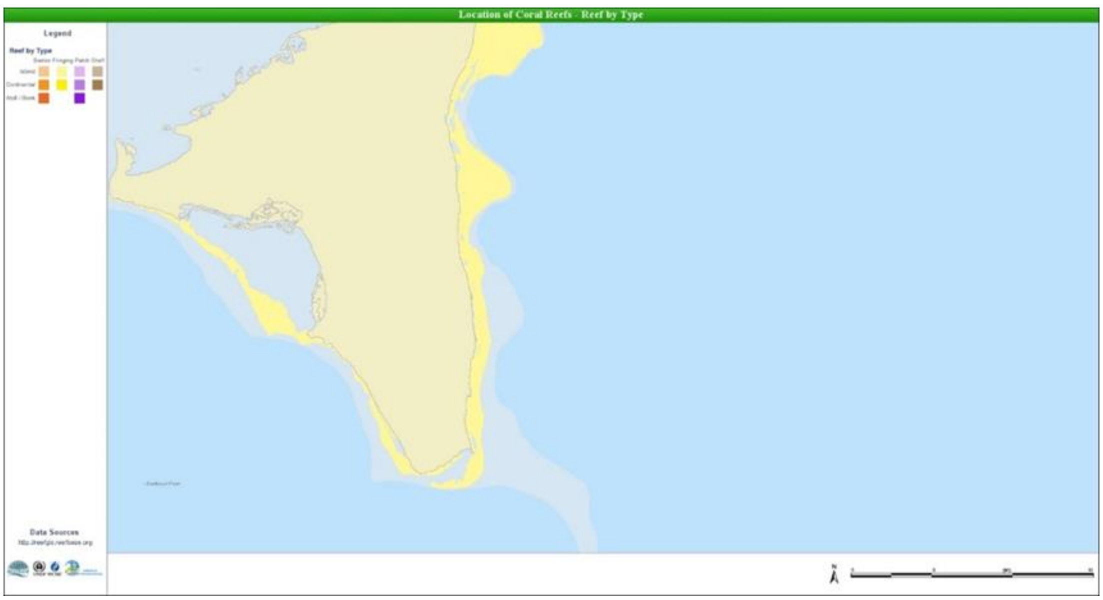

Figure 7.142 Reef type located along High Bank Bay benthic area.

<u>Hard Bottom Habitat (Algal Turf)</u>

Hard bottom habitat covers a large amount of the nearshore benthic survey area. The hard bottom habitat consists of a combination of 'flat' rock and sparse uneven rock features. Various species of red, brown and green algae cover the hard bottom formations; inclusive of *Dictyosphaeria cavernosa, Neomeris annulate, Sargassum fluitans, Galaxaura sp.* and *Lithothamnion* spp. Species of epifauna such as *Echinometra lucunter* were observed attached to the crevices and holes of the submerged rocks. Fish species observed in this benthic survey area include *Abudefduf saxatilis* and *Halichoeres bivittatus.* Some coral species were observed burrowed among the surfaces and crevices of the submerged rock formations; inclusive of *Siderastrea radians* and *Porites divaricata*. The species *Porites divaricata* was observed frequently throughout this habitat. However, this species showed signs of stress.

Figure 7.143 Floating Sargassum Sea Weed and Sergeant Major among hard bottom habit, Lesser Starlet Coral and Rock Boring Urchin attached to hard bottom habitat.

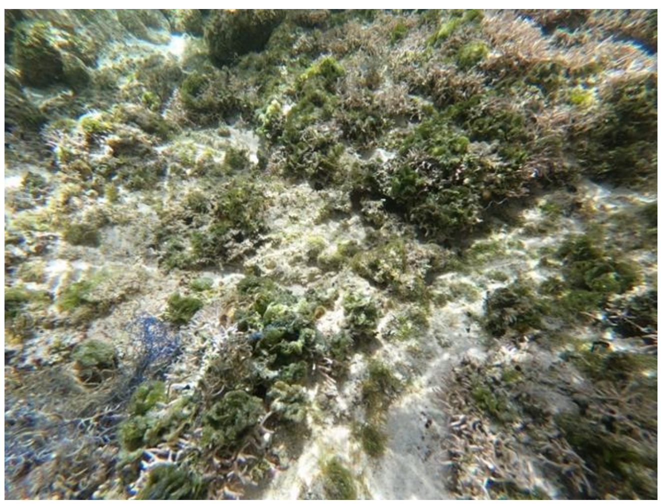

Figure 7.144 Marine debris among Thin Finger Coral and Green Bubble Weed algae

Beach Zone

The beach zone consists of sand and limestone features such as beach rock and shell deposits. Deceased *Sargassum fluitans* stretch along the beach face just before the high tide mark and fixed beach vegetation (Figure 75). Large slabs of limestone rock cover the foreshore environment as it extends from the water onto the sand (Figure 76). The hard bottom and rocky intertidal zone serves as a barrier that protects the foreshore from intense wave action from the Atlantic Ocean.

Figure 7.145 Beach face with deceased Sargassum fluitans, Limestone rock 'slabs' along the foreshore that extend onto the beach face.

Rocky Intertidal Zone

The rocky intertidal zone is located along the western end of the High Bank Bay beach. This habitat contains the littoral, sublittoral and supralittoral zones. Multiple rock formations are separated among this coastal environment, allowing wave activity to travel throughout this habitat. These structures are elevated at approximately 9 ft. and compose the supralittoral zone. This zone rarely experiences tidal influences except during major storm activity. Salt tolerant vegetation (*Hymenocallis arenicola*) is located on top of these rock formations. Some gastropods were observed within this area; inclusive of *Nerita tessellata.*

Figure 7.146 Exposed rock formations at High Bank Bay, Exposed supralittoral zone features with salt tolerant vegetation.

Artificial Reef (Shipwreck)

Shipwreck debris is present within the beach zone at High Bank Bay. Scattered pieces of the remains are located along the western boundary of the beach along the beach face and within the foreshore. At low tide, pieces of the metal debris are exposed as it rests in this shallow water environment. The metal debris is covered in numerous algae species, subsequently turning what was once debris into an artificial marine environment. Species of coral such as *Porites astreoides, Siderastrea radians, Gorgonia ventalina* and *Diploria strigose* were observed attached to the metal debris which was also covered in algae. Thus, creating a surface to produce a coral reef environment. Most fish species observed were recorded within this habitat; inclusive of *Abudefdus saxatilis, Halichoeres bivittatus, Eucinostomus melanopterus, Lutjanus apodus, Kyphosus sectatrix, Kyphosus cinerascens* and *Acanthurus chirurgus.*

Figure 7.147 Exposed metal debris during low tide, Algae covered shipwreck debris.

Figure 7.148 Mustard Hill Coral attached to metal debris and Slippery Dick, Slippery Dick and Sergeant Major among the artificial reef.

Figure 7.149 School of Bermuda Chub.

7.10.3 Conch Sound Point Marine Survey Methodology

Benthic surveys were completed on April 19, 2019, between the hours of 10:49 a.m. and 12:49 p.m. at low tide. This survey area consists of the northern boundary of Conch Sound Point Beach and extends approximately 1 mile toward the southern boundary of the beach. The purpose of the investigation was to record the presence and abundance of flora, epifauna and fauna species as well as assess benthic bottom types and cover. Using snorkel equipment, divers performed a roving survey by swimming parallel and perpendicular to the shore. This method was selected to gain an accurate representation of the marine environment. All observed marine species were recorded. More specifically, fish species were recorded and assigned one of four abundance categories based on their total species count within the area (Single = 1, Few = 2 - 11, Many = 11- 100, and Abundant = > 100).

7.10.3.1 Conch Sound Point Benthic Habitat Description

The Conch Sound Point benthic area is located along the eastern coast of South Abaco surrounded by the deep waters of the Atlantic Ocean. Its benthic habitat is a mixture of hard bottom, sandy bottom, beach zone and rocky intertidal zone.

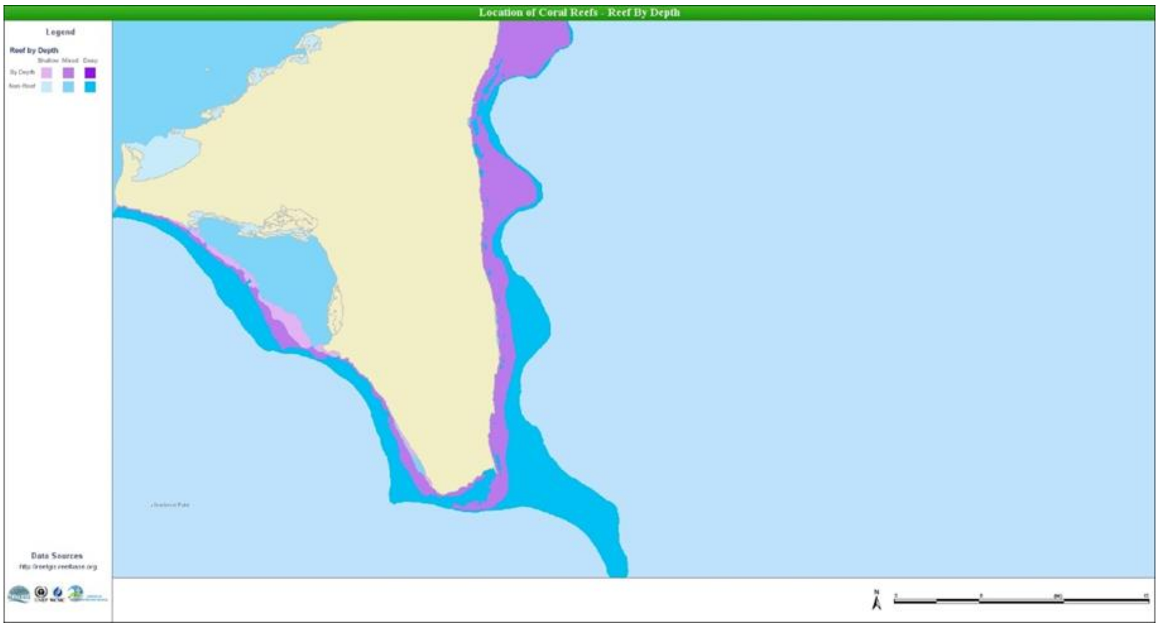

Figure 7.150 Depth of coral reef system located near Conch Sound Point.

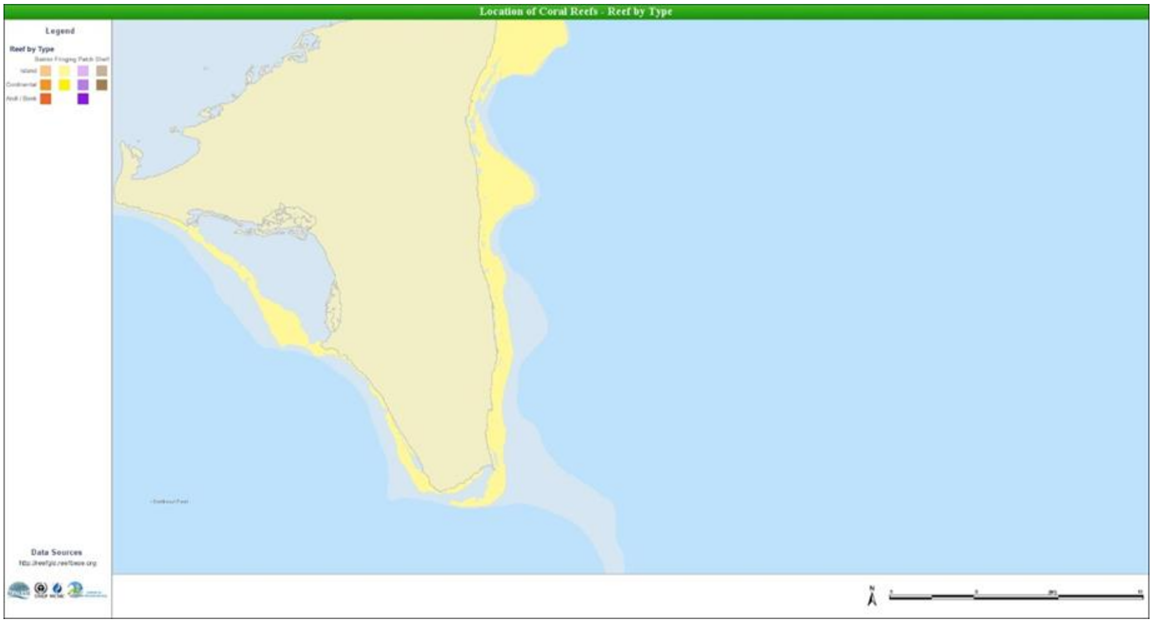

Figure 7.151 Reef type located along Conch Sound Point benthic area.

Figure 7.152 Marine Habitat Map.

Hard Bottom Habitat

Almost half of the benthic survey area is comprised of hard bottom habitat. This ecosystem contains subaquatic limestone rock formations such as boulders, slabs and scattered rocks. Algae and sand deposit cover the hard bottom surface area. Several algae species were observed among the algal turf; inclusive of *Padina jamaicensis, Penicillus capitatus*, *Dictyosphaeria cavernosa*, and *Udotea sp*. Some coral and epifauna species were observed among the submerged rock features; inclusive of *Siderastrea radians, Cliona tenuis* and *Eucidaris tribuloides.* Few species of fish were observed throughout this habitat; inclusive of *Abudefduf saxatilis, Thalassoma bifasciatum, Gerres cinereus and Acanthurus chirurgus.*

Figure 7.153 Sediment covered rock formations with Doctorfish and Slippery Dick, Subaquatic boulder covered in sediment and White Scroll Algae.

Figure 7.154 Lesser Starlet Coral nestled in coarse sand sediment, Sergeant Major in the distance and Sponge attached to rock.

Figure 7.155 Subaquatic limestone rock formation 'slab' covered in various green algae species such as Large-Leaf Hanging Vine and Paddle Blade.

Beach Zone

The beach foreshore consists of fine sand deposits that extend along the entire beach face. Rock features enclose the beach's nearshore environment forming a lagoon. This rock formation acts as a barrier protecting this environment from intense wave action of the Atlantic Ocean that lies parallel to the foreshore and provides a shallow water habitat. There are openings in the barrier rock formation which allows water to move in and out of the foreshore environment. These openings act as a natural flushing channel to support nutrient and sand deposits throughout the entire beach zone. Mounds of deceased *Sargassum fluitans* accumulate along the entire beach face just before the high tide mark and fixed vegetation.

Figure 7.156 Southern view of the beach face at low tide with deceased Sargassum Seaweed onshore, Foreshore beach environment at low tide.

Sandy Bottom

The sandy bottom habitat covers approximately less than half of the benthic survey area. This subaquatic sand habitat formed symmetrical ripples indicating consistent wave action and sediment distribution within this area. Various species of algae were observed within this habitat; inclusive of *Penicillus capitatus, Avrainvillea nigricans, Sargassum fluitans, Udotea sp.,* and *Halimeda copiosa.* A sparse patch of seagrass bed was observed containing *Syingodium filiforme* (Manatee Grass) among other algae.

Figure 7.157 Paddle Blade within the sandy bottom habitat, Sparse Manatee Grass with Large-Leaf Hanging Vine.

Figure 7.158 Sandy Bottom with green algae located in the distance.

Rocky Intertidal Zone

The rocky intertidal zone is situated along the northern boundary of the survey area. This habitat is categorized in zones due to its tidal ranges. The sublittoral zone was exposed during observation, displaying its tidal pools which contained marine invertebrate species such as *Acanthopleura granulate.* Ironshore limestone features within the littoral and supralittoral zone are elevated at approximately 4 ft. - 6 ft. This zone is connected to beach vegetation which is located a few feet to the west of this rocky shore environment.

Figure 7.159 Exposed littoral zone limestone feature, Fixed beach vegetation and exposed supralittoral zone with iron shore features.

Figure 7.160 Sublittoral zone exposed during low tide.

Figure 7.161 Fuzzy Chiton attached to the limestone rock of the rocky intertidal zone.

7.10.4 Observed Species

7.10.4.1 Leeward Harbour Observed Species

Table 7.22. Marine vertebrates observed during benthic surveys at Leeward Harbour

Common Name	Scientific Name	Abundance	Habitat
Sergeant Major	*Abudefduf saxatilis*	Few	Patch Reef
Blue Tang	*Acanthurus coeruleus*	Few	Hard Bottom
Ocean Surgeonfish	*Acanthurus bahianus*	Few	Hard Bottom
Bluehead Wrasse (Juvenile)	*Thalassoma bifasciatum*	Few	Hard Bottom
Fairy Basslet	*Gramma loreto*	Single	Hard Bottom
Beaugregory (Juvenile)	*Stegastes leucostictus*	Single	Hard Bottom
Slippery Dick	*Halichoeres bivittatus*	Few	Hard Bottom
Bicolor Damsel	*Stegastes partitus*	Single	Hard / Sandy Bottom
Blue Striped Grunt	*Haemulon sciurus*	Few	Hard Bottom
Spanish Grunt	*Haemulon macrostomum*	Few	Hard / Sandy Bottom
Pork Fish	*Anisotremus virginicus*	Single	Hard / Sandy Bottom
Schoolmaster	*Lutjanus apodus*	Few	Hard Bottom
Yellowtail Damselfish (Juvenile)	*Microspathodon chrysurus*	Single	Hard Bottom
Gray Snapper	*Lutjanus griseus*	Few	Hard Bottom
Saddled Blenny	*Malacoctenus triangulatus*	Single	Hard Bottom
Bermuda Chub	*Kyphosus sectatrix*	Few	Hard / Sandy Bottom
Banded Butterflyfish	*Chaetodon striatus*	Single	Hard Bottom
Sailor's Choice	*Haemulon parra*	Few	Patch Reef

Night Sergeant	*Abudefduf taurus*	Single	Hard / Sandy Bottom
Round Sardinella	*Sardinella aurita*	Abundant	Seagrass Bed

Table 7.23. Marine invertebrates observed during benthic surveys at Leeward Harbour

Common Name	Scientific Name	Habitat
Rock-Boring Urchin	*Echinometra lucunter*	Hard Bottom
Yellow Fan Worm	*Notaulax occidentalis*	Hard Bottom
	Cliona tenuis	Hard Bottom
Sun Anemone	*Stichodactyla helianthus*	Hard Bottom
Flamingo Tongue	*Cyphoma gibbosum*	Hard Bottom/ Venus Sea Fan
Toothed Nerite	*Nerita versicolor*	Rocky Intertidal Zone

Table 7.24. Coral species observed during benthic surveys at Leeward Harbour

Common Name	Scientific Name	Habitat
Elkhorn Coral	*Acropora palmata*	Hard Bottom / Patch Reef
Venus Sea Fan	*Gorgonia flabellum*	Hard Bottom / Patch Reef
Knobby Brain Coral	*Diploria clivosa*	Hard Bottom
Blade Fire Coral	*Millepora complanata*	Hard Bottom
Staghorn Coral	*Acropora cervicornis*	Hard Bottom
Elliptical Star Coral	*Dichocoenia stokesi*	Hard Bottom
Porous Sea Rod	*Psedoplexaura spp.*	Sandy Bottom
Mustard Hill Coral	*Porites astreoides*	Hard Bottom
Symmetrical Brain Coral	*Diploria strigosa*	Patch Reef

Table 7.25.Marine algae observed during benthic surveys at Leeward Harbour.

Common Name	Scientific Name	Habitat
Tubular Thicket Algae	*Galaxaura spp.*	Hard Bottom
White Scroll Algae	*Padina jamaicensis*	Hard Bottom
Turtle Grass	*Thalassia testudinum*	Seagrass Bed
Manatee Grass	*Syringodium filiforme*	Seagrass Bed
Sargassum Seaweed	*Sargassum fluitans*	Sandy Bottom
Neptune's Shaving Brush	*Penicillus capitatus*	Hard Bottom
Mermaid's Wine Glass	*Acetabularia crenulata*	Hard Bottom / Sandy Bottom
Mermaid's Fan	*Udotea sp.*	Seagrass Bed
White-Vein Sargassum	*Sargassum hystrix*	Hard Bottom
Leafy Rolled-Blade Algae	*Padina boergesenii*	Hard Bottom
Pink Coralline Algae	*Lithothamnion spp.*	Hard Bottom

7.10.4.2 High Bank Bay Observed Species

Table 7.26. Marine Vertebrate Species observed during benthic surveys at High Bank Bay.

Common Name	Scientific Name	Abundance Category	Habitat
Sergeant Major	*Abudefduf saxatilis*	Many	Hard Bottom/ Artificial Reef
Slippery Dick	*Halichoeres bivittatus*	Many	Hard Bottom/ Artificial Reef
Beaugregory (Juvenile)	*Stegastes leucostictus*	Single	Hard Bottom/ Artificial Reef
Flagfin Mojarra	*Eucinostomus melanopterus*	Single	Artificial Reef
Schoolmaster	*Lutjanus apodus*	Few	Artificial Reef
Bermuda Chub	*Kyphosus sectatrix*	Many	Artificial Reef
Top Sail Chub	*Kyphosus cinerascens*	Single	Artificial Reef
Saddled Blenny	*Malacoctenus triangulatus*	Single	Hard Bottom/ Artificial Reef
Three Spot Damselfish	*Stegastes planifrons*	Single	Artificial Reef
Yellowtail Parrotfish	*Sparisoma rubripinne*	Few	Artificial Reef
Doctor Fish	*Acanthurus chirurgus*	Few	Artificial Reef
Blue Tang	*Acanthurus coeruleus*	Single	Artificial Reef
Horse Eye Jack	*Caranx latus*	Single	Artificial Reef
Bluehead Wrasse	*Thalassoma bifasciatum*	Few	Hard Bottom/ Artificial Reef
Blue Striped Grunt	*Haemulon sciurus*	Single	Hard Bottom

Table 7.27. Coral Species observed during benthic surveys at High Bank Bay.

Common Name	Scientific Name	Habitat
Mustard Hill Coral	*Porites astreoides*	Artificial Reef
Lesser Starlet Coral	*Siderastrea radians*	Hard Bottom/Artificial Reef
Wide Mesh Sea Fan	*Gorgonia mariae*	Artificial Reef
Common Fan Coral	*Gorgonia ventalina*	Artificial Reef
Symmetrical Brain Coral	*Diploria strigosa*	Hard Bottom/Artificial Reef
Thin Finger Coral	*Porites divaricata*	Hard Bottom

Table 7.28. Marine Invertebrate Species observed during benthic surveys at High Bank Bay.

Common Name	Scientific Name	Habitat
Rock Boring Urchin	*Echinometra lucunter*	Hard Bottom
Fuzzy Chiton	*Acanthopleura granulata*	Rocky Intertidal Zone
Orange Sieve Encrusting Sponge	*Diplastrella megastellata*	Hard Bottom
Checkered Nerite	*Nerita tessellata*	Rocky Intertidal Zone

Table 7.29. Marine Algae Species observed during benthic surveys at High Bank Bay.

Common Name	Scientific Name	Habitat
Green Bubble Weed	*Dictyosphaeria cavernosa*	Hard Bottom
Fuzzy Tip Algae	*Neomeris sp.*	Hard Bottom
Bristle Ball	*Penicillus capitatus*	Hard Bottom
Sargassum Sea Weed	*Sargassum fluitans*	Hard Bottom/Artificial Reef
Sea Pearl	*Ventricaria ventricosa*	Hard Bottom
White Scroll Algae	*Padina jamaicensis*	Hard Bottom
Leafy Rolled Blade Algae	*Padina boergesenii*	Hard Bottom
Paddle Blade Algae	*Avrainvillea nigricans*	Artificial Reef
Sea Lettuce	*Ulva sp.*	Hard Bottom/Artificial Reef
Crustose Coralline Algae	*Lithothamnion spp.*	Hard Bottom
Y Branched Algae	*Dictyota sp.*	Artificial Reef
Spiny Seaweed	*Acanthophora spicifera*	Artificial Reef
Tubular Thicket	*Galaxaura sp.*	Artificial Reef

7.10.4.3 Conch Sound Point Observed Species

Table 7.30. Marine Vertebrate Species observed during benthic surveys at Conch Sound Point.

Common Name	Scientific Name	Abundances	Habitat
Bluehead Wrasse	*Thalassoma bifasciatum*	Single	Hard Bottom
Sergeant Major	*Abudefduf saxatilis*	Few	Hard Bottom
Yellowfin Mojarra	*Gerres cinereus*	Single	Hard Bottom
Doctor Fish	*Acanthurus chirurgus*	Few	Hard Bottom
Slippery Dick	*Halichoeres bivittatus*	Few	Hard Bottom
Yellowfin Parrotfish	*Sparisoma rubripinne*	Single	Hard Bottom
Coco Damselfish	*Stegastes variabilis*	Single	Hard Bottom
Pudding Wife	*Halichoeres radiatus*	Single	Hard Bottom

Table 7.31. observed during benthic surveys at Conch Sound Point.

Common Name	Scientific Name	Habitat
Lesser Starlet Coral	*Siderastrea radians*	Hard Bottom

Table 7.32. Marine Invertebrate Species observed during benthic surveys at Conch Sound Point.

Common Name	Scientific Name	Habitat
Slate Pencil Urchin	*Eucidaris tribuloides*	Hard Bottom
	Cliona tenuis	Hard Bottom
Fuzzy Chiton	*Acanthopleura granulata*	Rocky Intertidal Zone

Table 7.33 Marine Algae Species observed during benthic surveys at Conch Sound Point.

Common Name	Scientific Name	Habitat
Sargassum Sea Weed	*Sargassum fluitans*	Sandy Bottom
Paddle Blade Algae	*Avrainvillea nigricans*	Hard Bottom / Sandy Bottom
Large Leaf Hanging Vine	*Halimeda copiosa*	Hard Bottom
White Scroll Algae	*Padina jamaicensis*	Hard Bottom
Manatee Grass	*Syringodium filiforme*	Sandy Bottom
Green Bubble Weed	*Dictyoshpaeria cavernosa*	Hard Bottom
Mermaid Fan	*Udotea sp.*	Hard Bottom / Sandy Bottom
Bristle Ball	*Penicillus capitatus*	Hard Bottom / Sandy Bottom

7.10.5 Species of Cultural and Economic Importance

Two (2) critically endangered species were observed (*Acropora palmata* and *Acropora cervicornis*). Sightings of two (2) species of economic importance have been reported by locals (*Strombus gigas* and *Albula vulpes).* However, both of these economically important species were not observed during the assessment.

According to the IUCN, *Acropora palmata* and *Acropora cervicornis* are critically endangered coral species due to temperature extremes, storm activity and negative anthropogenic influences. Although, these species are critically endangered, their population trend is reported as stable (Aronson et al., 2008)[17]. *Acropora palmata* has a great importance in maintaining the integrity of coral reefs in the Caribbean, both functionally and structurally (Aronson et al., 2008)[18]. These coral species also provide many important services to human societies. *Acropora cervicornis* has an important ecological role as reef builders and they provide coastal protection for coastal inhabited communities, as well as protection for lagoons and mangroves from wave erosion, which are vital habitats for a range of commercial and non-commercial species (Aronson et al., 2008). Few observed coral species showed partial signs of distress and death which indicated that these species were affected by some unknown factors. Numerous juvenile fish species were observed within this habitat surrounding the coral reefs such as *Thalassoma bifasciatum*, *Microspathodon chrysurus* and *Stegastes leucostictus.* The presence of juvenile species indicates that this ecosystem may serve as a nursery for certain reef dependent species such as damselfish and wrasse. The juvenile wrasse and damselfish species utilize the rocky bottom and

[17] Aronson, R., Bruckner, A., Moore, J., Precht, B. & Weil, E. (2008). *Acropora cervicornis*. *The IUCN Red List of Threatened Species*. Retrieved from: <http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T133381A3716457.en>
[18] Aronson, R., Bruckner, A., Moore, J., Precht, B. & Weil, E. (2008). *Acropora palmata*. *The IUCN Red List of Threatened Species*. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T133006A3536699.en>

coral reef habitats as a food source, shelter and protection from large predators (Conboy et al., 2011)[19].

Abandoned Queen Conch (*Strombus gigas*) shells were observed within the seagrass habitat. The observation of developing conch middens within this habitat indicates anthropogenic threats such as bad fishing practices and fishing pressure within this coastal community. The Queen Conch generated $3.3 million USD in export in the year 2015 (Moultrie et al., 2016)[20]. Thus, proving its economic importance. Export is an important market for Sandy Point fishermen (Stoner et al., 2012)[21]. The minimum density required for reproduction is 56 conch/ha. Unfortunately, conch densities in Sandy Point average 6.4 conch/ha and increased only to 9.8 conch/ha west of Moore's Island. (Stoner et al., 2012). Therefore, it is projected that the conch fishing grounds between Sandy Point and Moore's Island are approaching collapse due to the increase in conch harvesting.

The shallow waters at LH are known by locals as a popular Bonefish site. However, during this marine survey there were no Bonefish observations within the survey area. As anecdotal research suggests, this species spawns in deeper waters between November - April. Bonefish (*Albula vulpes*) are known by locals as a commercially important species due to its ability to generate substantial economic income throughout The Bahamas. Therefore, The Bahamas has set certain catch and release regulations in place to preserve the species for continued economic support. Although, these regulations aid in the preservation of this commercially viable species, rough or poorly handled Bonefish, post-capture, may lead to likely mortality of this capture and release species (Danylchuck et al., 2007)[22]. The IUCN lists this species as near threatened due to threats of unsustainable fishing practices and habitat loss (Adams et al., 2012)[23]. "According to anecdotal accounts by Bahamian fishermen, large Bonefish appear to return to tidal creeks in the fall where they aggregate in large numbers prior to spawning" (Danylchuk et al., 2008)[24]. The close proximity to Cross Harbour National Park plays a significant role in Bonefish aggregation, as this species uses the shallow waters of this site to migrate toward deeper waters for spawning.

[19] Conboy, I. C. & Haynes, J. M. (2011). Potential of Pigeon Creek, San Salvador Bahamas nursery habitat for juvenile reef fish. *The International Journal of Bahamian Studies, 17* (2), 11-26.

[20] Moultrie, S., Deleveaux, E., Bethel, B., Laurent, Y., Maycock, V., Moss, S. & Anroy, R. (2016). Fisheries and aquaculture in The Bahamas: A review. Retrieved from <https://www.bahamas.gov.bs/wps/wcm/connect/e1d636dd-1a9b-4661-9e38-ba9bf546a534/FINAL+Bahamas+Fisheries+%26+Aquaculture+Sector+Review+17Nov16.pdf?MOD=AJPERES>

[21] Stoner, A. W., Davis, M. H., & Booker, C. J. (2012). Surveys of Queen Conch Populations and Reproductive Biology at Sandy Point and More's Island, Bight of Abaco, The Bahamas.

[22] Danylchuck, A. J., Danylchuck, S. E., Cooke, S. J., Goldberg, T. L., Koppelman, J. B. and Philipp, D. P. (2007). Post-release mortality of bonefish, *Albula vulpes*, exposed to different handling practices during catch-and-release angling in Eleuthera, The Bahamas. *Fisheries Management and Ecology. 14*, 149-154.

[23] Adams, A., Guindon, K., Horodysky, A., MacDonald, T., McBride, R., Shenker, J. & Ward, R. (2012). *Albula vulpes*. *The IUCN Red List of Threatened Species*. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T194303A2310733.en>

[24] A.J. Danylchuk, S.E. Danylchuk, S.J. Cooke, T.L. Goldberg, J. Koppelman and D. P. Philipp (2008). Ecology and management of bonefish (*Albula spp.*) in the Bahamian archipelago.

7.10.6 Human Influence

7.10.6.1 Leeward Harbour Human Influence

Sandy Point is the southernmost settlement on Abaco with a population of approximately 200 persons. The settlement is known for its long-standing fishing tradition, as many people in the community engage in either subsistence or commercial fishing. The ecological make-up of the area provides a variety of fishing grounds for fishers, including extensive mangrove system immediately adjacent to the settlement and along the southern coastline adjacent to the Leeward Harbour property. The southern tip of Abaco abuts the northern edge of the Northeast Providence Channel, deep water habitat commonly utilized for sports fishing and commercial fishing of open water fishes. Small fishing boats are commonly seen in the waters in and around Sandy Point, and crawfish traps are usually deployed in the soft sandy bottom habitat to the west and south of the Leeward Harbour site. The rocky shoreline along the southern coast of the site is also used by locals as a harvesting ground for whelks, chiton and other marine organisms utilizing the habitat.

To the east of the site is a defunct dock which was utilized by the mailboat to bring cargo to South Abaco. Hunters are known to hunt waterfowl in the wetland adjoining the LH property to the east. Evidence of shotgun shells were observed on the old dock road.

An existing ICT/cable line originating from North Eleuthera emerges ashore at the southwestern tip of the LH site and runs north along the western shoreline and into the Sandy Point settlement. The portions of the line on land were encased with concrete to protect the cable, however the casing has now become exposed due to coastal erosion and broken/damaged in a number of places where it is evident the line has been severed. A replacement cable runs above the high tide mark along the edge of the mangrove wetlands on the western shoreline of the site. Considerations will need to be made for incorporating the cable into the design of the development, or a relocation of the line to a more suitable location.

Figure 7.162. Images of subaqueous ICT cable off the southern shore of Leeward Harbour (2018).

Figure 7.163. Exposed ICT cable infrastructure along western shoreline of Leeward Harbour (2018).

7.10.6.2 High Bank Bay Human Influence

No fishing vessels were observed during this survey. However, the providence channel is known for heavy shipping traffic. Marine debris such as plastic and fishing nets were observed along the beach face and hard bottom habitat. This indicates the waves beyond the survey area are capable of transporting any anthropogenic elements within this habitat.

7.10.6.3 Conch Sound Point Human Influence

No human activity was observed during this survey. However, marine debris was observed; inclusive of twisted boat rope, cooking oil containers and plastic water bottles. Furthermore, a small makeshift shelter was constructed of wood and tarp, which is located at the high tide mark and point of fixed vegetation.

Figure 7.164. Improvised shelter structure .

7.10.7 Habitat Utilization and Food Sources for Native Fauna

Juvenile *Sardinella aurita* displayed feeding behavior in the seagrass community. This species is known to feed on plankton found in the seagrass. Dead seagrass has been shown to support plankton species due to its available amount of dissolved organic material. Thus, the seagrass bed supports food webs within this community. Various species were observed feeding on *Acropora palmata* such as *Microspathodon chrysurus* and *Stegastes leucostictus.*

Black Mangroves located within the rocky intertidal zone provide nutrients for gastropods, sponges, and other marine species when it produces leaf litter near its roots system. The tidal fluctuations also provide water and nutrients for these organisms.

Wave activity at CSP and HBB brings in nutrients from the Atlantic which settle within this shallow water habitat in the benthic survey area. The shallow water and rocky intertidal zone potentially provide food sources for species within these habitats. During tidal changes, it is possible that nutrient rich waters fill the rocky intertidal zone and shallow waters with sediment, algae and other marine species. These habitats encourage the growth of primary producers, which support essential marine food webs that support commercially important and endangered species.

7.11 Protected and Threatened Species

Anecdotal research suggests that the waters of Leeward Harbour are home to the Nassau Grouper (*Epinephelus striatus*), a commercially important marine species for the South Abaco communities as well as the wider Bahamas. This research also states that the Nassau Grouper spawns in waters east off the coast of South Abaco within the deeper waters of the Atlantic Ocean. According to the International Union for Conservation of Nature (IUCN), this species is considered critically engendered due to overfishing (Sadovy et al., 2018)[25]. Due to its importance, this species has a closed season (December 1st - February 28th) to prevent fishing exploitation and complete extinction of the species. However, during the site survey, there were no observations of Nassau Grouper or their spawning aggregations.

No endangered species or species of economic importance were observed while conducting the benthic survey at *Conch Sound Point*.

No endangered species or species of economic importance were observed while conducting the benthic survey at High Bank Bay. However, anecdotal reports indicate that Bonefish (*Albula vulpes)* and Nassau Grouper (*Epinephelus striatus*) spawning aggregations exist within the deeper waters of south Abaco. These species tend to travel in schools from the shallow waters within the continental shelf to venture into the deeper waters of the Atlantic Ocean.

According to the International Union of Conservation of Nature (IUCN), the Nassau Grouper is listed as critically endangered due to threats of overfishing, loss of coral reef habitat and

[25] Sadovy, Y., Aguilar-Perera, A. & Sosa-Cordero, E. (2018). *Epinephelus striatus*. *The IUCN Red List of Threatened Species.* Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T7862A46909843.en>

competition with invasive species (Sadovy et al., 2018)[26]. Due to these stressors, the government of The Bahamas implemented a closed season (December 1 to February 28) to lesson fishing impacts on this commercially important species.

Bonefish (*Albula vulpes*) are known for by locals as a commercially important species due to its ability to generate substantial economic income throughout The Bahamas. Therefore, The Bahamas has set certain catch and release regulations in place to preserve the species for continued economic support. The IUCN lists this species as near threatened due to threats of unsustainable fishing practices and habitat loss (Adams et al., 2012)[27]. The close proximity to Cross Harbour National Park plays a significant role in Bonefish aggregation as this species uses the shallow waters of this site to migrate toward deeper waters for spawning. Due to its proximity to Cross Harbour National Park, it is possible the connectivity of the two sites are vital for Bonefish spawning migration.

Moreover, accounts from the South Abaco communities state that marine mammal (both vulnerable and endangered) sightings occur within the waters off the coast of South Abaco and within the northeast providence channel. However, during the baseline assessment, no marine mammals were observed within the benthic survey area. It is noted marine mammals travel and forage within the deep Atlantic waters surrounding South Abaco. More specifically, along the Northwest Providence Channel which is located northwest off the Little Bahama Bank. According to the Bahamas Marine Mammal Research Organization (BMMRO), The Bahamas is home to at least twenty-five (25) species of marine mammals. Some of these species represent four groups of whales and dolphins, separated into their taxonomic families: oceanic dolphins, dwarf and pygmy sperm whales, sperm whales and beaked whales, as well as the West Indian manatee (BMMRO, 2019)[28].

The islands of the northern Bahamas have the highest avian diversity in the country. Abaco contains a rich assortment of endemic and specialty species with very restricted distributions. Several species of threatened birds use the three sites including the Bahama Swallow, Bahama Warbler, White-crowned Pigeon, Chuck-Wills Widow, Abaco Parrot, and Brown Pelican. In addition, other species of concern have also been observed including the Cape May Warbler, Chimney Swift, Mangrove Cuckoo, Wilson's Plover and White-tailed Tropicbird.

[26] Sadovy, Y., Aguilar-Perera, A. & Sosa-Cordero, E. 2018. *Epinephelus striatus*. *The IUCN Red List of Threatened Species* 2018. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T7862A46909843.en>.
[27] Adams, A., Guindon, K., Horodysky, A., MacDonald, T., McBride, R., Shenker, J. & Ward, R. 2012. *Albula vulpes*. *The IUCN Red List of Threatened Species* 2012: Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T194303A2310733.en>.
[28] Bahamas Marine Mammal Research Organization. (2019). **Guide to the most common marine mammal species in The Bahamas.** Retrieved from <http://www.bahamaswhales.org/species_guide.aspx>

7.12 INVASIVE SPECIES

There were no invasive species found within any site's marine habitat. Feral hogs and raccoons were seen within all three sites. Casuarina was also seen within each site.

7.13 AESTHETICS

7.13.1 Leeward Harbour Aesthetic

The proposed site at Leeward Harbour has no current development. However, infrastructure such as an airfield, public landfill, communications cables and a dock exist near the proposed site, as well as the communities of Sandy Point and Sands Cove. The subdivision of Sands Cove is quiet due to the lack of development. The Sandy Point settlement is quaint and colorful which provide an authentic Bahamian cultural experience. Disney cruise ships at Castaway Cay traverse the waters twice a week approximately 10 miles away from the proposed site. The development site is largely undeveloped and is dominated by vast expanses of pine forests, mangrove wetlands and miles of coastline. These natural features provide a peaceful and serene environment which provides soothing sounds of wildlife and the melodic movement of trees as they sway with the wind. Its crystal-clear waters are visually appealing and offers a serene experience. The marine life within these tranquil waters affords visitors the opportunity to experience an aquatic paradise.

7.13.2 High Bank Bay Aesthetic

The property at HBB and the areas surrounding are vast natural areas devoid of active development and infrastructure. The high sandy dunes of the property provide an aesthetically pleasing view of the high energy shorelines and the rolling hills on the property. South of the property, rocky cliffs and Hole in the Wall Lighthouse are visible from coastal areas and high ridges at HBB. The coastal areas are predominantly sandy, with significant marine debris accumulated along its shores. The ebb and flow of the tides reveal near shore rock outcroppings and expose intertidal benthic habitats rich with marine organisms. During the summer months of the year, large accumulations of Sargassum seaweed collect along the high tide mark.

The highest ridge on the property reaches up to 90ft asl, allowing for views of the coast and the interior broadleaf and pine forests. The coppice forests behind the ridge have tall canopies with shady, open understories, whereas the pine woodlands have open canopies with sunny, dense understories.

7.13.3 Conch Sound Point Aesthetics

The property at CSP and the areas surrounding are vast natural areas devoid of active development and infrastructure. The sandy dunes are not as high as its neighboring HBB property and has a lower profile and a calmer shoreline due to rocky outcroppings offshore.

South of the property, rocky cliffs and Hole in the Wall Lighthouse are visible from coastal areas and high ridges at CSP. The coastal areas are predominantly sandy, with significant marine debris accumulated along its shores. The ebb and flow of the tides reveal near shore rock outcroppings and expose intertidal benthic habitats rich with marine organisms. During the summer months of the year, large accumulations of Sargassum seaweed collect along the high tide mark.

The highest ridge on the property reaches up to 34 ft. asl, allowing for views of the coast and the interior broadleaf and pine forests. The coppice forests behind the ridge have tall canopies with shady, open understories, whereas the pine woodlands have open canopies with sunny, dense understories.

7.14 PROTECTED AREAS

There are two (2) national parks located within the vicinity of the proposed development sites; Abaco National Park and Cross Harbour National Park (see Figure below). These national parks were created to protect natural resources of economic and ecological importance.

Cross Harbour National Park (CHNP) was established in 2015 by the government of The Bahamas and encompasses 15,181.9 acres of marine and wetland habitat. This creative effort was brought on by the 2008 Caribbean Challenge Initiative, which consists of protecting 20% of the country's marine and near shore environments. CHNP is a wetland ecosystem that provides habitat for various commercially important species. Most importantly, studies show that Bonefish use the area as a breeding ground, as it is the most popular breeding ground for this species. Spawning aggregations travel from these flats to deeper waters to reproduce. Thus, labeling this shallow water habitat vital due to historical reproduction migration. Queen Conch and Nurse Sharks also utilize this habitat for breeding purposes. Various fish species from initial to terminal stages have been noted within this park. Therefore, the park establishes itself as a habitat of great importance to Bahamian marine ecological biodiversity. The cultural significance of this park is immeasurable. Locals use the shallow waters for subsistence and commercial fishing, ecotourism profits and recreational activities.

The Abaco National Park (ANP) was established by the Bahamas National Trust in 1994. This park encompasses 21,027.1 acres, of which 5,000 acres of pine forest is protected. This vast protected area was created to protect vital natural resources and preserve forest biodiversity such as Bahamian Pine *(Pinus caribaea var. bahamensis*), aquifers and the endemic Abaco Parrot (*Amazona lecocephala bahamensis*). Conservation of this area is vital to the species and promotes the stability of its population in the northern Bahamas. Unique among New World Parrots, these birds are subterranean nesters, nesting in naturally created limestone cavities on the ground of the pine forest.

An extensive tract of Mixed Broadleaf Coppice is protected in the ANP. The habitat/ecosystem is important for many reasons, including its historical value to The Bahamas and the biodiversity it supports. The Park also protects an extensive tract of Bahamian Pine. No other National Park protects such a large tract of this species and the ecosystem it supports. The area is known as a breeding ground for the White-Crowned Pigeon, the most popular game bird of the Bahamas.

ANP presents a great ecotourism opportunity for South Abaco residents and visitors. The ANP lends itself to nature tourism activities, with birding and hiking being the two most popular activities in the Park. The ANP is an IBA, as it protects critical feeding, breeding and nesting grounds for the endemic Bahama Parrots, as well as other endemic birds such as the Bahama Woodstar, Bahama Swallow, Bahama Yellow Throat, and Bahama Warbler. Abundant birding opportunities exist in the ANP as up to 111 species have been identified in the park thus far (ebird, 2019)[29].

Figure 7.165. Map depicting relative locations of Cross Harbour and Abaco National Parks to the Leeward Harbour property

7.15 Socio-economic Aspect

7.15.1 Human Uses of Biodiversity

7.15.1.1 Leeward Harbour Human Uses of Biodiversity

Fishing is a major source of food and income for residents of Sandy Point. Sports fishing is also a popular activity in the area, with reef fish, mangrove species and deep-water species as targeted species. Crawfish traps are commonly deployed in the area, and local fishermen from Sandy Point hunt within the mangrove estuaries east of the LH site. Curbs, whelks and other marine gastropods are collected along the rocky shoreline on the southern coast of the site. Queen Conch is harvested from sandy areas and seagrass beds in the shallow waters off the western shoreline of the LH site. Hunters are known to utilize the areas in and around the LH site for hunting waterfowl in wetlands, as well as wild hogs occupying the wetland habitats.

High species count suggests that there is rich species biodiversity at this marine ecosystem within Leeward Harbour. Ecosystem productivity and services increase due to rich biodiversity. Thus, improving the health status of this ecosystem. "High diversity therefore entails opportunities for

[29] https://ebird.org/home

more efficient resource use as well as providing stability to ecosystem processes in variable environments and in the face of disturbance" (Strong et al., 2015)[30]. As a result, the marine environment observed at Leeward harbor is a relatively healthy marine ecosystem.

Figure 7.166. Crawfish traps observed on the western shoreline of Leeward Harbour.

7.15.1.2 High Bank Bay and Conch Sound Point Human Uses of Biodiversity

The uses of biodiversity within the area of the proposed development encompasses the use of available natural resources for stakeholders. However, no onsite evidence shows active uses of

[30] Strong, J.A., Andonegi, E., Bizsel, K.C., Danovaro, R., Elliott, M., Franco, A., Garces, E., Little, S., Mazik, K., Moncheva, S., Papadopoulou, N., Patrico, J., Queiros, A.M., Smith, C., Stefanova, K. and Solaun, O. (2015). Marine biodiversity and ecosystem function relationships: The potential for practical monitoring applications. *Estuarine, Coastal and Shelf Science*, *161*, 46-64. Retrieved from <https://sta.uwi.edu/fst/lifesciences/sites/default/files/lifesciences/images/Acropora%20palmata%20-%20Elkhorn%20Coral.pdf>

biodiversity within this area. Due to the availability of wildlife, it is assumed that locals may use this forest habitat for its aesthetic and recreational value; which include the hunting of birds and wild hogs. Also, there is potential to harvest hard wood within this habitat. Furthermore, the eastern shoreline of Abaco may provide ambergris, a valuable whale by product.

7.15.2 Population/Demographics

According to Commonwealth of The Bahamas Census of population and Housing 2022 total population on Abaco is 16,587 (7,998 Male and 8,589 Female) with a total of 6,193 households as of 2022. South Abaco has a population of 6,530[31]. The Abaco population decreased by -3.7% (-637 population) from 2010 to 2022.

Sandy Point is primarily a fishing village, also having a primary school, community center, gas station, public clinic, fire station, public library, restaurants, guest houses and convenience stores. The community hosts its annual homecoming celebrations in the first week of June. The sandy beach north of the airstrip is typically utilized as part of the celebration.

The total employment rate in Abaco in the year 2019 is recorded at 13,265 and unemployment at 1,355 (9.3% unemployment rate)[32]. Castaway Cay is a cruise stopover point owned and operated by the Disney Cruise line and is located approximately 9 miles northwest of the Sandy Point settlement.

Commercial fishing is a source of income for Sandy Point residents. Typically, owners of personal fishing vessels, or fishers working on large trawlers operate in the waters of South Abaco. Bone fishing and sports fishing guides can also be found in Sandy Point.

Other employment opportunities existing in Sandy Point School include the public school, mailboat, police and fire services, or with one of the small businesses in, i.e. grocery stores, gas station, ecotourism opportunities, liquor store, restaurants, & hotels/lodges.

7.16 CULTURAL RESOURCES

7.16.1 Historical Overview

South Abaco is rooted in industrial occupations such as agriculture, logging, whaling, and ship wrecking. Portions of land within South Abaco were granted to a Loyalist Lt. Col. Thomas Brown in 1788. Early maps illustrate the origin names given to the property of the proposed Kakona development. For instance, Hole in the Wall was referred to as "Hole in Rock", Lantern Head was previously known as "Lanthorn" and Sandy Point was known as "Cross Harbour". These names and settlements referenced on ancient maps

[31] Bahamas National Statistics Institute. (2022). The Commonwealth of The Bahamas census of population and housing. Retrieved from < https://www.bahamas.gov.bs/wps/wcm/connect/c0d9fae8-54df-49e3-b4b9-92e29e0b264c/2022+CENSUS+PRELIMINARY+RESULTS_FINAL+April+12+2023.pdf?MOD=AJPERES >

[32] The Department of Statistics. (2019). Highlights from the May 2019 labour force and household income survey. Retrieved from <https://www.bahamas.gov.bs/wps/wcm/connect/819a4a40-602b-47a3-9da7-c90eeae0f679/Labour+Force+Report+May_2019.pdf?MOD=AJPERES>

indicate that these destinations were well known by mariners as they feared maneuvering the treacherous waters of South Abaco. However, these maps were not successful at informing sailors of the potential for shipwrecks along the South Abaco coast. The sabotage of passing ships was a popular industry within South Abaco. Between the 1700's and 1800's, significant totals of shipwrecks occurred near the coast that its waters became notorious for the intentional wrecking of passing merchant vessels. The Hole in the Wall property was purchased in order to provide a lighthouse to prevent the heinous wrecking practice. Thus, the Hole in the Wall lighthouse was built in 1836 with local resentment. Presently the lighthouse stands at 84ft. high at an elevation of approximately 124 ft.

Alexandria may have been the first of several settlements established in south Abaco; others include Barque Bay and Crossing Rocks which are both north of Lantern Head. Survey maps depict that coastal land east of Hole in the Wall were occupied by "squatters". These squatters were not determined. However, the building techniques and other evidence suggest that this area referred to as squatter's territory belonged to slaves and their dependents. Therefore, Sandy Point was mostly populated by slave descendants in the 1900s.

South Abaco populations increased in the later parts of the 1800's due to the cultivation of pineapple and sisal. Farmers, seamen and carpenters were the most common occupation of south Abaco locals. Women were also documented as farmers within these communities. In 1844, Abaco began exporting pineapples to England. Pineapple cultivation occurred in crown land northeast of Hole in the Wall and 445 acres of land in Lantern Head was designated for pineapple farming. Pineapple exports from South Abaco earned as much as £60,000. However, due to over production for the overseas market the demand decreased, and the price of pineapple was reduced. As a result, south Abaco farmers turned to sisal cultivation just after 1900 due to the product demand. Also, sisal thrived in a hot and dry climate and required less cultivation labor. Sisal exports generated £42,057 in revenue between 1906-1910. Since this crop proved to be financially beneficial, farmers produced mechanized facilities to process sisal at Hole in the Wall before 1905.

The existence of sisal at Lantern Head and Barque Bay indicates that farming of this plant was cultivated throughout South Abaco. Unfortunately, competition from the Philippines and reduced prices killed local profits and the sisal industry for south Abaco locals. As a result of failed agricultural exploits, records show that all south Abaco communities were drastically affected, which prompted the vacation of these settlements in the early 1900's. However, records show that that one family, Mr. Jasper Brown, stayed in Sandy Point in 1902. Remaining Sandy Point residents turned to sponging as a source of income. The Bahamas Timber Company was founded in 1906, which brought settlers back to South

Abaco; although, operation ceased in 1916. The events of World War I also removed locals from South Abaco as they were joined U.S. forces to support the war effort. Few residents returned, thus leaving the communities in south Abaco such as Alexandria, Barque Bay, Lantern Head and Cross Harbour a distant memory. Further information on the south Abaco communities can be retrieved from 'A Survey of Heritage Resources at High Bank Bay and Lantern Head Properties, South Abaco, The Bahamas' located in Appendix J.

7.16.2 Historical, Archaeological and Paleontological Resources

7.16.2.1 Leeward Harbour Historical, Archaeological and Paleontological Resources

The remains of a stone wall have been found in the Leeward Harbour site indicating historic usage of the area although it is not known at this time the extent of any activities. Defunct infrastructure for the ICT cable and lighthouse are found along the southern and western shoreline of the Leeward harbor property.

Figure 7.167. Remnants of Rocky Point 'lighthouse

7.16.2.2 High Bank Bay Historical, Archaeological and Paleontological Resources

Ruins at the southeast corner of the High Bank Bay property include the settlement which is also known as Barque Bay. High Bank Bay is 500 acres, that was granted to R.H. Sawyer and R. Menendez. There are three groups of buildings at Barque Bay. These buildings were situated for ease and access to the protected bay and its sandy beach. The most obvious feature of the settlement is the field wall enclosure as seen on the land presently. Building 1 is north of the northern closure wall, which consists of four structures including an oven, fireplace, well and a large building. This large building has three front entrances, which suggests it could be more than a family home. Building 2 is located inside a field wall enclosed at the northwest corner. The buildings consist of a well, kitchen and cistern; which indicate that this building could have been a home. Building 3, located mostly south, was constructed of wattle and mortar. This building was substantially lesser in size than the northern structures. These smaller size ruins consisted of wells and ovens, were possibly slave dwellings.

Figure 7.168. View of ruins at Barque Bay site.

Figure 7.169 View of ruins at Barque Bay site

Figure 7.170 View of ruins at Barque Bay site

Figure 7.171. View of ruins at Barque Bay site

Figure 7.172. View of ruins at Barque Bay site

Figure 7.173. View of ruins at Barque Bay site.

7.16.2.3 Conch Sound Point Historical, Archaeological and Paleontological Resources

There are no known historical, archaeological or paleontological resources at CSP.

7.16.3 Tourist and Recreational Areas

7.16.3.1 Leeward Harbour Tourist and Recreational Areas

The Sandy Point settlement hosts its annual Homecoming Festival in early June each year, with many of the festival's activities occurring at the public beach access, located ¼ mile north of the Leeward Harbour property. The sandy beaches along the western shore of the Sandy Point settlement is a popular gathering spot for locals and visitors alike.

Figure 7.174. Image depicting relative location of public beach to Leeward Harbour property

Recreational fishing activities are popular in Sandy Point, ranging from bone fishing in the sandy flats surrounding the settlement or other forms of sport fishing, scuba diving and marine mammal watching in the deep waters of the Northwest Providence Channel; less than a mile off the coast of South Abaco.

Disney's private island Castaway Cay is a vacation destination for Disney Cruise Line passengers featuring bathing beaches, hiking trails, water slides and other amenities (see Figure below). The island is located approximately 8 nm. northwest of the LH property and the Sandy Point settlement.

The South Abaco Pine Woodland and Broadleaf Coppice Forest provide a vast habitat wildlife hunting activities by local Abaconians.

Figure 7.175. Image depicting relative location of Castaway Cay to Leeward Harbour property.

7.16.3.2 High Bank Bay and Conch Sound Point Tourist and Recreational Areas

South Abaco is culturally known among Abaconians as a prime hunting ground for game birds and wild hogs. The extensive hectares of Pine woodland and Broadleaf Coppice Forest provide a vast habitat for local fauna to thrive, as the native vegetation provides food and shelter for popular game species such as White Crown Pigeons and Wild Hogs. The abundance of freshwater wetlands in South Abaco are also prime habitat for game fauna, as waterfowl species and wild hogs utilize these areas for feeding, breeding and shelter. Most of the hunting activity is practiced by residents to the island of Abaco, as well as hunters from other islands of The Bahamas. Local sports fishing lodges also provide bird and big game hunting opportunities for their guests.

However, the immediate areas surrounding HBB and CSP areas are rarely used for tourist or recreational activities due to its remote location. Hiking and birding activities are possible due to the availability of natural resources in the area and proximity to the Abaco National Park (ANP).

ANP also holds great potential for ecotourism opportunities for residents and visitors. The park is easily accessible and the supporting tourism infrastructure in Abaco (hotels, etc.) lends itself to the development of nature tourism activities with birding and hiking being the two most popular activities in the Park. Abaco has the best birding of any island in The Bahamas. The ANP is an Important Bird Area (IBA), as it protects critical feeding and breeding grounds for the endemic Bahama Parrots, as well as other endemic birds. BNT wardens and local tour guides provide tours to persons and groups interested in experiencing the nature-based tourism opportunities of the ANP. It is possible to see more Bahamian specialties on Abaco then on any other island. A visiting birder with a good guide can see Bahama Parrots, West Indian Woodpeckers, Bahama Swallows, Bahama Yellowthroats, Bahama Warblers, Loggerhead Kingbirds, Olive-capped Warblers and Bahama Mockingbirds. Bahamians who are willing to learn about birds and the other flora and fauna of the Park, as well as take a tour guide training, have a great economic opportunity awaiting them in Abaco.

Most fishing and water recreation activities occur along the northeastern coastline of South Abaco. Recreational fishing is a popular activity in Sandy Point, ranging from bone fishing in the sandy flats surrounding the settlement or other forms of sport fishing. Also, scuba diving and marine mammal watching in the deep waters of the Northeast Providence Channel opportunities are possible, less than a mile off the coast of South Abaco.

7.17 TRANSPORTATION

The Great Abaco Highway serves as the main thoroughfare for the island of Great Abaco and the main access road to gain access to the LH site. This road is extended in the northern district by the S.C. Bootie Highway, which continues to the northernmost tip of Abaco while the Great Abaco Highway provides road access to areas south of Marsh Harbour.

The Marsh Harbour International Airport is approximately 45 miles north of the proposed site along the Great Abaco Highway. This airport serves as the main port of entry for Abaco and is the busiest airport for the main island and its surrounding cays; receiving multiple domestic and international flights daily.

The Sandy Point airstrip exists 1-mile south of Sandy Point and serves to accommodate small aircraft. However, there is no FOB facility to support the airstrip. Therefore, leaving the airstrip unmanaged due to the lack of Bahamas Customs and Immigration regulation. This airstrip is void of a control tower and lacks communication services directly into South Abaco; although, pilots can communicate with radio frequencies in New Providence. Fire extinguishers are available. Its runway is constructed of 4,500 ft. x 100 ft. of asphalt.

The western and southern shoreline around the LH site are utilized by boaters destined for the South Abaco communities. The Government Dock is located approximately 5 miles north along the Sandy Point coastline. This dock serves the Mailboat cargo and passengers with access into South Abaco. Also, there is another dock located approximately 1 mile east along the LH coastline known as Rocky Point Dock. However, this dock is dilapidated and not in use.

Figure 7.176. Sandy Point Airstrip with access road and Great Abaco Highway

Figure 7.177. Western aerial approach viewpoint of the Sandy Point airstrip

Approximately 10 miles North of Road 50, the Great Abaco Highway splits westward towards Sandy Point, and southward towards Hole in The Wall Lighthouse (see Figure below). The Lighthouse Road is the only access to Road 50, much of its length passing through or adjacent to the ANP boundaries. The road is an unpaved dirt road, with old logging roads running perpendicular into the Pine Forests and towards the eastern and western coastlines of South Abaco. A historical road once existed along the landward boundary of the now designated Cross Harbour National Park.

Access to the HBB property is accessible through use of the Great Abaco Highway, The Lighthouse Road, and Road 50. The Lighthouse Road runs approximately 8.5 miles to the junction with Road 50, which is approximately 2.5 miles to the nearest junction to the HBB and CSP properties. Both Lighthouse Road and Road 50 are unpaved surfaces and become rocky at points.

Figure 7.178. Proposed South Abaco road improvements as part of the Kakona development.

8 ENVIRONMENTAL REGULATORY BODIES AND LAWS

8.1 RELEVANT REGULATORY BODIES

Office of the Prime Minister (OPM) - Office of the Prime Minister coordinates ministries, government, and parliamentary business. Specific related departments and agencies are listed below.

Department of Lands and Surveys - This department is responsible for planning, mapping, and monitoring of crown land (i.e., where beaches begin and end, high water marks, etc.).

National Emergency Management Agency (NEMA) - NEMA aims to reduce life and property loss in the event of a natural disaster.

Antiquities Monuments and Museum Corporation (AMMC) - The mission of AMMC is *"to protect, preserve, and promote the Historic Cultural Resources of The Bahamas, and to be the number one conservation Agency in the world. We will do this while protecting our environment, encouraging research and archaeology, and by protecting, preserving, and promoting our Historical Sites."*

Ministry of Agriculture, Marine Resources and Family Island Affairs - The Ministry of Agriculture Marine Resources and Local Government is responsible for the implementation, monitoring and evaluation of policies related to agricultural lands and marine resources. The Ministry serves as the Management and Scientific Authority for the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in The Bahamas.

Department of Marine Resources (DMR) - DMR is primarily responsible for the administration, management, and development of fisheries in The Bahamas. The department was created to administer, manage, and develop the fisheries sector as stipulated by the Fisheries Resources (Jurisdiction and Conservation) Act. The department is also tasked with enforcement of Fisheries Regulations, Marine Mammal Regulations and the Seafood Processing and Inspection Regulations.

Ministry of Public Works and Utilities - The Ministry of Public Works maintains the physical infrastructure and natural environment of The Bahamas by providing quality services to its client agencies.

Department of Public Works - The Department of Public Works maintains public infrastructure inclusive of government buildings, roads, docks, bridges, and cemeteries.

Department of Physical Planning - The Department of Physical Planning manages town, physical, country and land use planning, zoning, private roads and subdivisions for New Providence and the Family Islands.

Water and Sewerage Corporation - The Water and Sewerage Corporation is entrusted with managing, maintaining, distributing, and developing the water resources of The Bahamas.

Ministry of Environment and Natural Resources - The Ministry of Environment and Natural Resources serves to protect, conserve, and manage the environment of The Bahamas. This ministry focuses on environmental control, solid waste management, public sanitation, and the beautification of public areas such as parks and beaches.

Department of Environmental Planning & Protection (DEPP) - The functions of the Department are to provide for and ensure the integrated protection of the environment of The Bahamas and ensure the sustainable management of its natural resources." DEPP is responsible for the evaluation of EIAs and EMPs and managing international environmental conventions.

Department of Environmental Health Services (DEHS) - DEHS manages the disposal of all waste and management of environmental pollution (on land or in water). This department also promotes planning and approves various measures designed to ensure wise use of the environment.

Forestry Unit - The Forestry Unit's mandate is "to develop the forest resources of The Bahamas to their maximum potential by applying sound, scientific and sustained yield forest management principles and concepts."

Bahamas National Trust (BNT) - The mission of the BNT is "Conserving and protecting the natural resources of The Bahamas, through stewardship and education, for present and future generations."

Ministry of Labour - The Ministry of Labour oversees and regulates labour relations within The Bahamas.

Department of Labour - The Mission of the Department of Labour promotes good industrial relations between employer and employee, while promoting a high level of employment.

8.2 NATIONAL LAWS AND REGULATIONS

Agriculture and Fisheries Act, 1963 (Ch.242)- "An Act to provide for the supervision and development of agriculture and fisheries in The Bahamas," where Section 4 explains that "The Minister may make rules for all or any of the following purposes, (a) to define area hereinafter called 'protected areas' within which it shall be unlawful for any person except a licensee especially licensed in that behalf to plant, propagate, take, uproot or destroy any species of plant…".

Antiquities, Monuments and Museum Act, 1998 (Ch. 51) - "An Act to provide for the preservation, conservation, restoration, documentation, study and presentation of sites and objects of historical, anthropological, archaeological and paleontological interest, to establish a National Museum, and for matters ancillary thereto or connected therewith", where, section 3 speaks to the declaration of a monument by reason of its historical, anthropological, archaeological or paleontological significance.

Bahamas National Wetlands Policy[33] – see Ramsar Convention.

Bahamas Public Parks and Public Beaches Authority Act, 2014 – An Act to establish the public parks and public beaches authority, to provide for the property rights and liabilities of the public parks and public beaches authority and to identify, regulate, maintain, develop, and conserve public parks and public beaches and for connected purposes, Where section 5 speaks to functions of the Authority.

Buildings Regulation, 1971 (Ch. 200) - "An Act to regulate the construction, alteration and repair of buildings, to provide for the re- instatement or removal of dangerous or dilapidated buildings, to authorize the publication of a building code and for purposes connected therewith." Where, Section 2. (c) speaks to the interpretation of 'building' including "any dock, bulkhead, pier and any works for the protection of land against encroachment by, or for the recovery of land from, fresh or salt water;" and Section 17 speaks to the Building Code.

Buildings Regulation (General) Rules, 1971 - (further to Section 19 of Ch. 200) and Section 9 speaks to the execution of permitted works.

Coast Protection Act, 1968 (Ch. 204) - "An Act to make provision for the protection of the coast against erosion and encroachment by the sea and for purposes connected therewith", where section 8 speaks to approval for coastal protection work and section 9 speaks to the prohibition of excavation or removal of materials that compose of the seashore.

Conservation and Protection of the Physical Landscape of The Bahamas Act, 1997 (Ch. 260) - "An Act to make provision for the conservation and protection of the physical landscape of The Bahamas. The Act contains parts regarding administration, regulation of excavation and landfill operations, provisions governing dangerous excavations, landfill operations, quarries or mines, zoning of The Bahamas for the purposes of quarrying and mining operations, protected trees, and general entries," where Section 27 speaks to applications, permits, and licenses, appeals, fees, offences, and penalties.

Disaster Preparedness and Response Act, 2006 (Ch. 34A) - "An Act to provide for a more effective organization of the mitigation of, preparedness for, response to and recovery from emergencies and disasters." This Act contains parts regarding Director of NEMA, Advisory Committee, policy review and plan; emergency operation centers and shelters; obligations of other public officers; specifically, vulnerable areas; disaster alerts and emergencies; and miscellaneous entries.

Environmental Health Service Act, 1987 (Ch. 232)- "An Act to promote the conservation and maintenance of the environment in the interest of health, for proper sanitation in matters of food and drinks and generally, for the provision and control of services, activities and other matters connected therewith or incidental thereto", where section 5 speaks to functions of the Department of Environmental Health.

[33] http://www.best.gov.bs/Documents/Bahamas_national_wetlands_policy.pdf

Environmental Health Services (Collection and Disposal of Waste) Regulations, 2004 (Ch. 232) - "These Regulations may be cited as the Environmental Health Services (Collection and Disposal of Waste) Regulations, 2004", where section 18 speaks to removal of construction waste and section 19 speaks to industrial waste disposal.

Environmental Impact Assessment Regulations, 2020 – An extension of the Environmental Planning and Protection Act that outlines the Environmental Impact Assessment Regulations which apply throughout the territory of The Bahamas including every island and cay; "The Minister, in exercise of the powers conferred by section 12 of the Environmental Planning and Protection Act, 2019 (No. 40 of 2019)".

Environmental Planning and Protection, 2019 – An Act to establish the Department of Environmental Planning and Protection; to provide for the prevention or control of pollution, the regulation of activities, and the administration, conservation, and sustainable use of the environment; and for connected purposes.

Forestry Act, 2010 – An Act to provide the conservation and control of forests and for matter related thereto.

Forestry (Declaration of Protected Trees) Order, 2021 – The declaration of protected trees for the purpose of this Act are specified in Part I (Endemic or Endangered or Threatened Protected Trees) and II (Cultural or Historical and Economic Protected Trees).

Forestry (Amendment) Regulations, 2021 – "The Minister, in excise of the powers conferred by section 34 of the Forestry Act, 2010, makes the following Regulations." Where the amendment speaks to Regulation 36 subsection 3A "The Minister, acting on the advice of the Director of Forestry, may where a hurricane, tornado, or any other natural disaster has occurred in any island, islet or cay throughout The Bahamas which causes grave damage to any forest, forest estate, forest reserve, conservation forest or protected forest to be payable as specified in the Second Schedule, for royalties, permits and licenses for the purpose of these regulations."

Forestry Regulations, 2014 – "5. Application for Permit to harvest protected tree. An application for the grant of a permit under section 12 of the Act to harvest a protected tree, shall be made to the Director and shall contain all the relevant particulars set out in Form No. 3 (A) in the First Schedule including the payment of the prescribed fee as set out in the Second Schedule." and

"6. Permit to harvest protected tree. A permit granted under section 11 of the Act to harvest a protected tree shall be made in the manner set out in Form No. 3 (B) in the First Schedule, shall be accompanied by the payment of the prescribed fee as specified in the Second Schedule and shall be valid for six months from the date of the grant unless otherwise prescribed in the permit." and

"22. Construction or modification of road in a forest estate. A person shall not construct or modify a road or trail in a forest estate unless the construction or modification has been authorized by the Director of Forestry in writing, and the road, - a) or trail has been identified in an approved forest management plan; and b) layout has been approved by the Director of Forestry."

Fisheries Resources Jurisdiction and Conservation Act Regulations,**1986** which prohibits the removal of Sea Oats, *Uniola paniculata*. "13. No person shall cut, harvest, or remove from any beach or shore or from any area immediately adjacent thereto any Sea Oats except with the written permission of the Minister.[34]"

Health and Safety Work Act, 2002 (Ch. 321C) - "An Act to make provisions relating to health and safety at work and for connected purposes." where, Section 4 speaks to general duties of employers to their employees and where, Section 7 speaks to general duties of employees at work.

Health and Safety at Work (Amendment) Act, 2015 - (repeal and replacement of Section 17 of Ch. 321C) Contains parts regarding applications, permits and licenses, appeals, fees, offences, and penalties.

Marine Mammal Protection Act, 2005 (Ch. 244A) – "An Act to make provision for the protection of marine mammals".

Marine Mammal (General) Regulations, 2005 (Ch. 244A) – "These Regulations may be cited as the Marine Mammal Protection (General) Regulations and shall come into force on the first day of May 2006", where Section 18 speaks to Marine Mammal Protection (General) Regulations and Section 19 speaks to Marine Mammal (Captive Dolphin Facilities) Regulations.

Town Planning Act, 1961 (Ch. 255) - "An Act relating to town planning", where section 7 speaks to committee sanctioned development activities.

Water and Sewerage Corporation Act, 1976 - "An Act to establish a Water and Sewerage Corporation for the grant and control of water rights, the protection of water resources, regulating the extraction, use and supply of water, the disposal of sewage and for connected purposes." where section 3 speaks to government control of the production, extraction, and use of water in the public interest.

Wild Birds Protection Act, 1952 (Ch. 249) – "An Act to make provision for the protection of wild birds."

Wild Animal Protection Act, 1968 (Ch. 248) – "An Act to make provisions for the control of the taking and export of wild animals."

8.3 International Conventions and Agreements

Stockholm Convention on Persistent Organic Pollutants – "As set out in Article 1, the objective of the Stockholm Convention is to protect human health and the environment from persistent organic pollutants[35]."

[34] laws.bahamas.gov.bs/cms/images/LEGISLATION/SUBORDINATE/1986/1986-0010/FisheriesResourcesJurisdictionandConservationRegulations_1.pdf
[35] http://www.pops.int/TheConvention/Overview/tabid/3351/Default.aspx

Commission on Sustainable Development – "The United Nations Commission on Sustainable Development (CSD) was established by the UN General Assembly in December 1992 to ensure effective follow-up of United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit[36]."

Kyoto Protocol – The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005[37].

Basel Convention on the Control of Transboundary Movement of Hazardous Wastes – "The Basel Convention is a global agreement between countries to protect human health and the environment against the adverse effects of hazardous wastes." [38]

Ramsar Convention on Wetlands – "the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources. The Convention was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975."[39]

Minamata Convention - "The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. The Convention draws attention to a global and ubiquitous metal that, while naturally occurring, has broad uses in everyday objects and is released to the atmosphere, soil, and water from a variety of sources. Major highlights of the Minamata Convention include a ban on new mercury mines, the phase-out of existing ones, the phase out and phase down of mercury use in a number of products and processes, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining. The Convention also addresses interim storage of mercury and its disposal once it becomes waste, sites contaminated by mercury as well as health issues." http://www.mercuryconvention.org/

[36] https://sustainabledevelopment.un.org/intergovernmental/csd
[37] http://unfccc.int/kyoto_protocol/items/2830.php
[38] http://www.basel.int/
[39] Ramsar Convention Secretariat. 2014. https://www.ramsar.org/

9 Environmental Impact Analysis

9.1 Methodology for the Environmental Impact Assessment

The impact analysis is a critical component of the EIA process as it evaluates the potential impacts resulting from the interaction between project related activities and the surrounding environment during construction and operations phases of the Project. Impacts are described as changes brought about to the surrounding environment as a result of project related activities. The surrounding environment for this EIA is inclusive of the physical, biological, and socioeconomic environment within the Project's area of influence. Environmental aspects considered in this analysis are listed below.

Table 9.1. Environmental aspects under consideration for Impact Analysis.

Environmental Aspects	
Physical	Erosion
	Air Quality
	Noise Quality
	Hydrogeology
Coastal Processes	Hydrology
	Turbidity / Sedimentation
	Beach
Biological	Nearshore / Coastal Habitats
	Marine Habitats
	Terrestrial Habitat
	Terrestrial Fauna
	Marine Megafauna
Socioeconomics	Neighboring Communities
	Relocation
	Boat Traffic
	Economic
Cultural	Archaeological, Historic & Paleontological Resources
	Fishing
	Hunting

Project related activities during construction and operations have the potential to impact the surrounding environment, and the nature of these impacts can be Negative or Positive and Direct or Indirect. Negative impacts are activities which result in an adverse change or degradation from the environmental baseline, while positive impacts result in a beneficial change or improvement to the environmental aspect under consideration. Direct impacts result from the direct interaction between Project related activities and the surrounding environment, while indirect impacts consequences of the Project implementation on the surrounding environment on a larger time and distance scale. Additionally, other parameters such as Significance, Duration and Intensity are used in determining the scale of environmental impact.

Significance in this assessment is a determination of the degree of importance assigned to an environmental impact resulting from project related activities. An impact's significance is evaluated in terms of its magnitude and likelihood. Magnitude is a function of the impact's extent, whether restricted on site to the immediate project area, locally within a 10-mile radius, regionally to include the island of Exuma and the Central Bahamas and Nationally to include the extent of The Bahama Archipelago. The likelihood of an impact is a rating which evaluates the likely potential for an impact to occur, with typical rating categories being unlikely to occur, Likely to occur under most conditions, and definitely will occur.

The duration of the impact relates to the temporal scale which is required for changes in the host environment to return to baseline conditions or undetectable levels. Temporary impacts persist for a short duration and occur occasionally and/or intermittently. Short Term Impacts are expected to persist for the duration of the project activities related to the construction phase of the Project. Long Term impacts extend beyond the duration of the construction period and exist throughout the life of the Project. Permanent impacts persist far beyond the life of the Project and are irreversible changes to the host environment due to project related activities.

The intensity of an impact can be considered as Negligible, Low, Medium, or High. A Negligible impact is one which has no detectable change on the host environment. A low intensity impact does not affect the host environment in such a manner to alter natural flows and processes. Medium intensity impacts alter the natural flows and process of the host environment while allowing the flows and process to retain their natural functions. High intensity impacts alter natural flows and processes to the extent where natural functions are totally inhibited for a temporary or permanent period of time.

Cumulative impacts are the compounding effects of Project related activities when combined with past, current, or future actions related to this or another Project in the nearby environment. Cumulative impacts represent the interaction of impacting factors originating from different sources with the same host environment. The result is typically an exacerbation of the impact on the environmental aspect and is considered in this assessment.

9.2 LAND USE IMPACT

9.2.1 Leeward Harbour Land Use Impact

The property at LH is currently undeveloped and free from infrastructure aside from the ICT cable and relict lighthouse at Rocky Point. The proposed project will have to incorporate the ICT cable into the project's design to facilitate continued communication capabilities for South Abaco. The small defunct lighthouse at Rocky Point will be replaced with a functional light warning system for mariners traversing waters near the shallow Rocky Point.

The existing airstrip north of the property is unregulated and unmanaged and has been proposed as part of the external project improvements. The addition of the FBO building, Bahamas Customs and safety personal will improve the current state of the Sandy Point Airstrip.

The terrestrial areas of the property are utilized for hunting of waterfowl during the rainy season, as evidenced by a few spent shotgun shells observed near the wetlands in the northwestern area of the property. More evidence of spent shotgun shells were observed in areas around the perimeter of the large wetland east of the property. Higher volumes of shells observed at this location suggests that the offsite wetland is utilized more for hunting than wetlands on the LH property.

The rocky shore habitat in the coastal areas of the property provide habitat for whelks, chiton and other marine gastropods. Sandy Point residents are known to forage these areas to harvest such resources from these rocky shore areas. The southern shoreline of the property provides closer access to deeper waters, creating a casting spot for local subsistence fishermen from the community.

The near shore areas to the west of the property are sandy, shallow and is utilized for subsistence and recreational fishing. Crawfish traps were observed in the sargassum beds and sandy areas.

9.2.2 High Bank Bay and Conch Sound Point Land Use Impacts

The property at HBB and CSP is devoid of any current or active infrastructure, residential, commercial or industrial operations. The property possesses healthy terrestrial habitats for plant and animal life and provides ecosystems services which allow for the ecology of that site to function. Recreational activities on the HBB and CSP properties are limited to occasional bird hunting and beach combing. The proposed development will retain as much of the natural environmental and habitats as possible while providing residential, commercial, employment and recreational opportunities

The Abaco National Park is located west of the site and is used by locals and tourists for recreational activities such as hiking, swimming, bird watching and hunting. Privately owned land is located north and south of the proposed site. The historical Hole in the Wall Lighthouse is located south of HBB and CSP at the southern-most point of the island at an area known as Hole in The Wall.

9.3 Aesthetic Impact

9.3.1 Leeward Harbour Aesthetic Impact

The Northeast Providence channel is frequently traversed by marine vessels on a daily basis and are commonly seen on the horizon from the LH shoreline as well as the public beach and the Sandy Point community. The completion of the marina has the potential to encourage higher amounts of boat traffic in the near shore areas, impacting ambient noise levels in the immediate areas. The Kakona Harbour is designed to be aesthetically pleasing and complement the natural areas surrounding the property.

9.3.2 High Bank Bay and Conch Sound Point Aesthetic Impact

The development of HBB and CSP would not obstruct the view of any near entities, as the surrounding areas are undeveloped. The existing natural aesthetics of HBB and CSP will be incorporated into the design of the development. Land clearing activities will remove areas of vegetation for construction activities, and site grading may alter natural slopes on the property. The incorporation of native vegetation into landscaping activities will aim to replace vegetation impacted by construction activities.

9.4 Air Impact

During construction activities, ambient dust levels will temporarily increase in the immediate areas of the properties for the duration of the construction period. Possible emissions from boating activity within the LH marina may impact air quality during operations.

9.5 Noise Impact

During construction activities, ambient noise levels will temporarily increase in the immediate areas of the properties for the duration of the construction period. Noise levels will decrease during operation of the development, with sources primarily from onsite machinery and equipment, and noise related to guest and resident activities.

9.6 Groundwater Resource Impact

Groundwater resources within South Abaco are considered present and plentiful. Thus, potentially impacting the below surface resources on each site and the groundwater stored in the adjacent wetlands. During construction, the impact to the below surface resources can be moderate to negative, as the water table was measured at 0 to 20ft according to the study conducted by the US Army Corp. The excavation required for foundations and the installation of utilities is at approximately 6 feet below ground grade.

On all properties the low-lying areas of the mangrove wetland serve as a watershed area for the site, collecting site runoff during rain events and overwash during high storm surges. The surface water in these areas are an extension of the groundwater resources on the property, in which freshwater aquifers are known to accumulate near Holocene dune ridges.

As these areas at HBB and CSP are slated for creation of the lagoon, they will continue to serve as a water shed area for the windward face of the coastal ridges. Introduction of seawater into the inland lagoon basin may increase the potential of saltwater intrusion into nearby freshwater aquifers on site. Capping of lagoon walls and flushing channel will reduce the potential for saltwater intrusion of freshwater aquifers on site.

Surface runoff also collects in the lowland areas behind the highest ridges on the property. These lowland areas are slated for excavation to create golf course ponds on the property. These ponds will continue to serve as watershed areas for collection of surface runoff, however the potential for contamination of groundwater to due to run off from golf course and practice lawns as well as residential lawns bordering the lagoons is a consideration for this project activity. To reduce potential impacts to groundwater resources, the golf course and ponds can be lined with an impermeable liner to prevent groundwater contamination and also to collect and reuse water for irrigation purposes. In addition to impermeable liners, the golf course can utilize environmentally friendly and organic fertilizer and pest control methods.

9.7 GEOLOGY IMPACT

The Project is expected to include minor excavation activities associated with building foundation and pool construction at all three (3) sites. However, excavation at the LH location during the marina creation is classified as a major excavation activity. Which will result in removal of approximately 563,794.00 cy of excavated material.

Land clearing activities associated with the Project contribute to topsoil removal on site. Therefore, erosion impacts may occur within the sensitive habitats on site such as wetland and coastal habitats. Observed solution holes on site within the Pineland habitats require fill and compaction activities. Heavy machinery and stockpiling may aid in additional erosion activities on site. Erosion control measures are introduced in Section 13.4.1 and will be detailed in the Project's EMP.

9.7.1 Leeward Harbour Geological Impacts

Construction activity on the Project has the potential to impact the surrounding environment due to site runoff, exposure to wave activity and influenced sedimentation. The removal of upland vegetation increases the likelihood for the erosion of topsoil, which can negatively impact surrounding habitats if not properly managed by erosion control strategies on site. As the Project will be completely landscaped once construction activities are done, it is anticipated that erosion and sedimentation risks related to land clearing will last only the duration of the construction period.

Marina creation has the potential to increase sedimentation in nearby coastal areas due to influenced turbidity due to the mechanical removal of substrate. The spoils stockpiled from the marina creation can introduce runoff into the nearby marine environment and should be properly stored away from coastal areas. The loose sandy sediment characteristic of those coastal areas risk erosion under the introduction of ocean forces within the inland area.

The Project has the potential to impact the beach at LH during construction activity. The movement of construction vehicles and land clearing activities may temporarily reduce the aesthetic quality of the beaches at LH. However, this is expected to last only the duration of the construction period. The creation of the marina could potentially alter the beach conditions through altered process of erosion, sedimentation and accretion due to this activity. Furthermore, the alteration to mangrove habitats at LH has the potential to influence risk of beach erosion as mangroves bind sediment. Also, this alteration could impact the LH site leaving it exposed to effects of intense storm activity.

Construction Phase – Marina Creation

The creation of the marina will require complete removal of terrestrial habitat within the immediate area of the marina basin footprint. As the LH property is predominantly wetlands, the removal of the surface habitats will alter the hydrology of the site. The LH property serves as a watershed between the mangrove forests east of Sandy Point and the large ‘Duck Pond’ to the east of the property.

Excavation of the material from the marina basin footprint will disrupt and permanently alter subsurface hydrology in the immediate areas of the marina. Excavation of the marina basin will alter surface water flow and has the potential to introduce sediment into the near shore environments via surface runoff.

The ‘unplugging’ of the marina will release the accumulated landlocked water from the LH site into the surrounding near shore areas, also allowing seawater to enter the marina basin. This project activity has the potential to release suspended sediments into near shore areas and benthic habitats. The filling of the marina basin with seawater will potentially impact freshwater aquifers in the immediate areas surrounding the marina basin. Saltwater intrusion may occur in the areas, with an increase in salinity observed in surface waters on the property.

As material is dredged from the marina basin footprint, the saturated spoils when stored on land can potentially impact surface wetland on and around the property. Salty run off from spoil stockpiled can increase salinity of wetland habitats, as well as encourage sedimentation in surface water bodies.

Construction Phase – Upland Construction

Both organic and non-organic waste will be generated on site during the construction phase of the Project. Accumulated waste on site has the potential to block surface water flows and contaminate nearby wetlands. Typical solid wastes generated on construction sites include plastics, wood & paper products, scrap metals, cement, nails, electrical wiring and rebar.

Liquid and hazardous wastes have the potential to contaminate nearby wetlands and coastal areas if not properly managed. Lead based products, paint, asbestos, chemical solvents, paint thinners, aerosol cans and human waste are typical waste products of construction sites. Accidental discharges may occur during the construction phase of the project, with point sources including construction vehicles, fuel containers, cement trucks, temporary sanitary collection systems and other chemicals stored onsite.

Operations Phase – Marina

Accidental discharges from vessels and land-based sources have the potential to impact local water quality in and around the Leeward Harbour marina. Spills marinas during operation include petroleum-based products used in boat maintenance and repair, damaged or leaking engines, wastewater spills, fuel spills at fuel pumps, and surface run off during heavy rain or flooding events.

Routine marina operations have the potential to negatively impact nearby water quality as typical activities such as boat washing and repair, fueling and boat traffic in and around the marina. Boat washing can introduce detergents into the marina basin and nearby marine areas. Detergents can be poisonous to marine organisms and can thin out mucus layers, weaken gill function in fish, and lower the surface tension of water, impacting metabolic rates in other marine organisms. Algal blooms can be created through the buildup of phosphates used in detergents. Scrubbing, scraping, sanding, painting and welding of boats may include the use, storage and production of a wide range of chemicals and other hazardous materials including antifouling paint, solvents, acids, degreasers, fuels and oils. Haul out areas have the potential to contaminate terrestrial wetlands and sub surface water quality in the immediate areas of the maintenance areas.

9.7.2 High Bank Bay and Conch Sound Point Geological Impacts

The excavation of the lagoon areas (~586,122.13 cy) has the potential to increase sedimentation in nearby coastal areas. During excavation of the lagoon, turbidity within the inland area will increase due to the mechanical removal of substrate. The spoils stockpiled from the lagoon excavation can introduce runoff into the nearby marine environment and should be properly stored away from coastal areas. The loose sandy sediment characteristic of those coastal areas risk erosion under the introduction of ocean forces within the inland area.

Construction activity along the primary dunes system of the property presents the risk of compromising the dunes, integrity and increasing the risk of coastal erosion of the dunes. The natural vegetation colonizing the dunes are most important in retaining its shape and structure, and if removed during construction activities, should be replaced with other native coastal species once construction activities are complete.

9.8 TERRESTRIAL IMPACT

The estimated final percent of land occupation for the Project is an estimated 18.13%. See Table below for Project density summary table. The complete Project Density calculations are included in Appendix K.

Table 9.2. Project Density summary.

DISTURBED AREA DURING CONSTRUCTION			
Conch Sound Point	133.57 AC		5,818,120 SF
High Bank Bay	325.81 AC		14,192,375 SF
Leeward Harbor	90.17 AC		3,927,960 SF
TOTAL DISTURBED AREA	**549.55 AC**		**23,938,455 SF**
DISTURBED AREAS REPLANTED			
Conch Sound Point	66.90 AC		2,914,060 SF
High Bank Bay	276.52 AC		12,045,045 SF
Leeward Harbor	32.11 AC		1,398,760 SF
TOTAL AREA REPLANTED	**375.52 AC**		**16,357,865 SF**
EST. PERCENTAGES			
Disturbed Area during Construction	56.02%	549.55 AC	
Final Constructed Area	18.13%	177.85 AC	
TOTAL DEVELOPMENT PERCENTAGE - COMMERCIAL & RESIDNETIAL			**18.13%**
RESIDENTIAL DENSITY			
The Setai Residence Club - Conch Sound Point			125.00 ea
The Setai Sporting Club - High Bank Bay			171.00 ea
The Setai Harbor Club - Leeward Harbor			106.00 ea
TOTAL			**402.00 ea**

9.8.1 Leeward Harbour Terrestrial Impact

Terrestrial habitats to be impacted by construction activities includes the permanently flooded wetland, semi-permanently flooded wetland, ephemeral shrubland, coastal coppice, rocky shore, sand dune and mangrove wetlands. The marine benthic habitats to be impacted included soft and hard bottom benthic habitats.

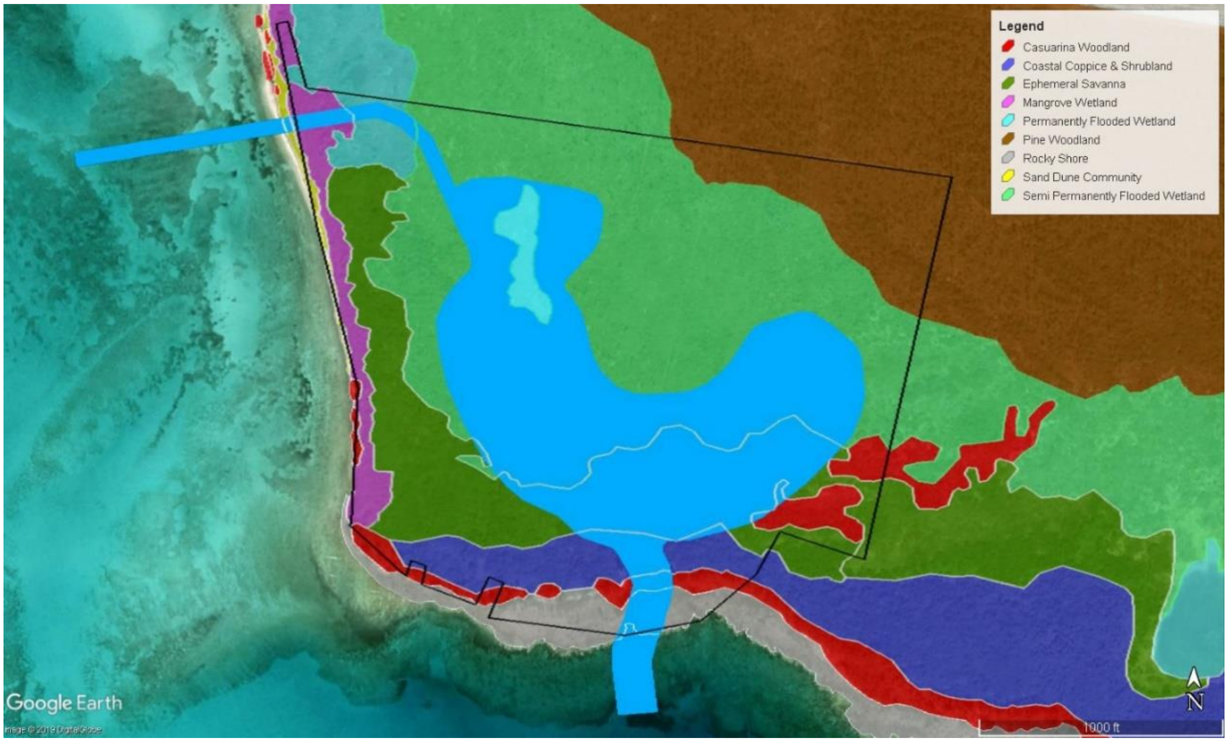

Figure 9.1. Leeward Harbour terrestrial habitat map with Kakona Project overlay.

Table 9.3. Terrestrial habitat loss estimates for Leeward Harbour

Terrestrial Habitat	Existing Onsite (acres)	Habitat area to be Impacted by Marina Creation (acres)	% removed	Area Remaining
Pine Woodland	7.18	0	0	7.18
Permanently Flooded Wetland	3.37	1.83	54	1.54
Semi-Permanently Flooded Wetland	54.4	22.48	41	31.92
Ephemeral Shrubland	22	8.36	38	13.64
Coastal Coppice	5.74	1	17	4.74
Mangrove	4.38	0.34	8	4.04
Rocky Shore	5	0.9	18	4.1
Sand Dune	1	0.04	4	0.96

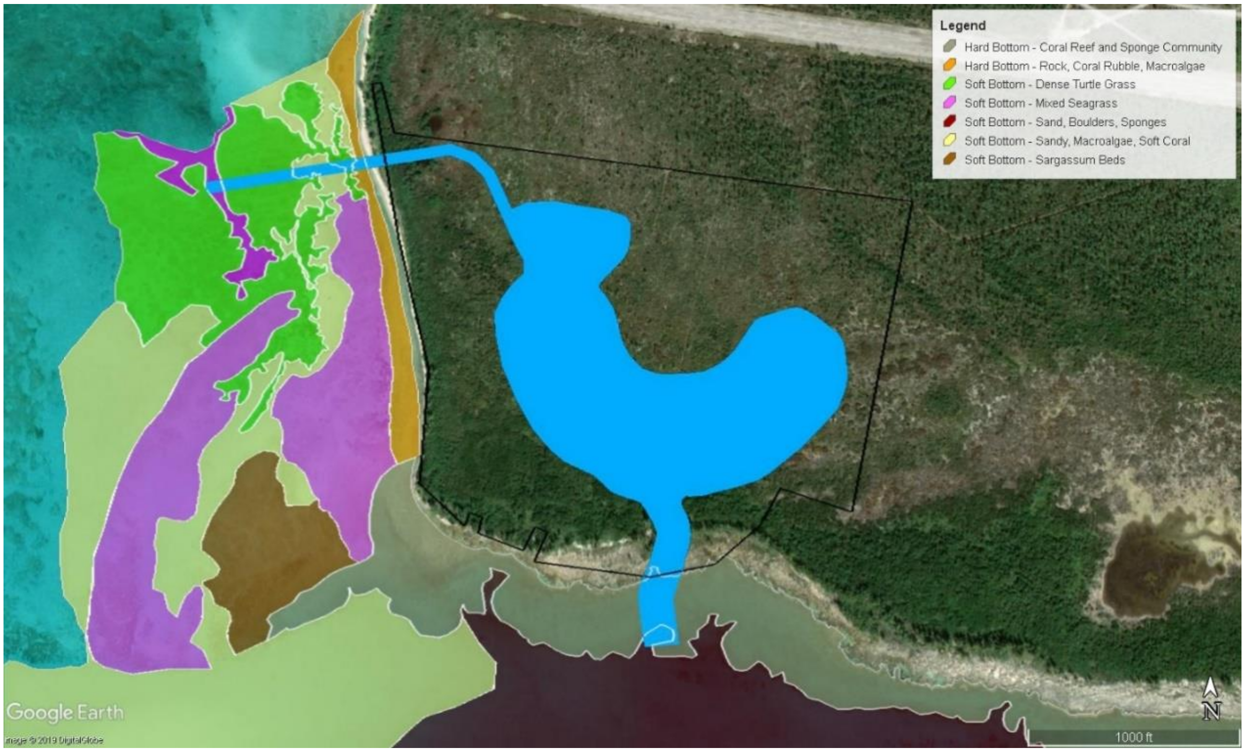

Figure 9.2. Leeward Harbour marine habitat map with Kakona Project overlay.

Table 9.4. Benthic habitat loss estimates for Leeward Harbour.

Benthic Habitat	Habitat Area to be Impacted by Entrance and Flushing Channels Creation (Acre)
Intertidal Zone	0.04
Hard Bottom - Reef and Sponge	0.96
Hard Bottom - Coral Rubble, Rock, Macroalgae	0.11
Soft Bottom - Dense Seagrass	0.61
Soft Bottom - Mixed Seagrass	0.12
Soft Bottom - Sandy	0.59

Table 9.5. Total land use estimates for Leeward Harbour before and after mitigation.

Leeward Harbour Total acreage	Area required for Marina Construction	Area required for Upland Development	Area remaining before Mitigation	Replanted Area	After Mitigation	% of total
103	35	53.51	14.49	49.49	63.98	62.12

The Developer does not intend to remove the pine woodland habitat during upland clearing activities associated with the Project. These areas present the risk of impacting nesting sites for the Abaco Parrot, and clearing of coppice vegetation will have impacts on local food sources for the Abaco Parrot and other resident and migratory birds for the duration of the construction period. Fragmentation of terrestrial habitats may also increase evapotranspiration during the construction period of the project. Reports of Abaco Parrot nesting sites suggest that they are located approximately 12 miles to the east (northeast and southeast) of the LH site . Although, evidence indicates Abaco Parrot nesting sites and flyways are located further east of the LH site, its existing habitat is conducive to the noted Abaco Parrot nesting sites and flyways near the ANP. Prior to land clearing activities, the land should be inspected for signs of the Abaco Parrot nests and nesting sites to avoid damage and interference of this species. A vegetative coppice/hardwood buffer should exist along the Project's boundary which acts as a contiguous hardwood corridor/habitat which provides foraging trees for parrots during the nonbreeding season[40].

Construction activities will temporarily impact terrestrial habitats during the duration of the construction period of the project. Although land is to be cleared, and vegetation removed, these areas will be revegetated using native flora suitable for the landscape. The landscaping design of the entire property has retained conservation corridors where continuous vegetated habitats are left in place to facilitate local flora and fauna utilizing these areas.

Impacts to the Abaco Parrot can potentially occur during construction and operations phases of the Project. Increased vehicular traffic, land clearing and road improvements activities within the LH property pose a risk to potential Abaco Parrots within the area. As the Abaco Parrots are ground nesters, destruction of nests and deaths are a serious consideration during land clearing activity. Conducting such activities outside of nesting season, combined with on-site nest surveys prior to clearing activities will reduce the likelihood of negative impacts to resident Abaco Parrot populations. However, most reports research on the Abaco Parrot indicate that its nesting and flyways are notably east of LH within the vast pine woodlands within the ANP and nearby area.

9.8.2 High Bank Bay and Conch Sound Point Terrestrial Impact

Terrestrial habitats to be impacted by construction activities includes the Pine Woodland, Interior broadleaf forests, coastal coppice, coastal shrublands, sandy dunes and

[40] *Stahla, C. (2007). Effects of Abaco national park rd. 49 & 50 clearing on the Abaco Parrot.*

mangrove wetlands. The marine benthic habitats to be impacted included hard bottom benthic habitats.

The introduction of roadways throughout the property can lead to edge effects in interior broadleaf forest vegetation, leading to possible introductions of invasive species and impacting microclimates in the forest understory and within karst features on the property. Fragmentation of terrestrial habitats may also increase evapotranspiration during the construction period of the project. Construction activities will temporarily impact terrestrial habitats during the duration of the construction period of the Project. Although land is to be cleared, and vegetation removed, these areas will be revegetated using native flora suitable for the landscape. The landscaping design of the entire property has retained conservation corridors where continuous vegetated habitats are left in place to facilitate local flora and fauna utilizing these areas.

Land clearing in the Pine woodland areas present the risk of impacting nesting sites for the Abaco Parrot, and clearing of coppice vegetation will have impacts on local food sources for the Abaco Parrot and other resident and migratory birds for the duration of the construction period.

The Project lies just outside the boundaries of the Abaco Parrot nesting territories (see Figures below) as it abuts the ANP boundaries. Therefore, avoiding major Abaco Parrot flyways and nesting locations. However, it is possible that the Project's site may contain food sources for this species. Studies show that the Abaco Parrots roost at night and along the inner edge of the coppice bordering on pine forests and in inland "coppice islands," which occur in pine yards where coppice vegetation replaces pine as a result of succession (Gnam et al., 1991)[41].

The Developer is committed to encouraging the continued development of the Abaco Parrot. Possible mitigation strategies suggest that pine trees should not be cleared at least 150 ft. from a parrot net. Also, a vegetative coppice or hardwood buffer should exist along the site boundary which should include any hardwood tree over 4 cm. in diameter (Stahla, 2007)[42].

[41] Gnam, R. and Burchsted, A. (1991). Population estimates for the Bahama parrot on Abaco island, Bahamas.Journalof Field Ornithology. 62 (1),139-146.
[42] *Stahla, C. (2007). Effects of Abaco national park rd. 49 & 50 clearing on the Abaco Parrot.*

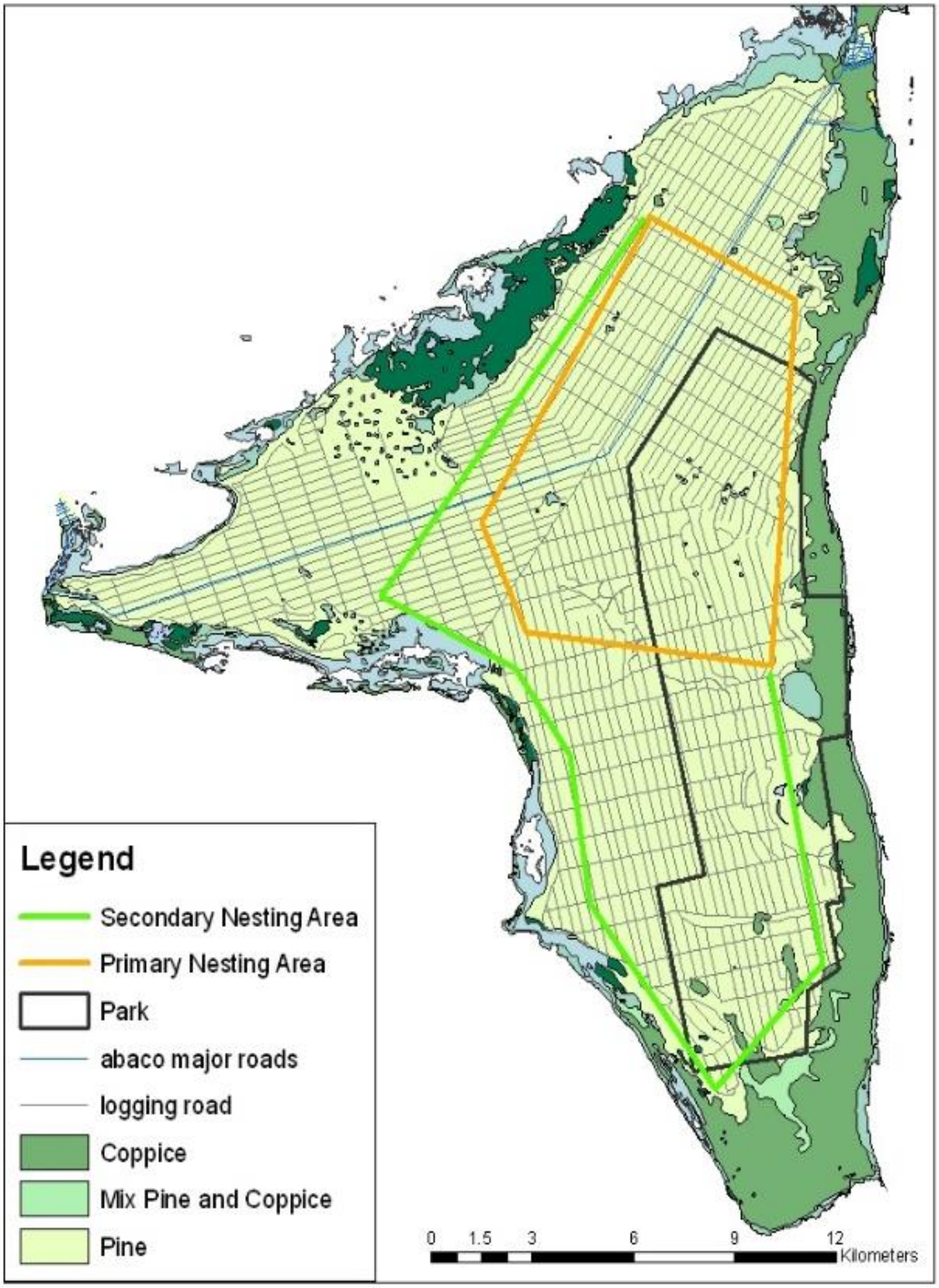

Figure 9.3. Active nesting territories.

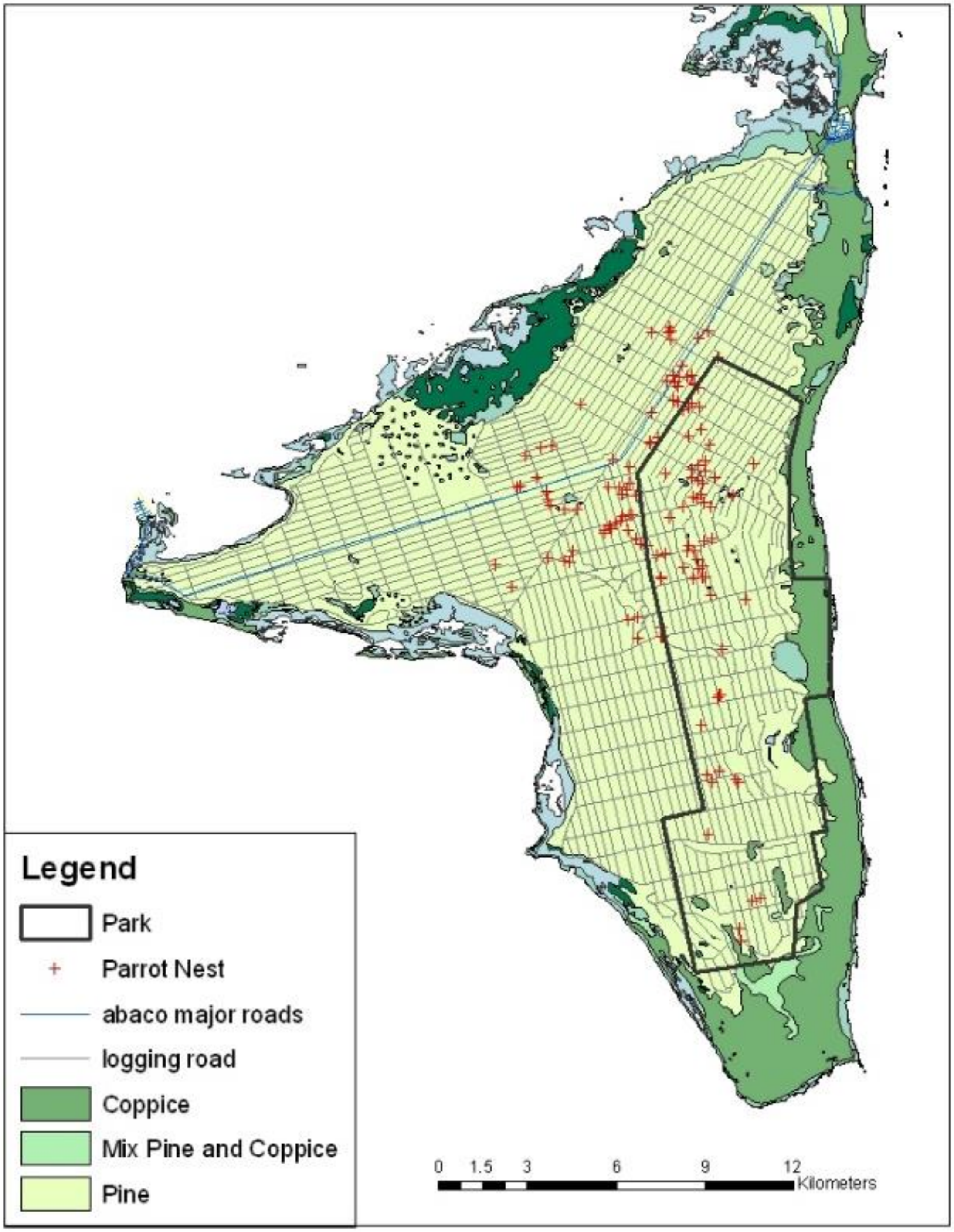

Figure 9.4. GPS Abaco Parrot nest points.

The HBB and CSP properties abut the Abaco National Park to the west and north, a 20,000 protected area featuring extensive stands of pine forests, broadleaf coppice, coastal areas and wetlands. The ANP also protects the feeding and breeding ground for the endemic Abaco parrot, which utilized the Pine Forests for ground nesting and the broadleaf coppice forests for foraging and feeding.

Impacts to the ANP can potentially occur during construction and operations phases of the proposed project. Increased vehicular traffic, land clearing and road improvements activities outside of the boundaries to the HBB and CSP properties poses a risk to resident flora and fauna in the ANP. As the Abaco Parrots are ground nesters, destruction of nests and deaths are a serious consideration during land clearing activity. Conducting such activities outside of nesting season, combined with onsite nesting surveys prior to clearing activities will reduce the likelihood of negative impacts to resident Abaco Parrot populations.

Abaco parrot populations in the ANP are at risk of predation by introduced predators to the area, namely feral cats and racoons. Waste management during construction and operations phases will be critical to manage pests on the HBB and CSP properties, which can potentially spread to the ANP. Considerations may also be given for restriction on outdoor cats on the HHB and CSP properties to prevent feral introductions to the ANP.

9.9 MARINE IMPACT

9.9.1 Leeward Harbour Marine Impact

Dredging Impacts and Mitigation

Dredging could impact marine resources due to habitat loss and increased sound frequency. Habitat loss is a direct impact due to dredging activity; which is the removal of the seabed and sediment. Habitat loss due to the proposed development could include the possible removal of coral reefs, mangroves and seagrass beds. Furthermore, this form of construction deters marine activity, as species avoid areas of disruption, which would then negatively impact biodiversity within this area. Some marine species could be affected due to the noise pollution created by dredging activities. Increased sound can influence marine species such as fish, octopus, squid, crabs and turtles, as these species detect low frequency sounds (National Research Council, 2003)[43].

Although, no marine mammals were observed during baseline studies, dredging activity has the potential to cause direct and indirect impacts on marine mammals that transverse off the coast of South Abaco. These impacts may result in increased noise production, physical injury, changes to the physical environment and food availability. Noise pollution due to dredging activity can affect marine mammals as the noise frequencies can possibly range from 20 Hz to 500 Hz. General marine mammal hearing ranges are interpreted as low, mid and high frequency, ranging from 7 Hz to 160 kHz (see Table below). This noise

[43] *National Research Council. 2003. Ocean Noise and Marine Mammals. Washington, DC: The National Academies Press. https://doi.org/10.17226/10564.*

disturbance due to dredging can induce stress by causing temporary or permanent auditory injury, interfere with foraging activity, communication, reduce reproductive behavior and increase their susceptibility to diseases. Also, the effects of dredging can affect their physical environment. Increased turbidity due to dredging activity may cause habitat degradation due to sediment coverage and direct habitat loss. For instance, seagrass bed removal effects the feeding habits of herbivorous sirenians, which affect their survival and distribution (Todd et al., 2015)[44]. Furthermore, seagrass beds are vital to the food web as it is a primary producer and the removal of this habitat can negatively affect trophic levels. Marine mammal death related to vessel collision is possible due to increased speeds of 10-14 kn. (Todd et al., 2015). In some cases, this can be related to noise pollution as it interferes with communication between mother and calf resulting in calf related injuries and death.

Mitigation measures to alleviate the effects of dredging on marine mammals would include the selection of dredging type. Based on geotechnical studies, the developer will select which dredging type would be used for the marina development which performs efficiently and with less noise impact. The dredging duration also plays an important role in mitigation, as it can limit the sound frequencies by reducing the noise exposure. Although, high turbidity can smother benthic organisms, this process can be short lived and contained by employing the use of turbidity silt curtains.

In terms of direct effects, collisions are possible, but unlikely, given the slow speed of dredgers. Though marine mammal collision is possible, active dredgers are stationary or move at slow speeds of 1–3 kn. Risk of collision between marine mammals and active dredgers is minimal. Collision risk is perhaps greater when dredgers are in transit, as speeds can reach 12–16 kn. , but in areas already characterized by heavy shipping traffic. The addition of dredging vessels is unlikely to increase the collision risk substantially. If dredging is well managed this activity can avoid critical habitats, times when animals may be distracted, or areas where calves are abundant (Todd et al., 2015).

[44] Todd, V. L. G., Todd, I. B., Gardiner, J. C., Morrin, E. C. N., MacPherson, N. A., DiMarzio, N. A. and Thomsen, F. (2015). A review of impacts of marine dredging activities on marine mammals. *Journal of Marine Science, 72*: 328-340.

Table 9.6. Marine mammal hearing groups, auditory weighting and exposure function parameters[45]

Hearing Group	Generalized Hearing Range*
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz

* Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007) and PW pinniped (approximation).

Hearing Group	*a*	*b*	*f₁* (kHz)	*f₂* (kHz)	*C* (dB)	*K* (dB)
Low-frequency (LF) cetaceans	1.0	2	0.2	19	0.13	179
Mid-frequency (MF) cetaceans	1.6	2	8.8	110	1.20	177
High-frequency (HF) cetaceans	1.8	2	12	140	1.36	152
Phocid pinnipeds (PW) (underwater)	1.0	2	1.9	30	0.75	180
Otariid pinnipeds (OW) (underwater)	2.0	2	0.94	25	0.64	198

Staghorn and Elkhorn corals may be negatively impacted due to the dredging activities for the two marina channels. These coral species support coral reef development, which then influences marine biodiversity. Unfortunately, there is a possibility that the presence of SCTLD may be presently impacting these and other coral species which affects the migration option of coral relocation. Relocating these corals is not recommended if confirmed, as this disease can spread and affect other healthy coral reef systems.

Pollution Impacts and Mitigation

The construction and operation phases of the Kakona Harbor could impact the water quality of the surrounding marine environment. Large amounts of pollutants such as surface run off, oil spill, solid waste, sewage discharge and cleaning chemicals could

[45] Pritzker, P. S., Sullivan, K. D., and Sobeck, E. (2018). 2018 Revision to: Technical Guidance for Assessing the effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0); Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts.

potentially leave a lasting effect on the marine resources and ecosystem within this area. These types of pollutants negatively affect the marine sediment, flora and fauna. Most importantly, once the marine habitats are affected by pollutants, this could impact the entire ecosystem by promoting habitat degradation, bioaccumulation and biomagnification within the tissues of organisms. Solid waste deposit during marina and upland operations could cause habitat degradation due to the prohibition of a light source which restricts algae and coral growth. This type of pollution also poses a threat to fauna as they may ingest the solid waste matter or become entangled within these objects, causing suffocation. Furthermore, if solid waste debris is left discarded within the marine environment, eventually its dissolved particles would become easily available for ingestion and absorption by marine flora and fauna through a process of bioavailability. “The two basic routes of exposure for organisms are transport of dissolved contaminants in pore water across biological membranes, and ingestion of contaminated food or sediment particles with subsequent transport across the gut” (United States Environmental Protection Agency, 2000)[46]. Therefore, contributing to bioaccumulation and biomagnification throughout the marine ecosystem’s vital food webs which also include some avian species; thus, impacting stakeholders within the South Abaco communities. The impacts of hazardous liquid and sewage waste also contribute to this process of bioaccumulation due to the availability of increased nutrients and hazardous chemicals, which affect water quality. Introduced nutrients have the potential to encourage rapid algae growth which in turn could result in extensive amounts of algae known as algae bloom. This process includes a list of contributing chemical and physical factors such as; high turbidity rate, low dissolved oxygen, and high rates of nitrates (nitrogen and ammonia).

Mitigation of the effects of the negative impacts due to the changes in water quality involves the design and operational practices of the marina. The land development surrounding the marina would follow coastal setback guidelines to prevent potential run off pollution into the immediate marine environment. During construction and operation of the Leeward Harbour marina, Blue Flag marina criteria should be followed to ensure best environmental practices.

9.9.2 High Bank Bay and Conch Sound Point Marine Impact

Excavation associated with the construction of the High Bank Bay lagoon will directly impact the immediate marine environment due to the removal of some hard-bottom substrate. However, this impact to marine resources is minor due to the small percentage of hard bottom habitat proposed to be removed. Furthermore, dredging activity is unlikely to affect marine mammals within the

[46] United States Environmental Protection Agency. (2000). Bioaccumulation testing and interrelation for the purpose of sediment quality assessment: Status and needs. *EPA Report,* EPA-823-R-00-001. Retrieved from: <https://clu-in.org/download/contaminantfocus/sediments/bioaccum-status-and-needs.pdf>

offshore marine environment due to the limited duration of dredging and the selection of noninvasive dredging type.

During operation, no motorized watercrafts are allowed within the HBB lagoon. This reduces the risk of direct marine impacts from vessels such as fuel spills and sewage discharge. The proposed development of a full sized 18-hole golf course, Hotel, lagoon and residential area may possibly generate minor environmental impacts to the marine resources in this area. The golf course covers an estimated 104 acres of the total development at High Bank Bay. Almost half of the development of the golf course is designed near the coastal zone of High Bank Bay (Holes 1, 2, 3, 15, 16, 17 & 18). Due to the position of the golf course, special consideration should be given to the water demand (~144,000 gpd) regarding the effects of irrigation on the immediate marine environment. Therefore, potentially affecting the water quality. Untreated grey water irrigation may affect the water quality of the immediate marine environment by introducing nutrients and influencing dissolved oxygen. These effects include overstimulated growth of certain species of algae. As a result, the inorganic material from dead algae influence the availability of dissolved oxygen within the marine environment. Thus, affecting the development of marine organisms and biodiversity.

These impacts are unlikely to occur within the immediate marine area at HBB. The developer intends to use treated grey water irrigation for golf course maintenance and developing a flushing channel within the lagoon area. The use of treated gray water reduces the risk that influence changes in water quality. Therefore, avoiding the formation of a toxic marine environment. Furthermore, the flushing channel should eliminate stagnant water within the lagoon. Stagnant water may contribute to poor water quality from indirect non-point source pollution due to the position of the golf course and residential lots near the coast. The constant movement of water and wave activity should aid in the movement of water and disburse nutrients within the coastal area. Also, the presence of the shipwreck offsets the hard-bottom habitat loss as this encourages algae and coral growth within the immediate beach foreshore of HBB.

9.9.3 Conch Sound Point Marine Impact

Excavation associated with the construction of the two flushing channels at the CSP saltwater lagoon will directly impact the immediate marine environment due to the removal of some soft and hard bottom substrate. However, this impact to marine resources are minor due to the small percentage of hard bottom habitat proposed to be removed. Furthermore, dredging activity is unlikely to affect marine mammals within the offshore marine environment due to the limited duration and extent of dredging.

During operation, no motorized watercrafts are allowed within the CSP saltwater lagoon. This reduces the risk of direct marine impacts from vessels such as fuel spills and sewage discharge.

The proposed development of the ocean front estates, beach club and grill and cottages can potentially cause minor environmental impacts to the marine resources in this area. Untreated grey water irrigation may affect the water quality of the immediate marine environment by introducing nutrients and influencing dissolved oxygen. These effects include overstimulated growth of certain species of algae. As a result, the inorganic material from dead algae influence the availability of dissolved oxygen within the marine environment. Thus, affecting the development of marine organisms and biodiversity.

These impacts are unlikely to occur within the immediate marine area at CSP. The Developer intends to use treated grey water to irrigate the Grand Lawn and developing a flushing channel within the lagoon area. The use of treated gray water reduces the risk that influence changes in water quality. Therefore, avoiding the formation of a toxic marine environment. Furthermore, the flushing channel should eliminate stagnant water within the lagoon. Stagnant water may contribute to poor water quality from indirect non-point source pollution due to the position of the coastal infrastructure and residential lots near the coast. The constant movement of water and wave activity will aid in the movement of water and disburse nutrients within the coastal area.

9.10 Socio-Economic Impact

9.10.1 Social

No relocation impacts are anticipated from the proposed project.

The Project will bring significant economic benefits to the South Abaco community and residents. Aside from direct economic benefits for persons employed at the development, or owning a commercial venture related engaged with the development, the Project developer proposes to implement a series of improvements external to the project, including repairs to the old ferry dock, upgrades and renovations to the Sandy Point Airstrip, improvements to the Sandy Point Landfill, road improvements to Lighthouse road and road 50, and provision of staff housing during construction and operations.

The developer has committed to a long-term partnership with the South Abaco community and its stakeholders to provide maximum benefits form the project while preserving the pristine South Abaco environment and its ecological services.

9.10.2 Economics

The three properties associated with the Kakona development (High Bank Bay, Conch Sound Point and Leeward Harbour) are expected to provide great economic impact for communities in South Abaco, as well as the wider Bahamas. This is due to direct, indirect and induced avenues of generated revenue. Direct economic impact represents the immediate benefits to individuals and companies directly providing goods and services to visitors. Indirect economic impact refers to the secondary benefits to suppliers of goods and services to the directly-involved companies. Induced economic impact represents employee wages from direct and indirect impact spent on local retail goods generating additional economic output.

Construction Expenditures

Over a ten-year period, total construction expenditures of $985 million will generate an estimated $366 million in Gross Domestic Product (GDP) for The Bahamas; of which an estimated $264 million will generate directly from the construction sector. Direct construction employment averages over 736 persons, peaking at 1,000 jobs for Bahamians (Sacks et al., 2007)[47].

Development	Total (Cumulative)
Total Construction Expenditures	**984,587,069**
Gross Domestic Product	
Direct	**263,728,112**
Indirect	**41,781,689**
Induced	**61,101,960**
TOTAL	**366,611,761**
Wages	
Direct	**148,513,137**
Indirect	**12,093,448**
Induced	**32,121,317**
TOTAL	**192,727,902**
Employment	
Direct	**736**
Indirect	**73**
Induced	**195**
TOTAL	**1,004**

Figure 9.5. Kakona Total Construction Expenditures

[47] Sacks, A., Goodger, D. and Edmonds, K. (2007). The economic impact of the development of south Abaco: A cost benefit analysis. *Tourism Economics.*

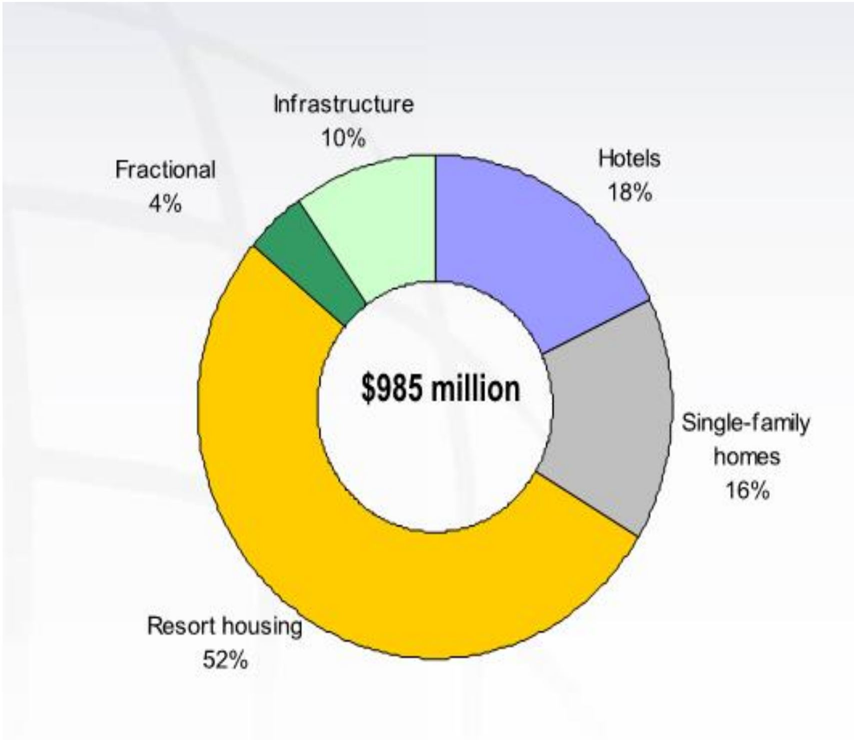

Figure 9.6. Kakona percentage of construction expenditures

Visitor Spending

Projected visitation is estimated at nearly 170,000 within the first year of development. The development of Kakona in South Abaco will generate an estimated $262 million in revenue due to visitor spending. In addition, direct taxes (inclusive of stamp duty, departure tax, property tax and occupancy tax) exceeding $17 million per year will be paid via visitor spending (Sacks et al., 2007). A large portion of the revenue generated from visitor spending is a result of food and beverage sales followed by hotel room revenue.

Expenditures, $ million				
	20-Year Sum		(Full Build)	
Hotel room revenue	$	948	$	47
Food and beverage	$	1,860	$	96
Home services	$	707	$	32
Transportation	$	388	$	20
Recreation	$	496	$	26
Other	$	465	$	24
Sub-total	$	4,863	$	244
+ direct taxes	$	1,186	$	17
TOTAL	$	6,049	$	262

Figure 9.7. Visitor Spending Generated Revenue

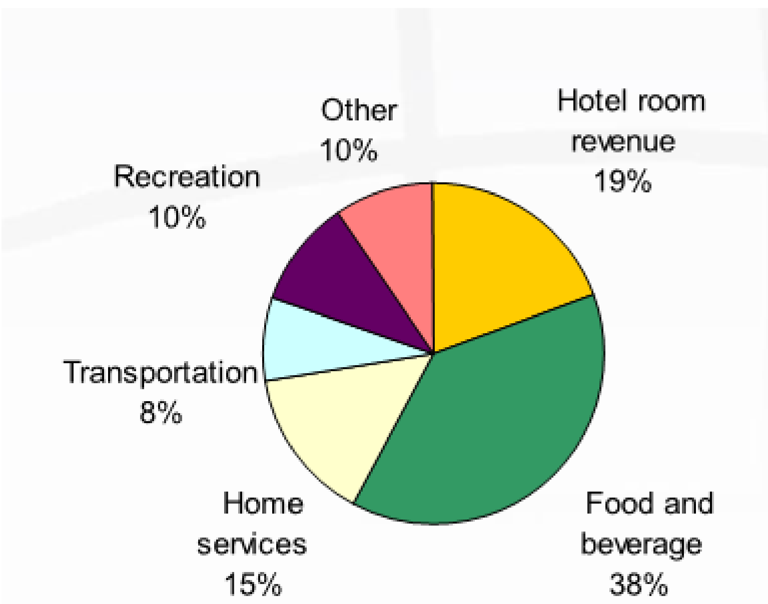

Figure 9.8. Percentage of income generated from visitor spending

Resort Operations

Over a 20-year period, resort operations estimate to generate $2.35 billion in GDP for The Bahamas, supplying an estimated $1.6 billion in local wages and salaries. At full operation, the new facilities will directly sustain 1,727 direct jobs and a total of 2,318 jobs (Sacks et al., 2007).

Operations	20-Year Cumulative
GDP Summary	
Direct	**1,584,000,506**
Indirect	**251,856,080**
Induced	**515,875,701**
TOTAL	**2,351,732,287**
Wages Summary	
Direct	**1,247,124,946**
Indirect	**119,994,591**
Induced	**246,862,580**
TOTAL	**1,613,982,117**
Employment Summary	**Full Build**
Direct	**1,727**
Indirect	**194**
Induced	**397**
TOTAL	**2,318**

Figure 9.9. Resort Operations GDP, Wages and employment Summary

Government Revenue

Over a 23-year period, this new project will generate an estimated $1.9 billion in government revenues, the majority of which will come from import duties. It is assumed that 3% of the residential and fractional units will turn over per year, generating ongoing stamp tax (Sacks et al., 2007). The Economic Impact of the Development of South Abaco: A Cost Benefit Analysis is included in Appendix L.

Government Revenue*	23-Year Cumulative	
Stamp conveyance on property purchase	$	6,100,000
Stamp Conveyance, first sales (10%)	$	62,763,227
Stamp Conveyance on Resales (3% of stock/yr)	$	53,699,439
Property Tax on lots/homes	$	97,520,175
Business License Fee	$	12,271,958
National Insurance	$	109,746,995
Construction Import Duties	$	24,388,866
Operations Import Duties	$	666,249,698
Departure Tax	$	44,146,677
Occupancy Tax	$	113,750,751
TOTAL REVENUE	$	1,185,837,786

*Net of concessions. Includes 3 construction years and 20 years of operations.

Figure 9.10. Bahamian government revenue generated over a 23-year period

Concessions	23-Year Cumulative	
HEA Construction Import Duties (all development)	$	130,417,901
HEA Real Property Tax (rental units)	$	290,752,297
Land Concession		
TOTAL	$	421,170,198

ROI Metrics	23-Year Cumulative	
Total GDP Impact	$	2,718,344,048
Total Tax Impact	$	1,185,837,786
NPV (5%)	$	609,880,724
Total Concession	$	421,170,198
NPV (5%)	$	247,818,688

Benefit to Cost	23-Year Cumulative
CAPEX / Concession (NPV)	3.0
Tax Revenue / Concession (NPV)	2.5
GDP Impact / Concession (NPV)	6.0

Figure 9.11. Tax revenue generated of a 23-year period

9.11 Archeological and Cultural Impact

Historical resources and culturally significant recreational activities may be temporarily impacted due to the construction of the Project. However, the Developer intends to provide beach access south of the Project boundary.

9.12 Traffic and Transportation Impact

The road improvements planned for the Lighthouse Road, Road 50 and the proposed creation of a new coastal road will all increase vehicular access to the Kakona properties, and by extension the ANP. As the lighthouse traverses through the ANP, increases in traffic through the Park can positively impact Park visitation and visibility by guests and residents to the HBB and CSP developments. Increased traffic may also negatively impact local air quality and noise levels through the ANP, as well as increase incidents of collisions of vehicle with resident and migratory birds in the ANP. Educational signage and posted speed limits within the ANP can reduce incidents of vehicular collision with local fauna. Also, boat traffic in shallow areas around the LH marina may increase turbidity from engine kick up of bottom sediments.

Upgrades to the Sandy Point airstrip will increase air traffic for small private and commercial aircraft. As the airstrip is currently unregulated, construction of an FBO for Air Traffic Control, Customs and Emergency Services will help to manage and regulate air traffic in the South Abaco area. The proposed upgrades to the Sandy Point airstrip and Ferry Dock will improve accessibility of travelers and goods to and from South Abaco, with the potential to stimulate the local economy.

Moreover, the Project may impact major Queen Conch harvesting grounds at Moore’s Island, as it encourages marine traffic within the area. As this area is known to support the South Abaco communities, as well as other northern Bahama Islands. Concern for increased traffic may affect local fishermen. Furthermore, in 2011 Disney’s Castaway Cay has established the first coral nursery in The Bahamas to offset degrading coral species near Castaway Cay and Sandy Point. Increased mariner traffic may impact snorkelers viewing the coral nursey or impact the nursey in its entirety.

10 Summary Table of Potential Environmental Impacts

Table 10.1. Summary impact table significance rating key.

Impact Significance Key	Negligible/None	Minor	Moderate	Severe	Beneficial

Negligible/No Impact (White) ☐ – negligible impact is one which has no detectable change on the host environment. Medium intensity impacts alter the natural flows and process of the host environment while allowing the flows and process to retain their natural functions.

Minor Impact (Yellow) – minor/low intensity impact does not affect the host environment in such a manner to alter natural flows and processes.

Moderate Impact (Orange) – moderate/high intensity impacts alter natural flows and processes to the extent where natural functions are totally inhibited for a temporary or permanent period of time.

Severe Impact (Red) – adverse/negative impacts to the immediate/extended environment and stakeholders.

Beneficial Impact (Green) – positive impacts on the surrounding environment and/or stakeholders.

Table 10.2. Significance key.

Magnitude			
Extent	**Duration**	**Intensity**	**Likelihood**
On Site (O)	Temporary (T)	Negligible (N)	Unlikely (U)
Local (L)	Short-Term (ST)	Low (LW)	Likely (LK)
Regional (R)	Long-Term (LT)	Medium (M)	Definite (D)
National (N)	Permanent (P)	High (H)	

Extent - the function of the impact's extent, whether restricted on site to the immediate project area, locally within a 10-mile radius, regionally to include the island of Abaco and the Northern Bahamas and Nationally to include the extent of The Bahama Archipelago.

Duration - impact relates to the temporal scale which is required for changes in the host environment to return to baseline conditions or undetectable levels. Temporary impacts persist for a short duration and occur occasionally and/or intermittently. Short Term Impacts are expected to persist for the duration of the project activities related to the construction phase of the Project. Long Term impacts extend beyond the duration of the construction period and exist throughout the life of the project. Permanent impacts persist far beyond the life of the project and are irreversible changes to the host environment due to project related activities.

Intensity - can be considered as Negligible, Low, Medium or High. A Negligible impact is one which has no detectable change on the host environment. A low intensity impact does not affect the host environment in such a manner to alter natural flows and processes. Medium intensity impacts alter the natural flows and process of the host environment while allowing the flows and process to retain their natural functions. High intensity impacts alter natural flows and processes to the extent where natural functions are totally inhibited for a temporary or permanent period of time.

Likelihood - a rating which evaluates the likely potential for an impact to occur, with typical rating categories being unlikely to occur, Likely to occur under most conditions, and definitely will occur.

10.1 Leeward Harbour Summary Tables of Potential Environmental Impacts

Table 10.3. Leeward Harbour Impact Potential Matrix.

Leeward Harbour - Impact Potential Matrix

		Aspect																	
Project Component	**Impacting Factor**	**Physical**			**Coastal Processes**		**Biological**						**So-Econ**				**Cultural**		
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing
										Construction									
Marina Creation	Land Clearing		*	*	*		*		*	*							*	*	
	Excavation	*	*	*	*		*		*	*							*	*	
	Entrance Channel Dredging			*	*	*		*			*	*			*				*
	Flushing Channel Dredging			*	*	*		*			*	*			*				*
	Marina Opening	*		*	*	*		*			*	*			*				*
	Spoil Stockpiling	*			*		*			*									
Upland Construction	Land Clearing		*	*	*		*		*	*							*	*	
	Solid Waste		*				*	*	*	*	*	*						*	
	Liquid & Hazardous Waste	*	*					*		*	*	*						*	
	Discharges	*	*				*	*		*	*	*						*	
	Noise		*	*					*									*	
	Emissions		*						*									*	
	Infrastructure Installation															*			
										Operations									
Marina	**Accidental**																		
	Oil Spills	*	*					*			*	*	*						*
	Sewage Discharge	*	*					*			*	*	*						*
	Fuel Spill	*	*					*			*	*	*						*
	Surface Runoff	*			*			*			*	*	*						*
	Routine																		
	Boat Wash & Repair	*	*	*				*			*	*	*						*
	Fuel Dock	*	*					*			*	*	*						*
	Boat Traffic	*	*	*	*			*			*	*	*		*	*			*
Resort & Marina Village	**Routine**																		
	Solid Waste																		
	Discharges																		
	Noise																		
	Emissions																		
	Retail, Resort, Restaurants												*			*			

Table 10.4. Leeward Harbour external project improvements potential impact matrix

External Project Improvements																					
Project Component	**Impacting Factor**	**Physical**			**Coastal Processes**		**Biological**						**So-Econ**				**Cultural**				
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing		
Road Improvements & Construction	Queen's Highway to Road 50 (9 miles)			*			*		*	*			*		*	*					
	Roundabout at Intersection Lighthouse Road and Road 50			*			*		*	*			*		*	*					
	Road 50 (3.5 miles)			*			*		*	*			*		*	*					
	Roundabout at intersection of Road 50 and property access roads			*			*		*	*			*		*	*					
	New Coastal Road from Sandy Point Airport to Eagle Bay to Road 50 (10 miles)			*			*						*		*	*					
	South Abaco Ferry Dock Repair			*			*				*	*	*		*	*					
	Maintenance and upkeep	*	*	*									*		*	*					
	Utility area near existing landfill			*									*			*					
	Improvements to existing landfill	*	*	*			*		*	*			*			*					
	Man Camp			*									*	*		*					
	Staff Housing			*									*	*		*					
	Container Receiving and Storage			*									*		*	*					

Table 10.5. Impact significance matrix for physical impacts at Leeward Harbour.

Leeward Harbor - Impact Significance Matrix - Extent (E), Duration (D), Intensity (I), Likelihood (L)													
		Aspect											
Project Component	Impacting Factor	Physical											
		Hydrology & Hydrogeology				Air Quality				Noise			
Construction													
		E	D	I	L	E	D	I	L	E	D	I	L
Marina Creation	Land Clearing	O	P	H	D	O	T	LW	D	O	T	LW	D
	Excavation	O	P	H	D	O	T	LW	D	O	T	M	D
	Entrance Channel Dredging	O	P	H	D	O	T	LW	D	L	T	M	D
	Flushing Channel Dredging	O	P	H	D	O	T	LW	D	L	T	M	D
	Marina Opening	O	P	H	D	O	T	LW	LK	O	T	M	LK
	Spoil Stockpiling	O	T	M	LK	O	T	LW	LK	O	T	N	U
Upland Construction	Land Clearing	O	ST	M	LK	O	T	LW	D	O	T	LW	D
	Solid Waste	L	ST	M	LK	O	ST	LW	LK	O	T	N	U
	Liquid & Hazardous Waste	L	ST	M	LK	O	ST	M	LK	O	T	N	U
	Discharges	L	ST	M	LK	O	ST	M	LK	O	T	N	U
	Noise	O	ST	LW	LK	O	ST	LW	D	O	T	N	LK
	Emissions	O	T	LW	LK	O	ST	M	D	O	T	LW	LK
	Infrastructure Installation	L	ST	M	LK	O	ST	H	D	O	T	LW	LK
Operations													
Marina	Accidental	E	D	I	L	E	D	I	L	E	D	I	L
	Oil Spills	L	T	M	LK	L	LT	H	LK	L	LT	M	LK
	Sewage Discharge	L	T	M	LK	L	ST	H	LK	O	ST	LW	U
	Fuel Spill	L	T	M	LK	L	ST	H	LK	L	ST	M	LK
	Surface Runoff	L	T	M	LK	O	ST	LW	LK	O	ST	LW	LK
	Boat Wash & Repair	L	T	H	LK	O	LT	M	D	O	LT	LW	LK
	Fuel Dock	L	T	H	LK	O	LT	LW	D	L	LT	LW	LK
	Boat Traffic	L	T	M	LK	L	LT	LW	D	L	LT	LW	LK
Resort & Marina Village	Routine												
	Solid Waste	L	ST	M	LK	O	T	LW	U	O	T	LW	U

	Liquid & Hazardous Waste	L	LT	H	LK	O	ST	M	LK	O	ST	M	LK
	Noise	O	T	M	LK	O	LT	LW	D	O	LT	LW	D
	Emissions	L	ST	M	LK	L	LT	LW	D	L	LT	LW	D
	Retail, Resort, Restaurants	O	T	LW	LK	O	T	LW	U	O	T	LW	U
External Project Improvements													
		E	**D**	**I**	**L**	**E**	**D**	**I**	**L**	**E**	**D**	**I**	**L**
Road Improvements & Construction	Great Abaco Highway to Road 50 (9 miles)	O	ST	H	LK	O	T	M	LK	O	T	LW	LK
	Roundabout at Intersection Lighthouse Road and Road 50	O	ST	H	LK	O	T	M	LK	O	T	LW	LK
	Road 50 (3.5 miles)	O	ST	H	LK	O	T	M	LK	O	T	LW	LK
	Roundabout at intersection of Road 50 and property access roads	O	ST	H	LK	O	T	M	LK	O	T	LW	LK
	New Coastal Road from Sandy Point Airport to Eagle Bay to Road 50 (10 miles)	O	ST	H	D	O	T	M	LK	O	T	LW	LK
	South Abaco Ferry Dock Repair	O	ST	M	LK	O	T	M	LK	O	T	LW	LK
	Maintenance and upkeep	O	LT	H	D	O	T	M	LK	O	T	LW	LK
	Utility area near existing landfill	O	ST	M	LK	O	T	M	LK	O	T	LW	LK
	Improvements to existing landfill	O	LT	H	D	O	T	M	LK	O	T	LW	LK
	Man Camp	O	ST	M	LK	O	T	M	LK	O	T	LW	LK
	Staff Housing	O	ST	M	LK	O	T	M	LK	O	T	LW	LK
	Container Receiving and Storage	O	ST	LW	LK	O	T	M	LK	O	T	LW	LK

Table 10.6. Impact significance matrix for coastal processes at Leeward Harbour.

Leeward Harbour - Impact Significance Matrix - Extent (E), Duration (D), Intensity (I), Likelihood (L)									
		Aspect							
Project Component	Impacting Factor	Coastal							
		Erosion and Sedimentation				Beach			
Construction									
		E	D	I	L	E	D	I	L
Marina Creation	Land Clearing	O	ST	M	D	O	T	M	D
	Excavation	O	ST	LW	D	O	ST	H	D
	Entrance Channel Dredging	O	ST	M	D	O	ST	M	LK
	Flushing Channel Dredging	O	ST	M	D	O	ST	M	LK
	Marina Opening	O	T	M	D	O	ST	M	LK
	Spoil Stockpiling	O	ST	M	D	O	ST	M	D
Upland Construction	Land Clearing	O	ST	M	D	O	T	M	LK
	Solid Waste	O	ST	M	LK	O	ST	M	LK
	Liquid & Hazardous Waste	O	ST	M	LK	O	ST	M	LK
	Discharges	O	ST	M	LK	O	ST	M	LK
	Noise	O	ST	M	LK	O	ST	M	LK
	Emissions	O	ST	M	LK	O	ST	M	LK
	Infrastructure Installation	O	T	H	LK	O	ST	M	D
Operations									
Marina	Accidental	E	D	I	L	E	D	I	L
	Oil Spills					L	ST	H	LK
	Sewage Discharge					O	ST	M	LK
	Fuel Spill					L	ST	M	LK
	Surface Runoff	L	T	M	LK	O	ST	M	LK
	Routine								
	Boat Wash & Repair					O	ST	M	LK
	Fuel Dock					O	ST	M	LK
	Boat Traffic	L	LT	M	LK	O	ST	M	LK

Resort & Marina Village	**Routine**								
	Solid Waste					O	T	LW	LK
	Liquid & Hazardous Waste					O	ST	LW	LK
	Noise					O	T	LW	LK
	Emissions					O	T	LW	LK
	Retail, Resort, Restaurants					O	T	N	U
External Project Improvements									
		E	**D**	**I**	**L**	**E**	**D**	**I**	**L**
Road Improvements & Construction	Great Abaco Highway to Road 50 (9 miles)	O	ST	M	LK	O	ST	M	LK
	Roundabout at Intersection Lighthouse Road and Road 50	O	ST	M	LK	O	ST	M	LK
	Road 50 (3.5 miles)	O	ST	M	LK	O	ST	M	LK
	Roundabout at intersection of Road 50 and property access roads	O	ST	M	LK	O	ST	M	LK
	New Coastal Road from Sandy Point Airport to Eagle Bay to Road 50 (10 miles)	O	ST	M	LK	O	ST	M	LK
	South Abaco Ferry Dock Repair	O	ST	M	LK	O	ST	M	LK
	Maintenance and upkeep	O	ST	M	LK	O	ST	M	LK
	Utility area near existing landfill	O	ST	M	LK	O	ST	M	LK
	Improvements to existing landfill	O	ST	M	LK	O	ST	M	LK
	Man Camp	O	ST	M	LK	O	ST	M	LK
	Staff Housing	O	ST	M	LK	O	ST	M	LK
	Container Receiving and Storage	O	ST	M	LK	O	ST	M	LK

Table 10.7. Impact significance matrix for biological impacts at Leeward Harbour

Leeward Harbour - Impact Significance Matrix - Extent (E), Duration (D), Intensity (I), Likelihood (L)																									
		Aspect																							
Project Component	Impacting Factor	Biological																							
		Terrestrial Habitats				Marine Habitats				Birds				Terrestrial Flora				Marine Mammals				Marine Resources			
Construction																									
		E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L
Marina Creation	Land Clearing	O	P	H	D	O	ST	M	LK	O	ST	M	LK	O	ST	H	D	O	ST	LW	LK	O	ST	H	LK
	Excavation	O	P	M	D	O	P	H	D	O	ST	M	LK	O	ST	M	D	O	ST	LW	LK	O	ST	H	LK
	Entrance Channel Dredging	O	P	H	D	O	P	H	D	O	ST	M	LK	O	ST	H	D	O	ST	LW	LK	O	ST	H	LK
	Flushing Channel Dredging	O	P	H	D	O	P	H	D	O	ST	M	LK	O	ST	H	D	O	ST	LW	LK	O	ST	H	LK
	Marina Opening	O	P	H	D	O	T	LW	LK	O	ST	M	LK	O	ST	H	D	O	ST	LW	LK	O	ST	M	LK
	Spoil Stockpiling	O	ST	M	LK	O	ST	M	LK	O	ST	M	LK	O	ST	M	LK	O	ST	LW	LK	O	ST	LW	LK
Upland Construction	Land Clearing	O	LT	H	D	O	ST	M	LK	O	ST	M	LK	O	ST	H	D								
	Solid Waste	O	ST	M	LK	O	ST	M	LK	O	ST	LW	LK	O	ST	M	LK	O	ST	M	LK	O	ST	M	LK
	Liquid & Hazardous Waste	O	ST	M	LK	O	ST	M	LK	O	ST	LW	LK	O	ST	M	LK	O	ST	M	LK	O	ST	M	LK
	Discharges	O	ST	M	LK	O	ST	M	LK	O	ST	LW	LK	O	ST	M	LK	O	ST	M	LK	O	ST	M	LK
	Noise	O	ST	M	LK	L	ST	M	LK	O	ST	M	LK	O	ST	M	LK	L	ST	M	LK	O	ST	M	LK
	Emissions	O	ST	M	LK	O	ST	M	LK	O	ST	LW	LK	O	ST	M	LK	O	ST	M	LK	O	ST	M	LK
	Infrastructure Installation	O	ST	LW	LK	O	ST	LW	LK	L	ST	LW	LK	O	ST	M	LK	O	ST	M	LK	O	ST	M	LK
Operations																									
Marina	Accidental	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L
	Oil Spills	O	LT	M	LK	O	LT	H	LK	O	LT	M	LK	O	ST	M	LK	O	LT	M	LK	O	LT	H	LK
	Sewage Discharge	O	LT	M	LK	O	LT	H	LK	O	LT	M	LK	O	ST	M	LK	O	LT	M	LK	O	LT	H	LK
	Fuel Spill	O	LT	M	LK	O	LT	H	LK	O	LT	M	LK	O	ST	M	LK	O	LT	M	LK	O	LT	H	LK
	Surface Runoff	O	LT	M	LK	O	LT	H	LK	O	LT	M	LK	O	ST	M	LK	O	LT	M	LK	O	LT	H	LK
	Routine																								
	Boat Wash & Repair	O	LT	M	LK	O	LT	M	LK	O	LT	M	LK					O	LT	M	LK	O	LT	M	LK
	Fuel Dock	O	LT	M	LK	O	LT	M	LK	O	LT	M	LK					O	LT	M	LK	O	LT	M	LK
	Boat Traffic	O	LT	M	LK	L	LT	M	LK									O	LT	H	LK	O	LT	H	LK
Resort & Marina Village	Routine																								
	Solid Waste	O	LT	M	LK	O	ST	M	LK	O	LT	LW	LK	O	LT	LW	LK	O	LT	M	LK	O	LT	M	LK
	Liquid & Hazardous Waste	O	LT	M	LK	O	ST	M	LK	O	LT	M	LK	O	LT	M	LK	O	LT	M	LK	O	LT	M	LK
	Noise					L	LT	H	LK	O	LT	LW	LK					O	LT	LW	LK	O	LT	LW	LK
	Emissions	O	LT	LW	LK	O				O	LT	LW	LK	O	LT	LW	LK								
	Retail, Resort, Restaurants																								
External Project Improvements																									
		E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L

Road Improvements & Construction	Great Abaco Highway to Road 50 (9 miles)	L	LT	LW	LK					L	LT	M	LK	L	LT	M	LK								
	Roundabout at Intersection Lighthouse Road and Road 50	L	LT	LW	LK					L	LT	M	LK	L	LT	M	LK								
	Road 50 (3.5 miles)	L	LT	LW	LK					L	LT	M	LK	L	LT	M	LK								
	Roundabout at intersection of Road 50 and property access roads	L	LT	LW	LK					L	LT	M	LK	L	LT	M	LK								
	New Coastal Road from Sandy Point Airport to Eagle Bay to Road 50 (10 miles)	L	LT	LW	LK					L	LT	M	LK	L	LT	M	LK								
	South Abaco Ferry Dock Repair	L	LT	LW	LK	L	P	LW	LK									L	ST	LW	LK	L	ST	LW	LK
	Maintenance and upkeep	O	LT	LW	LK																				
	Utility area near existing landfill	O	LT	LW	LK																				
	Improvements to existing landfill	L	LT	H	D					L	LT	H	LK	L	LT	H	LK								
	Man Camp	L	LT	LW	LK					L	LT	LW	LK	L	LT	LW	LK								
	Staff Housing	L	LT	LW	LK					L	LT	LW	LK	L	LT	LW	LK								
	Container Receiving and Storage	L	LT	LW	LK					L	LT	LW	LK	L	LT	LW	LK								

Table 10.8. Impact significance matrix for socio-economic impacts of Leeward Harbour

Leeward Harbour - Impact Significance Matrix - Extent (E), Duration (D), Intensity (I), Likelihood (L)																	
		Aspect															
Project Component	Impacting Factor	Socio-Economic															
		Neighboring Communities				Relocation				Traffic				Economic			
Construction																	
		E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L
Marina Creation	Land Clearing													O	ST	H	D
	Excavation													O	ST	H	D
	Entrance Channel Dredging					L	T	LW	D	O	ST	LW	U	O	ST	H	D
	Flushing Channel Dredging					L	T	LW	D	O	ST	LW	U	O	ST	H	D
	Marina Opening									O	ST	LW	U	L	LT	H	D
	Spoil Stockpiling													L	ST	H	D
Upland Construction	Land Clearing													O	ST	H	D
	Solid Waste																
	Liquid & Hazardous Waste																
	Discharges																
	Noise																
	Emissions																
	Infrastructure Installation													O	ST	H	D
Operations																	
Marina	Accidental	E	D	I	L	E	D	I	L	E	D	I	L	E	D	I	L
	Oil Spills																
	Sewage Discharge																
	Fuel Spill																
	Surface Runoff																
	Routine																
	Boat Wash & Repair													O	ST	H	D
	Fuel Dock													O	ST	H	D
	Boat Traffic									O	LT	M	LK	O	ST	H	D
Resort & Marina Village	Routine																
	Solid Waste																

	Liquid & Hazardous Waste																
	Noise																
	Emissions																
	Retail, Resort, Restaurants													O	ST	H	D
External Project Improvements																	
		E	**D**	**I**	**L**	**E**	**D**	**I**	**L**	**E**	**D**	**I**	**L**	**E**	**D**	**I**	**L**
Road Improvements & Construction	Great Abaco Highway to Road 50 (9 miles)	O	LT	H	D					L	LT	H	D	O	ST	H	D
	Roundabout at Intersection Lighthouse Road and Road 50	O	LT	H	D					L	LT	H	D	O	ST	H	D
	Road 50 (3.5 miles)	O	LT	H	D					L	LT	H	D	O	ST	H	D
	Roundabout at intersection of Road 50 and property access roads	O	LT	H	D					L	LT	H	D	O	ST	H	D
	New Coastal Road from Sandy Point Airport to Eagle Bay to Road 50 (10 miles)	O	LT	H	D					L	LT	H	D	O	ST	H	D
	South Abaco Ferry Dock Repair	O	LT	H	D					L	LT	H	D	O	ST	H	D
	Maintenance and upkeep	O	LT	H	D					L	LT	H	D	O	LT	H	D
	Utility area near existing landfill	O	LT	H	D									O	LT	H	D
	Improvements to existing landfill	O	LT	H	D									O	LT	H	D
	Man Camp	O	ST	H	D									O	ST	H	D
	Staff Housing	O	LT	H	D									O	LT	H	D
	Container Receiving and Storage	O	LT	H	D					L	LT	LW	LK	O	LT	H	D

Table 10.9. Leeward Harbour cultural impacts significance matrix

Leeward Harbour - Impact Significance Matrix - Extent (E), Duration (D), Intensity (I), Likelihood (L)													
		Aspect											
Project Component	Impacting Factor	Cultural											
		Archaeological, Historic & Paleontological Resources				Hunting				Fishing			
Construction													
		E	D	I	L	E	D	I	L	E	D	I	L
Marina Creation	Land Clearing	O	ST	LW	U	O	P	LW	U				
	Excavation	O	ST	LW	U								
	Entrance Channel Dredging									O	ST	M	LK
	Flushing Channel Dredging									O	ST	M	LK
	Marina Opening									O	ST	M	LK
	Spoil Stockpiling												
Upland Construction	Land Clearing	O	ST	LW	U	O	P	LW	U				
	Solid Waste					O	ST	LW	U				
	Liquid & Hazardous Waste					O	ST	LW	U				
	Discharges					O	ST	LW	U				
	Noise					O	ST	LW	U				
	Emissions					O	ST	LW	U				
	Infrastructure Installation												
Operations													
Marina	Accidental	E	D	I	L	E	D	I	L	E	D	I	L
	Oil Spills									O	ST	M	LK
	Sewage Discharge									O	ST	M	LK
	Fuel Spill									O	ST	M	LK
	Surface Runoff									O	ST	M	LK
	Routine												
	Boat Wash & Repair									O	ST	M	LK
	Fuel Dock									O	ST	M	LK
	Boat Traffic									O	ST	M	LK

Resort & Marina Village	Routine												
	Solid Waste					O	ST	LW	U	O	ST	M	LK
	Liquid & Hazardous Waste					O	ST	LW	U				
	Noise					O	ST	LW	U				
	Emissions					O	ST	LW	U				
	Retail, Resort, Restaurants									O	ST	M	LK
External Project Improvements													
		E	D	I	L	E	D	I	L	E	D	I	L
Road Improvements & Construction	Great Abaco Highway to Road 50 (9 miles)	O	ST	LW	U	O	P	H					
	Roundabout at Intersection Lighthouse Road and Road 50	O	ST	LW	U	O	P	H					
	Road 50 (3.5 miles)	O	ST	LW	U	O	P	H					
	Roundabout at intersection of Road 50 and property access roads	O	ST	LW	U	O	P	H					
	New Coastal Road from Sandy Point Airport to Eagle Bay to Road 50 (10 miles)	O	ST	LW	U	O	P	H					
	South Abaco Ferry Dock Repair	O	ST	LW	U	O	P	H		L	LT	H	D
	Maintenance and upkeep	O	ST	LW	U	O	P	H					
	Utility area near existing landfill	O	ST	LW	U	O	P	H					
	Improvements to existing landfill	O	ST	LW	U	O	P	H					
	Man Camp	O	ST	LW	U	O	P	H					
	Staff Housing	O	ST	LW	U	O	P	H					
	Container Receiving and Storage	O	ST	LW	U	O	P	H					

Table 10.10. Leeward Harbour summary Impact rating table.

Leeward Harbour – Summary Impact Rating Table

		Aspect																	
Project Component	**Impacting Factor**	**Physical**			**Coastal Processes**		**Biological**						**So-Econ**				**Cultural**		
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing
Construction																			
Marina Creation	Land Clearing																		
	Excavation																		
	Entrance Channel Dredging																		
	Flushing Channel Dredging																		
	Marina Opening																		
	Spoil Stockpiling																		
	Dock Piles Installation																		
Upland Construction	Land Clearing																		
	Solid Waste																		
	Liquid & Hazardous Waste																		
	Discharges																		
	Noise																		
	Emissions																		
	Infrastructure Installation																		
Operations																			
Marina	**Accidental**																		
	Oil Spills																		
	Sewage Discharge																		
	Fuel Spill																		
	Surface Runoff																		
	Routine																		
	Boat Wash & Repair																		
	Fuel Dock																		
	Boat Traffic																		
Resort & Marina Village	**Routine**																		

	Solid Waste																		
	Liquid & Hazardous Waste																		
	Noise																		
	Emissions																		
	Retail, Resort, Restaurants																		

External Project Improvements

Project Component	**Impacting Factor**	**Physical**			**Coastal Processes**		**Biological**						**Socio-Economic**				**Cultural**		
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing
Road Improvements & Construction	Great Abaco Highway to Road 50 (9 miles)																		
	Roundabout at Intersection Lighthouse Road and Road 50																		
	Road 50 (3.5 miles)																		
	Roundabout at intersection of Road 50 and property access roads																		
	New Coastal Road from Sandy Point Airport to Eagle Bay to Road 50 (10 miles)																		
	South Abaco Ferry Dock Repair																		
	Maintenance and upkeep																		
	Utility area near existing landfill																		
	Improvements to existing landfill																		
	Man Camp																		
	Staff Housing																		
	Container Receiving and Storage																		

10.2 HIGH BANK BAY SUMMARY TABLES OF POTENTIAL ENVIRONMENTAL IMPACTS

Table 10.11. Potential environmental impacts of High Bank Bay.

		Aspect																	
Project Component	**Impacting Factor**	**Physical**			**Coastal Processes**		**Biological**						**Socio-Economic**				**Cultural**		
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing
									Construction										
18-Hole Golf Corse	Land Clearing	*	*	*	*	*	*		*	*								*	
	Excavation of Ponds	*	*	*	*		*		*									*	
	Spoil Stockpiling		*	*			*			*									
	Liquid & Hazardous Waste		*					*											
	Emissions		*				*		*										
	Solid Waste		*			*													
	Landscaping					*		*		*		*							*
	Installed Infrastructure												*			*			
The Sporting Club & Amenities	Land Clearing	*	*	*	*	*	*		*	*								*	
	Solid Waste		*			*	*	*	*	*		*							*
	Liquid & Hazardous Waste	*	*			*	*	*	*	*		*							*
	Discharges	*				*	*	*				*							
	Noise			*					*										
	Emissions		*				*												
	Infrastructure Installation												*		*	*			

Lagoon Creation	Land Clearing	*	*	*	*	*	*	*	*	*		*							
	Excavation	*		*	*	*	*	*		*									
	Dredging	*		*	*	*	*	*			*	*							*
	Liquid & Hazardous Waste	*				*	*	*	*			*							
	Discharges	*			*	*	*	*				*							
	Noise			*		*	*	*	*		*	*							
	Emissions		*			*	*		*										
	Spoil Stockpiling		*			*	*			*									
BOH / Utilities	Land Clearing	*	*	*	*		*		*	*								*	
	Solid Waste						*		*	*									
	Liquid & Hazardous Waste	*					*		*	*									
	Discharge	*					*		*	*									
	Noise		*	*			*		*										
	Emissions		*				*		*										
	RO System / Well	*		*	*		*		*	*									
	Operations																		
18-Hole Golf Course	**Accidental Impacts**																		
	Surface Runoff	*			*	*	*	*		*		*							*
	Solid Waste	*				*	*	*	*	*		*							*
	Installed Infrastructure															*			
The Sporting Club & Amenities	Discharge	*			*	*	*	*	*	*		*							
	Emissions		*				*		*	*									
	Solid Waste	*				*	*	*	*	*		*							
	Installed Infrastructure												*			*			
Residential Lots	Discharge	*			*	*	*	*	*	*		*							
	Solid Waste	*				*	*	*	*	*		*							
	Liquid & Hazardous Waste	*	*			*	*	*	*	*		*							
	Installed Infrastructure												*			*			
BOH / Utilities	Liquid & Hazardous Waste	*					*		*	*									
	Emissions		*				*		*										

	Discharge	*			*		*		*	*									
	Noise			*			*		*										
	Solid Waste						*		*	*									

Table 10.12. High Bank Bay summary Impact rating table.

High Bank Bay - Summary Impact Rating Table																			
		Aspect[48]																	
Project Component	Impacting Factor	Physical			Coastal Processes		Biological						Socio-Economic				Cultural		
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing
Construction																			
18-Hole Golf Corse	Land Clearing																		
	Excavation of Ponds																		
	Spoil Stockpiling																		
	Liquid & Hazardous Waste Waste																		
	Emissions																		
	Solid Waste																		
	Landscaping																		
	Installed Infrastructure																		
The Sporting Club & Amenities	Land Clearing																		
	Solid Waste																		
	Liquid & Hazardous Waste																		
	Discharges																		
	Noise																		
	Emissions																		
	Infrastructure Installation																		
Lagoon Creation	Land Clearing																		
	Excavation																		

48 Yellow- Minor Impact, Orange- Moderate Impact, White- No Impact, Red- Adverse Impact, and Green-Beneficial Impact.

	Dredging																		
	Liquid & Hazardous Waste																		
	Discharges																		
	Noise																		
	Emissions																		
	Spoil Stockpiling																		
BOH / Utilities	Land Clearing																		
	Solid Waste																		
	Liquid & Hazardous Waste																		
	Discharge																		
	Noise																		
	Emissions																		
	RO System / Well																		
Operations																			
18-Hole Golf Course	**Accidental Impacts**																		
	Surface Runoff																		
	Solid Waste																		
	Installed Infrastructure																		
The Sporting Club & Amenities	Discharge																		
	Emissions																		
	Solid Waste																		
	Installed Infrastructure																		
Residential Lots	Discharge																		
	Solid Waste																		
	Liquid & Hazardous Waste																		
	Installed Infrastructure																		
BOH / Utilities	Liquid & Hazardous Waste																		
	Emissions																		
	Discharge																		
	Noise																		
	Solid Waste																		

10.3 CONCH SOUND POINT SUMMARY TABLES OF POTENTIAL ENVIRONMENTAL IMPACTS

Table 10.13. Potential environmental impacts of Conch Sound Point – South Abaco.

		Aspect																	
Project Component	**Impacting Factor**	**Physical**			**Coastal Processes**		**Biological**						**Socio-Economic**				**Cultural**		
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing
									Construction										
Golf Practice Area	Land Clearing	*	*	*	*	*	*		*	*								*	
	Spoil Stockpiling		*	*			*			*									
	Liquid & Hazardous Waste		*					*											
	Emissions		*				*		*										
	Solid Waste		*			*													
	Landscaping					*		*		*		*							*
	Installed Infrastructure												*			*			
The Residence Club & Amenities	Land Clearing	*	*	*	*	*	*		*	*								*	
	Excavation of Ponds	*	*	*	*		*		*									*	
	Solid Waste		*			*	*	*	*	*		*							*
	Liquid & Hazardous Waste	*	*			*	*	*	*	*		*							*
	Discharges	*				*	*	*				*							
	Noise			*					*										
	Emissions		*				*												
	Infrastructure Installation												*		*	*			
Lagoon Creation	Land Clearing	*	*	*	*	*	*	*	*	*		*							

	Excavation	*		*	*	*	*	*		*									
	Dredging	*		*	*	*	*	*			*	*							*
	Liquid & Hazardous Waste	*				*	*	*	*			*							
	Discharges	*			*	*	*	*				*							
	Noise			*		*	*	*	*		*	*							
	Emissions		*			*	*		*										
	Spoil Stockpiling		*			*	*			*									
BOH / Utilities	Land Clearing	*	*	*	*		*		*	*								*	
	Solid Waste						*		*	*									
	Liquid & Hazardous Waste	*					*		*	*									
	Discharge	*					*		*	*									
	Noise		*	*			*		*										
	Emissions		*				*		*										
	RO System / Well	*		*	*		*		*	*									
	Operations																		
Golf Practice Area	**Accidental Impacts**																		
	Surface Runoff	*			*	*	*	*		*		*							*
	Solid Waste	*				*	*	*	*	*		*							*
	Installed Infrastructure															*			
The Residence Club & Amenities	Discharge	*			*	*	*	*	*	*		*							
	Emissions		*				*		*	*									
	Solid Waste	*				*	*	*	*	*		*							
	Installed Infrastructure												*			*			
Residential Lots	Discharge	*			*	*	*	*	*	*		*							
	Solid Waste	*				*	*	*	*	*		*							
	Liquid & Hazardous Waste	*	*			*	*	*	*	*		*							
	Installed Infrastructure												*			*			
BOH / Utilities	Liquid & Hazardous Waste	*					*		*	*									
	Emissions		*				*		*										
	Discharge	*			*		*		*	*									

	Noise			*			*		*										
	Solid Waste						*		*	*									

Table 10.14. Conch Sound Point summary Impact rating table.

Conch Sound Point - Summary Impact Rating Table

		Aspect[49]																	
Project Component	**Impacting Factor**	**Physical**			**Coastal Process**		**Biological**						**Socio-Economic**				**Cultural**		
		Hydrology & Hydrogeology	Air Quality	Noise	Erosion & Sedimentation	Beach	Terrestrial Habitats	Marine Habitats	Birds	Terrestrial Flora	Marine Mammals	Marine Resources	Neighboring Communities	Relocation	Traffic	Economic	Archaeological, Historic & Paleontological Resources	Hunting	Fishing
Construction																			
Golf Practice Area	Land Clearing	Yellow	Orange	Yellow	Orange	Orange	Red		Orange	Red								Yellow	
	Excavation of Ponds	Orange	Yellow	Yellow	Orange		Red		Orange									Yellow	
	Spoil Stockpiling		Yellow	Yellow			Yellow			Yellow									
	Liquid & Hazardous		Orange					Orange											
	Emissions		Yellow				Yellow		Orange										
	Solid Waste		Yellow			Orange													
	Landscaping					Yellow		Yellow		Orange		Yellow							Yellow
	Installed Infrastructure												Green			Green			
The Residence Club & Amenities	Land Clearing	Orange	Orange	Yellow	Orange	Orange	Red		Orange	Red								Yellow	
	Solid Waste		Yellow			Yellow	Orange	Orange	Orange	Orange		Orange							Yellow
	Liquid & Hazardous Waste	Orange	Yellow			Yellow	Yellow	Yellow	Orange	Orange		Yellow							Orange
	Discharges	Orange				Orange	Orange	Orange				Orange							
	Noise			Yellow					Yellow										
	Emissions		Yellow				Yellow												

49 Yellow- Minor Impact, Orange- Moderate Impact, White- No Impact, Red- Adverse Impact, and Green-Beneficial Impact.

	Infrastructure Installation																		
Lagoon Creation	Land Clearing																		
	Excavation																		
	Dredging																		
	Liquid & Hazardous																		
	Discharges																		
	Noise																		
	Emissions																		
	Spoil Stockpiling																		
BOH / Utilities	Land Clearing																		
	Solid Waste																		
	Liquid & Hazardous																		
	Discharge																		
	Noise																		
	Emissions																		
	RO System / Well																		
Operations																			
Golf Practice	**Accidental**																		
	Surface Runoff																		
	Solid Waste																		
	Installed Infrastructure																		
The Residence Club &	Discharge																		
	Emissions																		
	Solid Waste																		
	Installed Infrastructure																		
Residential Lots	Discharge																		
	Solid Waste																		
	Liquid & Hazardous																		

	Installed Infrastructure																		
BOH / Utilities	Liquid & Hazardous																		
	Emissions																		
	Discharge																		
	Noise																		
	Solid Waste																		

11 PUBLIC CONSULTATION

No recent public consultations have been held as yet regarding the Kakona project.

12 ENVIRONMENTAL MANAGEMENT

An effective Environmental Management Plan (EMP) will be developed once site plans have been finalized and the Project has been approval to proceed with the creation of the EMP document by DEPP. The document will include the following specific guidelines which outline a management plan to ensure aspects of the Project which are relevant to environmental protection are clear and defined.

- Purpose, Scope, and Content will summarize the purpose and identify the project components and activities to which the plans will apply.
- Organizational Charts will outline responsibilities of various staff and contact information for construction, operations and emergencies.
- Summary of Impacts, Accidents/Malfunctions will summarize the predicted ongoing environmental and socio-economic impacts from the proposed activities during the various stages of the project. This section will also describe various accidents including fires, explosions, natural events and/or malfunctions due to acts of sabotage that could possibly occur, as well as the nature and scope of the impacts these occurrences could pose to the environment and the public.
- Erosion and Sediment Control sections will include construction guidelines: to minimize building generated sediment, for overseeing turbidity management, to assure correct installation, for the maintenance of silt curtains, for regular inspections of site and sediment control protection, etc.
- Hazardous and Solid Waste Management sections will identify locations and criteria for secure hazardous material storage and will outline disposal techniques for solid and hazardous waste.
- Emergency Management sections will outline procedures, protocols, and locations of relevant equipment in the event of a hurricane, fire, or other natural hazard.
- Summary of Environmental Regulatory Bodies and Standards will identify the relevant regulatory bodies having jurisdiction relating to environmental protection as applicable to the implementation of each stage of the project. The section will also summarize the proposed environmental standards for each affected resource impacted by activities associated with the development.
- Planned Mitigation Measures will describe actions that will be applied to meet the environmental standards established for the project. Each mitigation measure will be briefly described in relation to the impacts associated with the project. Also referenced will be those specific mitigation plans that may be applied during project implementation.

- Measures for Responding to Potential Accidents will include the actions to be undertaken in response to fires, explosions or major spills which could occur as a result of accidents, natural events, acts of sabotage, or malfunctions.
- Responsibilities and Accountabilities will identify the processes, procedures, and mechanisms for implementation of the mitigation as well as for responding to emergencies. It will include responsibilities for mitigation, accident response, and monitoring and it will identify the party responsible for insuring any reporting that is to be coordinated with applicable governmental agencies.
- Training will describe the types, participants, information content, and schedules to be implemented so those responsible are knowledgeable about performing mitigation, responding to emergencies, monitoring, and reporting.
- Public Grievances will include mechanisms for stakeholders to voice their concerns to the Developer during construction and operations.

12.1 Draft Environmental Management Plan (EMP) Terms of Reference (ToR)

1. Executive Summary
2. Introduction
3. Project Description
4. Relevant Environmental Regulatory Bodies
5. Environmental Management Organization
6. Environmental Impacts Summary
7. Management Plans and Mitigation Strategies
8. Emergency, Health, and Safety Plan
9. Public Grievance Mechanism
10. Monitoring and Reporting
11. Conclusion

13 Recommendations And Mitigation Strategies

13.1 Methodology

The following recommendations and mitigation strategies are a combination of best management practices used in previous experiences on similar developments. In accordance with these practices, a full- time Environmental Monitor will be on each site during construction to ensure mitigation measures outlined in the Environmental Management Plan are always adhered to during development. Following construction, these practices should be taken on by a resident Environmental Manager. These practices include capitalizing on environmental windows (opportune times outside of mating / spawning or migrating seasons) for valued ecosystem components (Nassau Grouper, Abaco Parrot, etc.), as much as reasonably practicable, in an effort to limit disturbances to the natural environment during construction and operational activities.

13.2 Biological Resource Management

13.2.1 Terrestrial Resource Management

Identified protected plant species should be flagged and preclearance surveys conducted to avoid removal or destruction of mature species. These plants should be relocated to an onsite nursery and incorporated into the Project's landscape design. Landscaping activities should take place as soon as possible to reinstate ecosystem function and will aim to incorporate native flora into the design. The Developer will apply for a protected tree removal permit from the Forestry Unit. Which will help guide the land clearing process. If bird nests are observed during the preclearance surveys, they should be removed and placed in a similar habitat away from construction and human interference.

A mangrove management plan should be established to manage species removal and incorporate replanting/restoration efforts within the adjacent wetland ecosystem. Thus, increasing biodiversity within the area. Coastline stabilization includes planting native plant species within the beach sand / dune area to reduce erosions affects.

Invasive species will be removed from the site during the land clearing activities of the Project. Invasive species of *Casuarina equisetifolia* and *Scaevola taccada* should be removed from all coastal areas on the properties. Both species will continue to accelerate coastal erosion of the dune system along the western shoreline of the property, as well as decrease biodiversity in the immediate areas of colonization.

Removal of invasive species should entail removal of both above and below ground portion so the plant, as these species readily sucker from roots. Due to the proximity to coastal waters and sensitive habitats, the use of herbicides is not recommended for removal of invasives on the property. It is also recommended that invasive species removal occur during periods when plants species are not in fruit, as removal of the host plants can spread seeds on the property during removal. Removal of invasive species should be complemented by replanting de-vegetated areas with native coastal species. A mangrove management and invasive species removal plan will be detailed in the Project's EMP.

13.2.2 Marine Resource Management

Preclearance surveys of the marine environment should be conducted prior to marina construction (entrance and flushing channels) and lagoon excavation (entrance channels). This is to ensure that slow moving marine organisms and those confined to the benthos are relocated away from the active dredge zone.

The revetment and bulkhead construction should be completed prior to flooding the marina basin. A silt fence will be utilized to prevent sediment into the new marina. Precautions during construction will be taken to prevent any sediment from reaching the basin. Turbidity curtains should be installed prior to entrance channel dredge activity to reduce increased sedimentation.

Although not confirmed, it is possible that SCTLD may be present among the coral species observed at LH. Due to this, coral relocation is not recommended to avoid the spread of disease or other sources of contamination. However, the development of a coral nursery at a suitable location can aid in the development of endangered coral species. Which can be out planted in suitable areas to create more coral reef structures and increase biodiversity. This process will be guided by DEPP and DMR and outlined in the Project's EMP.

The use of a living wall within the marina can assist in creating new habitat within this inland marine basin. The use of rip rap boulders in conjunction with mangrove plants can help to attract marine species into these new habitats. It is known that specie such as manatees favor marina harbor in search of fresh waste. Due to this, signage should be erected to alert boaters of their presence (see figure below), as well as encouraged to use propeller guards. Prior to installation, if piles are used, they should be wrapped in PVC casing to prevent leaching of chemical into the surrounding marine environments.

Figure 13.1. *Example of signage that can be used to alert boaters to remain cautious of marine mammals.*

During marina operation, marine grade trash receptables will be stationed at regular points around the marina basin to ensure guests and users of the marina will have ample opportunity to dispose of solid wastes from their respective vessels, as well as from general activities within the marina village at LH. The marine trash receptable should have a locking lid, that can withstand the harsh elements of the coastal environment. Receptacle should be firmly secured in its location, so as to prevent accidental tipping or introduction of the trash receptacle or its contents into the marine environment.

Marina sewage pump out services will be available for vessels utilizing the marina. The provision of this service is important to prevent the dumping of sewage in near or offshore water surrounding the LH harbour. The disposal of pumped sewage will be in accordance with local laws and best management practices. The pump out station should be located away from the fueling pump to keep electrical wiring a safe distance away from flammable chemicals. Spill kits will be located at multiple points around the marina basin to ensure quick access in the event of an accidental spill. Emergency shut off valves will be installed and made accessible in the event fuel supplies need to be shut down. The spill protection and cleanup plan will be outlined in the projects EMP and onsite training for marina staff will be conducted to ensure efficient execution of the plan in the event of a spill.

Boat owners, marina occupants and residents will also be educated on spill recovery protocol and encouraged to engage in sound environmental practices with regards to use of petroleum chemicals within the marina basin. Boaters should also be encouraged to report spills to the marina staff to ensure quick recovery of spilled material.

13.3 Groundwater Resource Management

To avoid a negative long-term impact to the groundwater resources, the site can be elevated prior to excavation. Also, proper site drainage and construction site orientation can reduce impacts to the water table and surrounding surface bodies of water. Once the site is elevated, the groundwater level will be deeper below the surface. Appropriate spill management will be implemented to prevent construction related accidental oil and fuel spills from percolating through the limestone to the water table. Additional mitigation and best practices are introduced in Section 13.6 and will be detailed in the EMP.

13.4 Turbidity and Erosion Control

During marina creation at LH, the inland marina basin and channels will be excavated prior to unplugging of the marina to the open sea. The marina plug will only be removed once the turbidity of the inland basin has settled and turbidity curtain is in place to protect surrounding near shore environment from turbidity plumes. Turbidity curtain will be installed prior to dredging of the marina channels. Sustained turbidity has the potential to lower sunlight levels and negatively impact photosynthetic marine organisms.

13.4.1 Erosion Control

During construction at each site, erosion control devices such as silt socks should be installed along the perimeter fencing. Silt Socks allow water to flow through at a controlled rate while trapping sediment. This is achieved by a filter fabric filled with organic material. Furthermore, excavations should occur during minimal or no rain to avoid agitated erosion from rainfall. Disturbed soil should be covered to reduce displacement. Vegetated buffers include leaving the perimeter along the site vegetated/undisturbed to avoid on site erosion.

Planting native species and mulching are erosion control measures that occur during the landscaping design of the Project's operations phase. Native plant root system helps compact sand / soil and prevent erosion. Whereas mulching aids in soil coverage and prevents wind erosion.

13.5 Waste Management (solid, liquid hazardous)

Waste collection and containment will follow standards provided by the Department of Environmental Health Services (DEHS) and will be guided by the EMP. Solid waste will be removed from each site daily by a DEHS approved waste removal service provider and covered during transportation to disposal location (South Abaco Landfill). The waste removal service provider must provide proof of disposal / treatment / recycling processes from the Department of Environmental Health Services. Detailed solid waste management will be included in the Project's EMP.

13.6 Spill Management

Spill Management will primarily focus on spill prevention measures and secondarily focus on clean up and mitigation. In the event of a spill, the spill will be monitored and reported using a form similar to the one shown below the table. To prevent spills during construction the guidelines described in the table below will be followed on site. The Environmental Monitor will ensure the guidelines are followed.

Table 13.1. Spill management.

Spill Prevention	Required Equipment
Place drip trays beneath taps and valves and use overflow and drop containment measures at connection points or at other possible overflow points.	Drip trays
Secure the fuel and chemical storage area to prevent vandalism and damage of storage containers. An impermeable liner will be placed under storage containers in the back of house area and a secondary spill containment will be used.	Impermeable liner Spill berm
Use caution during hand transfer of fuel from storage containers to refuel equipment. Use a funnel to reduce the chances of leaks or spills.	Fuel storage containers Funnels
Fuel will be stored and transported in designated fuel storage containers. The containers will be covered until the fuel is needed for refueling.	Fuel storage containers Funnels
Do not store fuel or oil in damaged, unsealed containers. If a container is damaged, place the damaged container in an overdrum to prevent spills or leaks.	Overdrum
Use spill pallets and safety storage platforms when fuel / chemicals are transported around the site.	Spill pallets Safety Storage platform
Equipment will be maintained and serviced regularly by a local contractor to prevent leaks.	N/A
Equipment and vehicles will be repaired at a designated location on the construction site. The site will be lined with an impermeable liner to prevent oil, gas, diesel, etc. from percolating through the surface. If equipment repairs must be	Impermeable liner Spill berm

made on-the-spot, mechanics will use an impermeable liner during repairs to prevent contamination of the ground.	
Safety Data Sheets (SDS) will be available on site in two locations. SDS will be available in the site office and near the respective storage areas for the fuel and chemicals.	Relevant Safety Data Sheets

Table 13.2. Example Spill Report Form for each Project site.

Date: ____________________ Weather Conditions: __________________________

Staff on Duty: ____

Contact Information: ____

Spill Details

Type of Spill/Product: ____

Description of Spill Location of Spill: ____
____

Spill Estimated Quantity: ____

Remediation Method: ____

Disposal Method: ____

Cause of Spill:

____
____
____

Prevention Method Employed: ____
____

Please identify spill location on the map provided below *(Insert photo of site plan for appropriate site below):*

Notes: ____
____
____

Please attach photos of spill activity.

Signed by:

________________________________   Site Safety Manager

Subcontractors will typically develop additional spill prevention measures during construction based on the project activities as construction progresses. In case of a spill, it should be reported to the Site Manager and contained immediately. If the spill cannot be contained, this information should be communicated to the site manager who will contact the relevant Emergency Personnel on the island. A full spill management plan will be outlined within the EMP.

13.7 Health and Safety

During construction, workers at all sites would be trained in proper tool operation and safety, handling of materials, driver safety and knowledge of first aid and safety response. All employees will be trained by requiring attendance of the "All Employee" training course. New hires will complete
the course for "All Employees" and any other appropriate segments of training required for their specific duty assignments within 30 days of starting work. The "All Employee" training course will include the following elements:

- Spill prevention, response, and reporting procedures,
- Discussion of good housekeeping practices,
- Site Orientation & Personal Protective Equipment (PPE) Requirements,
- Proper use of PPE,
- Identification of the Pollution Prevention and Spill Response Team members and their respective responsibilities.
- Emergency Exits and Procedures; and
- Environmental Requirements.

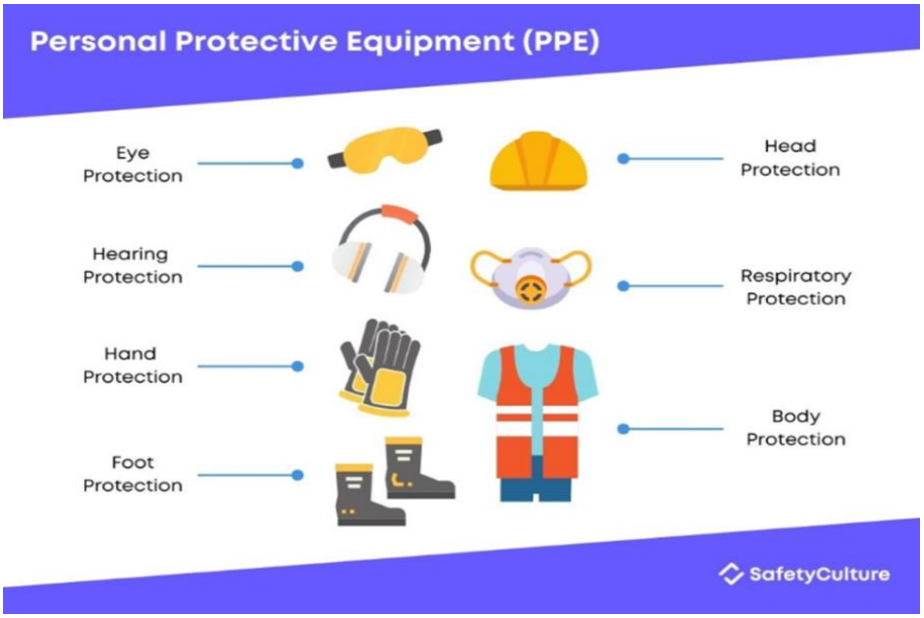

Figure 13.2. Example of PPE[50]

Safety personnel should be trained in health and safety techniques, to be used in case of an emergency and to act as emergency first responders to ensure the safety of staff at the Project construction site. The Project will comply with applicable security guidance or regulations developed by The Bahamas or international regulations and guidance, concerning the protection of sensitive facilities from acts of terrorism.

13.8 Fire Management

Recommended fire management for the Project sites includes the following:

- Project personnel will be trained in fire/explosion prevention and response.
- No burning or smoking will be allowed on the Project construction site.
- Fire extinguishers will always be accessible at designated muster stations on site.
- No burning, welding, or other source of ignition shall be applied to any enclosed tank or vessel, even if there are some openings, until it has first been determined that no possibility of explosion exists and authority for the work is obtained from the foreman or Supervisor.
- Employees should be aware of the locations of fire extinguishers that have been provided throughout the project and know- how to use them. A five-pound ABC rated fire extinguisher must be readily available while welding, burning, cutting, or using flammable gases or liquids. Smoking is not permitted around gasoline or other flammable liquids or gases.
- Equipment must be turned off before refueling.

[50] https://safetyculture.com/topics/ppe-safety/

- Gasoline must be stored and transported only in approved safety containers and gasoline must not be used for cleaning purposes. Compressed gas cylinders must be kept secured, upright, capped and separated when not in use. Empty gas cylinders should be marked and returned to the storage area for pickup.
- Compressed gas cylinders must be kept secured, upright, capped and separated when not in use. Empty gas cylinders should be marked and returned to the storage area for pickup.
- It is recommended that a fire break should be included in Project plans during construction and operation phases due to the proximity of the Pineland habitats and their combustible nature.

Detailed fire management will be included in the Project's EMP.

13.9 Severe Weather / Hurricane Management

An employee for each Project site will be assigned the role of storm tracker who will be responsible for notifying the Site Manager of the storm's progress. Once a Hurricane Warning is released by The Bahamas Department of Meteorology, the hurricane prepared plan will be initiated.

The Site Manager will assign a person in charge who will be responsible for implementation of the Hurricane Plan. The Hurricane Plan is a series of checklists to make preparing for and recovering from the storm as straightforward as possible. There will be weekly check in meetings place during the Hurricane season (June 1 to November 20), to discuss the Hurricane Action Plan and the team members' roles and responsibilities.

Before the storm checklist:

- Make a list of names, addresses and phone numbers for vendors and contractors who can provide recovery services or supplies.
- Keep evacuation routes open for all vehicles.
- Fully charge all devices and batteries.
- Remove loose jobsite materials and debris that could become projectiles and clean the jobsite daily.
- Have garbage in dumpsters and other containers consolidated and properly disposed and remove dumpsters from the site.
- Move materials that cannot be relocated or secured otherwise to shipping containers/storage boxes. Cover all materials that cannot be relocated and elevate them to at least 4 inches above the floor to reduce water damage exposure.
- Ensure that construction trailers and shipping containers/storage boxes are properly anchored and tied down. If anchors are not available, use concrete filled drums with embedded reinforcing steel loops and tether at least three locations for each trailer or storage container.
- Stop all material deliveries.

- All construction equipment mats should be tied together and anchored.
- Make a video/photographic record of the jobsite and surrounding properties to document the project condition and status prior to the storm.
- Fuel all vehicles and emergency equipment (such as generators)
- Once the site is secure, instruct subcontractors and employees to vacate the jobsite and not to return until the danger has passed.
- Establish a meeting place, if possible, for key recovery members.

13.9.1 Flood Management

Storm surge is a common feature of hurricanes in Small Island Developing States (SIDS) like The Bahamas. A storm surge is the abnormal rise in seawater or surface water bodies during a storm caused primarily by the storm's winds pushing water onshore or in the direction or in the direction the storm winds are moving[51 & 52].

It is recommended that drainage well structures are installed prior to the commencement of construction activities at each Project site to reduce flood impacts. The construction site should be oriented in a way that allows water to flow into these wells. As it relates to the lagoons at HBB and CSP, the site construction site should be oriented to allow water to flow into these features. Thus, filling the lagoons naturally and creating on-site drainage. These drainage wells will collect water and/or run-off from the site. Also, anti-erosion strategies such as silt fencing should be incorporated in the design of the construction site. Best management practices for flood management will be outlined in the EMP.

13.10 MARINE/VEHICULAR TRAFFIC CONTROL

To mitigate possible traffic impacts it is recommended that visible signage is erected along the access route to assist with traffic diversion where necessary (see figure below).

Figure 13.3. Examples of road construction signage.

Once operational, appropriate signage should be placed along the reconfigured road for public viewing. Furthermore, road striping should be clearly visible by motorists to indicate lane changes and direction.

[51] What is storm surge? (noaa.gov)
[52] Storm Surges, Seiches and Edge Waves | Wisconsin Sea Grant

Marina construction may affect marine traffic. Therefore, suggested passage routes should be outlined and communicated to boaters within the community. Furthermore, appropriate signage should be placed in visible areas for boaters to be made aware of marina construction activities and diverted routes. Communication can be made via VHF radio frequency to alert boaters of activities.

During operation, the marina may cause disruptions for watercraft operators / community boaters. Therefore, appropriate signage and lights should be placed in visible areas to alert boaters of the marina and to avoid collision and accidents.

13.11 Outreach and Education

13.11.1 Leeward Harbour Outreach and Education

The program at LH should endeavor to educate the general public regarding the plans for the development and the Project's direct and indirect benefits to the South Abaco communities. The Project's proponent should also educate the general public regarding the environmentally conscious practices the development will implement during construction and operations phases.

The program at LH should also engage its residents and guests regarding environmental considerations for the marina at LH. Posting of marina rules and regulations, Blue Flag criteria, prohibited practices and general educational signage should be posted to inform guests how to avoid negatively impacting the surrounding environments of South Abaco. Signage posted should also include no wake zones, and speed limitations to reduce incidents of collision between marine mammals and reptiles.

13.11.2 High Bank Bay and Conch Sound Point Outreach and Education

To the greatest extent possible, the project will preserve protected species of flora during land clearing and excavation activities. Where feasible, protected, rare, endemic or endangered species will be transplanted to other suitable areas on the property.

The program at HBB and CSP should endeavor to educate the general public regarding the plans for the development and the project direct and indirect benefits to the South Abaco communities. The project proponent should also educate the general public regarding the environmentally conscious practices the development will implement during construction and operations phases.

The program at HBB and CSP should also engage its residents and guests regarding environmental considerations for the lagoon and nearby marine resources. Posting of lagoon rules, prohibited practices and general educational signage should be posted to inform guests how to avoid negatively impacting the surrounding marine environments of South Abaco.

14 CONCLUSION

The development of The Setai- Kakona Resort Development has the potential to stimulate the economy of Abaco, as well as the economy of wider Bahamas. The most potentially adverse impacts result from those that affect geology, groundwater resources, marine and terrestrial (flora and fauna) and historical/cultural resources. The Project will have some moderate to severe impacts onsite and potentially on the immediate environments surrounding the properties. Mitigation strategies will be employed, where possible, to lessen the overall environmental impacts of the project, allowing the full socioeconomic benefits of the project to be realized by South Abaco residents and stakeholders. The potential socioeconomic benefits of this project are much needed amongst the locals and stakeholders of South Abaco. Despite the potentially adverse impacts associated with construction and operation of the proposed Project, the overall design of the Project and Developer's commitment to a low density, low impact residential community will allow for effective mitigation strategies to be employed during construction and operations phases of the Project.

The Project's activities at LH which have the potential to cause severe adverse impacts include impacts to terrestrial and marine habitats are due to upland clearing and creation of upland infrastructure associated with the marina and aerodrome; as well as the impact to the marine environment due to the creation of the marina and flushing channels. Other potential moderate adverse impacts from the Project's activities include impacts to water quality and hydrology due to the marina creation. The removal of terrestrial habitats will be mitigated through the preservation of habitat corridors, replanting with natives, and transplanting of rare endemic or endangered species elsewhere on the property.

The proposed Project development at HBB and CSP will have some moderate to severe impacts onsite and potentially on the immediate environments surrounding the properties. HBB and CSP Project activities which have the potential to cause severe adverse impacts include impacts to terrestrial habitats and bird populations due to land clearing during the creation of the golf and practice courses and upland infrastructure. Other potential moderate adverse impacts from the HBB and CSP Project activities include impacts to water quality and hydrology due to excavation for the saltwater and freshwater lagoon and golf course ponds on the property. Furthermore, some moderate impacts to the observed historical ruins during construction and road clearing at the HBB site are considered.

Effective mitigation strategies have the potential to lessen and even eradicate environmental impacts due to the Project activities. Recommendations on best practices and industry standard operations will be provided in the Environmental Management Plan for the Project. The Developer, SALDCO Ltd. is committed to minimizing the adverse environmental impact of the Project activities, while maximizing the environmental and social benefits of the proposed development through mitigation measures summarized below:

- The removal of marine and nearshore habitats will be mitigated by establishing a coral nursery to develop endangered coral species for out-planting in suitable environments, mangrove restoration efforts, signage and possible propeller guards for mariners.

- Anti-erosion and flood strategies such as silt fencing, and site orientation should be incorporated in the design of the construction site.
- Preclearance surveys prior to land clearing activities to remove any observed bird nests and flag mature protected trees.
- Marine preclearance surveys prior to construction to relocate marine resources.
- The removal of terrestrial habitats will be mitigated through the preservation of habitat corridors, replanting with natives, and transplanting of rare endemic or endangered species elsewhere on the property.
- Consultation with AMMC on the observed historical features on preservation and management efforts.
- Proper site drainage and construction site orientation can reduce impacts to the water table and surrounding surface bodies of water. Once the site is elevated, the groundwater level will be deeper below the surface. Appropriate spill management will be implemented to prevent construction related accidental oil and fuel spills from percolating through the limestone to the water table.

15 Appendices

Appendix A – Approval to Purchase

DAVIS & Co. est.1973
COUNSEL & ATTORNEYS-AT-LAW
NOTARIES PUBLIC

8th May, 2023

Dr. Rhianna Neely-Murphy PhD.
Director
Department of Environmental Planning and Protection

Danielle M. Hanek Msc.
Director
Forestry Unit

Ministry of Environment and Natural Resources
Charlotte House, 1st Floor
Shirley & Charlotte Streets
Nassau, The Bahamas

Dear Dr. Neely-Murphy & Ms. Hanek:

Re: South Abaco Land Development Co. Ltd.

We act on behalf of the South Abaco Land Development Company Limited ("SALDCO"), the developers of a proposed mixed use resort development slated for South Abaco, The Bahamas.

This communication is being sent pursuant to questions raised in our client's application to obtain a Certificate of Environmental Clearance from The Department of Environmental Planning and Protection ("DEPP"). Please see our answers to the questions raised as follows: -

1. **Leeward Harbour exact acreage and conveyance:**

According to the draft purchase sale agreement relative to our client's proposed purchase of the Leeward Harbour property ("the Subject Property") from Leeward Harbour Investments Ltd. and a survey plan of the subject property prepared by land surveyor Dale Grant at the behest of Leeward Harbour Development that is dated 30th August, 2018 the Subject Property comprises some Forty-eight and Seventy-four Hundredths (48.74) acres. Our client is also in the process of negotiating the acquisition of an additional Forty-seven and Fifty-four Hundredths (47.54) acres from the Treasurer of the Bahamas to facilitate its proposed marina. Upon completion of the aforementioned acquisitions, our client's total

THE PARTHENON, 17 WEST STREET NORTH
P.O. BOX N-7940. NASSAU, BAHAMAS
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www.daviscobahamas.com
info@daviscobahamas.com

acreage for its proposed Leeward Harbour Development will be Ninety-six and Twenty-Eight Hundredths (96.28) acres. We have not yet received copies of the title documents from Leeward Harbour Investments Ltd. therefore we can not comment on the contents therein.

6. **Conveyance for Leeward Harbour:**

Our client has received approval from the Bahamas Investment Authority to purchase the Subject Property however it has not yet concluded the acquisition. As a result, there is currently no conveyance available for the same. As previously mentioned herein we have not yet received copies of the title documents relative to the Subject Property from Leeward Harbour Investments Ltd.

7. **Additional conveyance for Conch Sound Point:**

Please see the attached Conveyances for Conch Sound Point and High Bank Bay properties. The additional land at each location is under contract with closings scheduled for December 2023 and June 2024. Please also the see attached approval to purchase the aforementioned properties.

Should you have any further request or concerns, feel free to contact our Chambers.

Yours truly,
Davis & Co.

Robert M. Coakley

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APPENDIX B - THE SETAI KAKONA RESORT DEVELOPMENT MASTER PLAN

LEGEND

1. CONNECTS TO MAIN HIGHWAY
2. MAIN ENTRY ROUND ABOUT
3. HARBOURSIDE VILLAS
4. BEACH FRONT VILLAS
5. RESTAURANT
6. HARBOUR VILLAGE
7. BOUTIQUE HOTEL
8. CLUB
9. CONDO
10. MARINA MULTI-USE PLAZA
11. SIGNATUR RESTAURANT
12. ISLAND RETREAT
13. FUELING
14. DRY STACK STORAGE
15. BACK OF HOUSE / MARINE SERVICES GATED ENTRANCE
16. CENTRAL RECEIVING / BACK OF HOUSE
17. LIGHT MARINE INDUSTRIAL
18. PARKING
19. FACILITIES PLANT
20. FBO/ CUSTOMS HOUSE
21. APRON / PLANE PARKING

- A SUPER YACHTS
- B DRYSTACK & TRANSIENT DOCKS (40' to 100')
- C FUEL DOCK
- D STERN TO SLIPS (UP TO 80')
- E FLOATING DOCK SLIPS (UP TO 100')
- F FLUSHING CHANNEL
- G ENTRANCE CHANNEL

LEGEND

1. THE GRAND ANA CHAMPIONSHIP GOLF COURSE
2. RESORT HOTEL & SPA
3. LAGOON BUNGALOWS
4. PRIVATE BEACHFRONT BUNGALOWS
5. SHORT GAME ACADEMY AREA
6. ENTRY DRIVEWAY AND LANDSCAPE ST.
7. SPORTS RECREATION CENTER
8. RESORT OPERATIONS & BOH
9. ENTRY LANDSCAPE
10. RESORT RESIDENTIAL
11. GOLF & BEACH CLUB
12. TOWN CENTER
13. PAVILION & WATCH TOWER
14. WELLNESS RETREAT
15. EXSITING RUINS

03.05.2021

KAKONA

HIGH BANK BAY ILLUSTRATIVE PLAN

SCALE: 1”=200’-0”

0 50’ 100’ 200’ 400’ 800’

KAKONA

BLUR WORK SHOP

HKS edsa

*adapted masterplan illustration from original content developed by HKS & EDSA

LEGEND

1. ENTRY DRIVEWAY AND LANDSCAPE STATEMENT
2. LODGE
3. BEACH
4. GRAND LAWN
5. GRAND BAR
6. PRACTICE & SIGNATURE PUTTING AREA
7. OCEAN FRONT ESTATES
8. HILL TOP ESTATES
9. PRESERVE VIEW ESTATES
10. FRESH WATER LAGOON
11. PRESERVE TRAILS
12. FLUSHING CHANNEL
13. SALT WATER LAGOON
14. COTTAGE
15. BUNGALOW
16. CLUB
17. ESTATE LAGOON RETREAT, POOL, LAZY RIVER, DOCK, EVENT PAVILION
18. FORMAL LAWN
19. EVENT LAWNS & MULTI-PURPOSE FIELDS
20. BOTANICAL GARDENS RETREAT
21. ENTRY GUARD HOUSE & SIGNATURE BRIDGE
22. ESTATE VILLAGE
23. TOWNHOUSES
24. TOWN PLAZA, LAWN, CLUBHOUSE, POOL, RESTAURANT
25. DAY CARE FACILITY
26. BOH , NURSERY, FACILITY MANAGEMENT

03.05.2021

KAKONA

CONCH SOUND POINT ILLUSTRATIVE PLAN

SCALE: 1”=200’-0”

0 50’ 100’ 200’ 400’ 800’

KAKONA

BLUR WORK SHOP

HKS edsa

*adapted masterplan illustration from original content developed by HKS & EDSA

APPENDIX C – PROJECT PHASING

SETAI RESIDENCE CLUB

PHASE ONE

LEGEND

1. ENTRY DRIVEWAY AND LANDSCAPE STATEMENT
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Revised 11.10.21

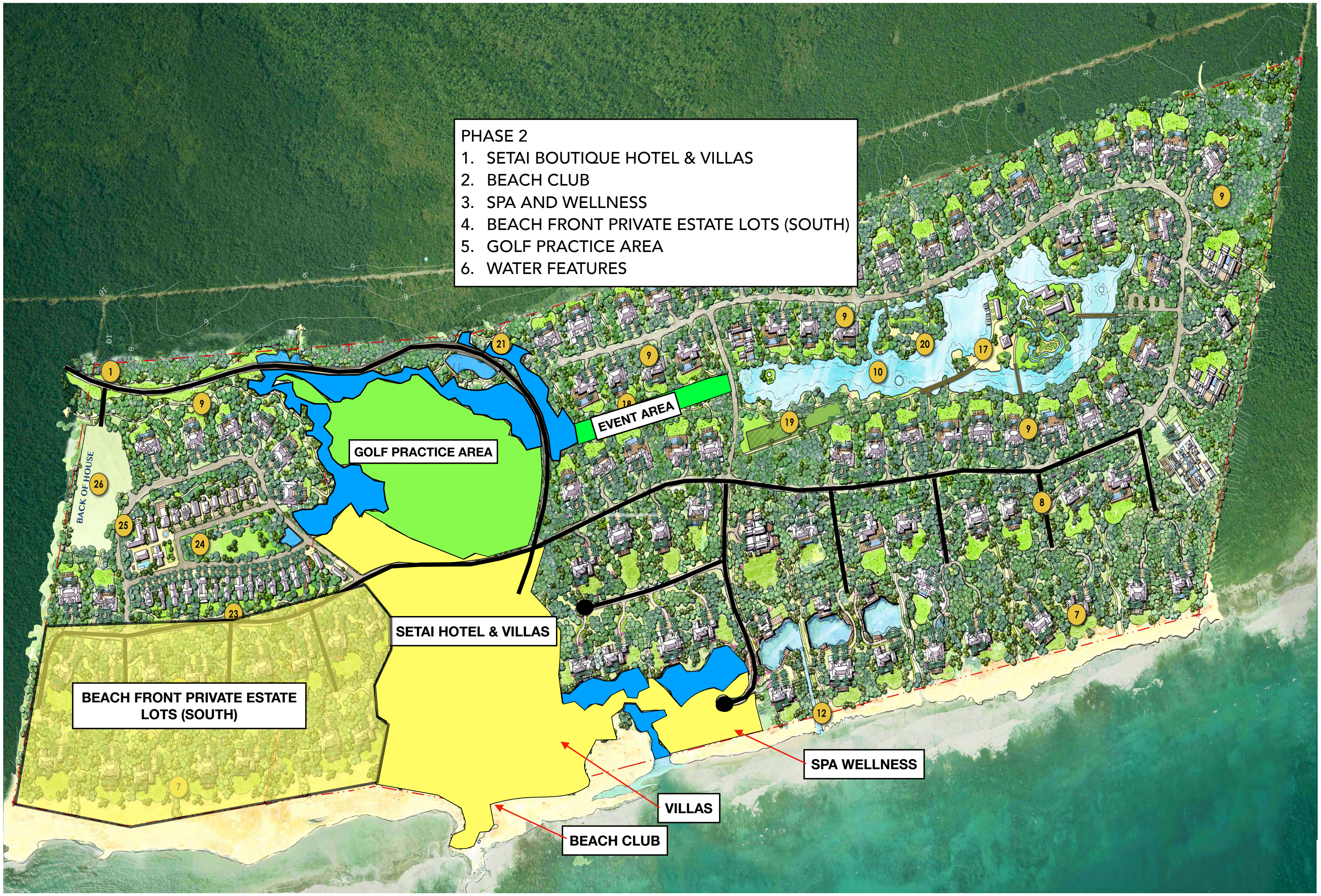
KAKONA

CONCH SOUND POINT ILLUSTRATIVE PLAN

SCALE: 1"=200'-0"
0 50' 100' 200' 400' 800'

SETAI RESIDENCE CLUB

PHASE TWO



LEGEND

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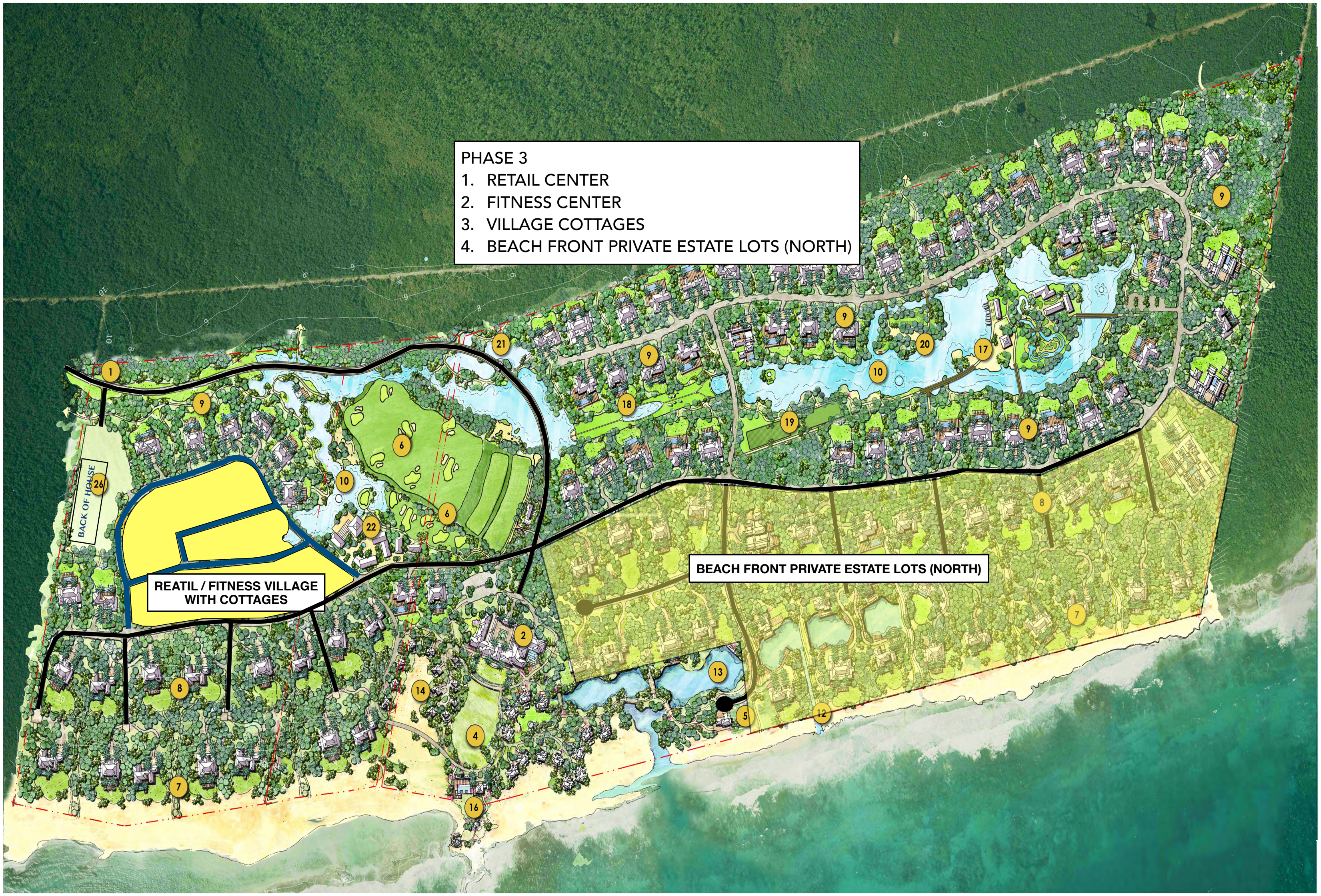
26. BOH , NURSERY, FACILITY MANAGEMENT

Revised 11.10.21

SETAI RESIDENCE CLUB

PHASE THREE



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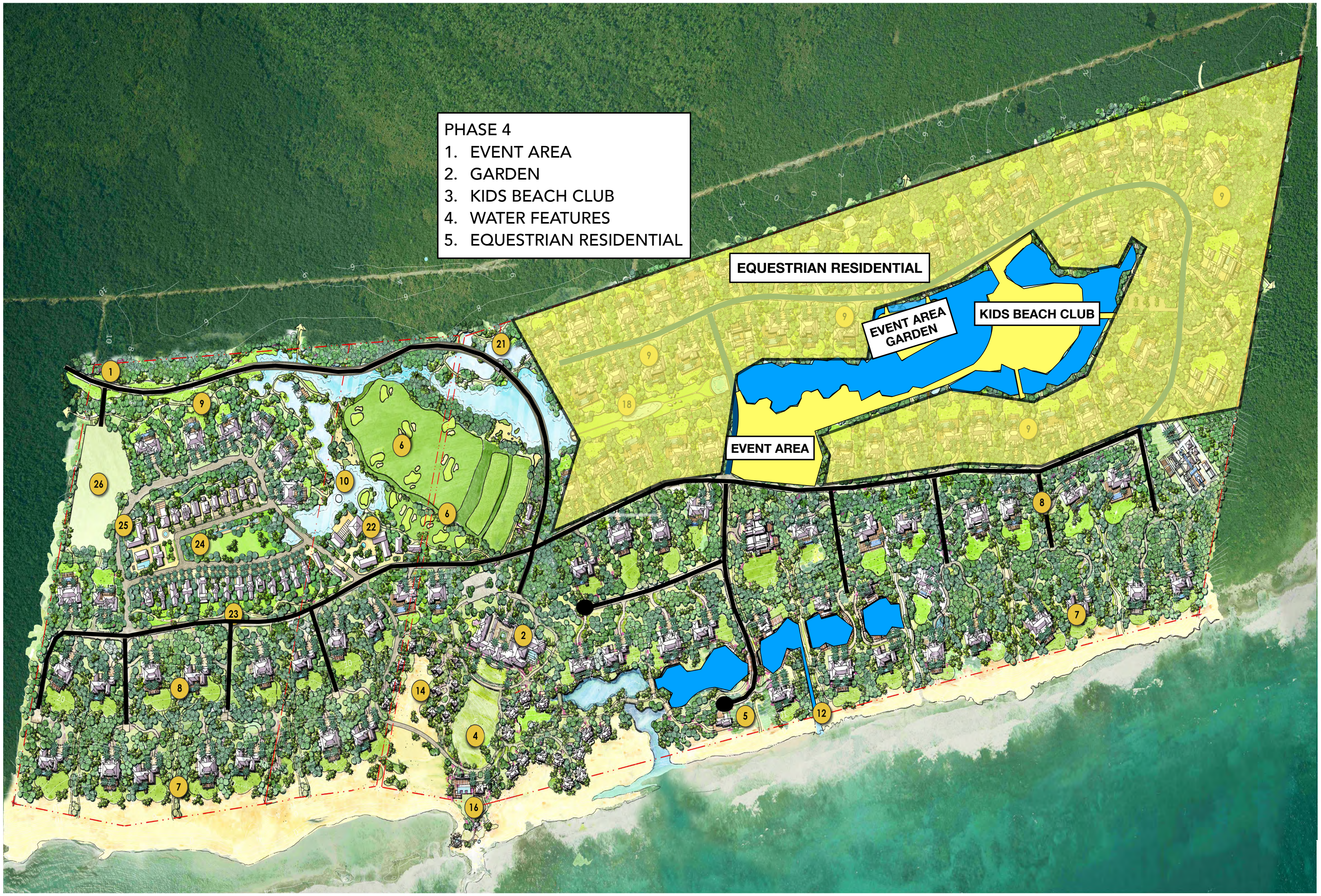
SETAI RESIDENCE CLUB

PHASE FOUR



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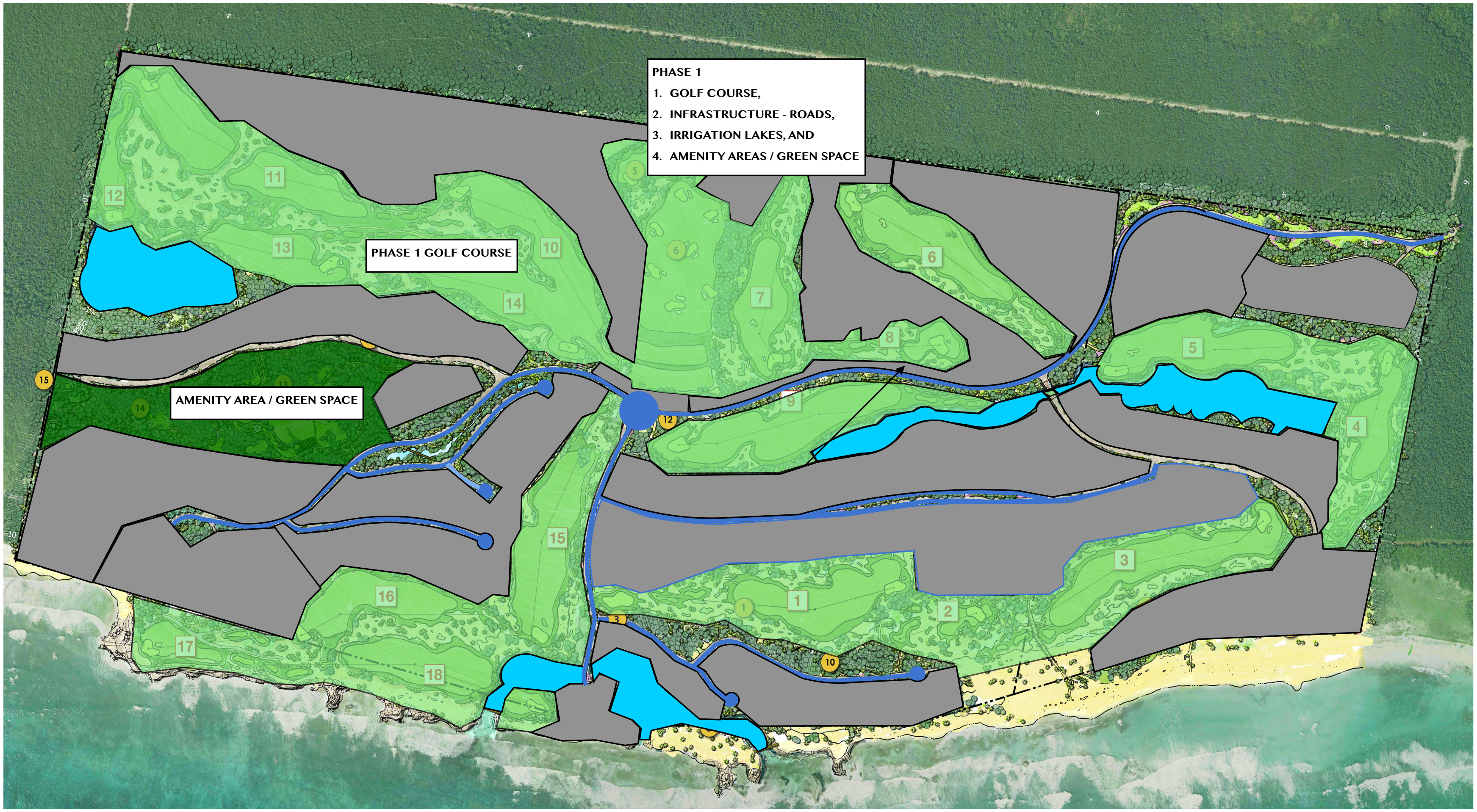
Revised 11.10.21

SETAI SPORTING CLUB

PHASE ONE



LEGEND

1. THE GRAND ANA CHAMPIONSHIP GOLF COURSE
2. RESORT HOTEL & SPA
3. LAGOON BUNGALOWS
4. PRIVATE BEACHFRONT BUNGALOWS
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14. WELLNESS RETREAT
15. EXSITING RUINS

Revised 11.10.21

KAKONA

HIGH BANK BAY ILLUSTRATIVE PLAN

SCALE: 1"=200'-0"
0 50' 100' 200' 400' 800'

SETAI SPORTING CLUB

PHASE TWO

LEGEND

1. THE GRAND ANA CHAMPIONSHIP GOLF COURSE
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SETAI SPORTING CLUB

PHASE THREE

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*adapted masterplan illustration from original content developed by HKS & EDSA

SETAI SPORTING CLUB

PHASE FOUR

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Revised 11.10.21

SETAI SPORTING CLUB

PHASE FIVE

LEGEND

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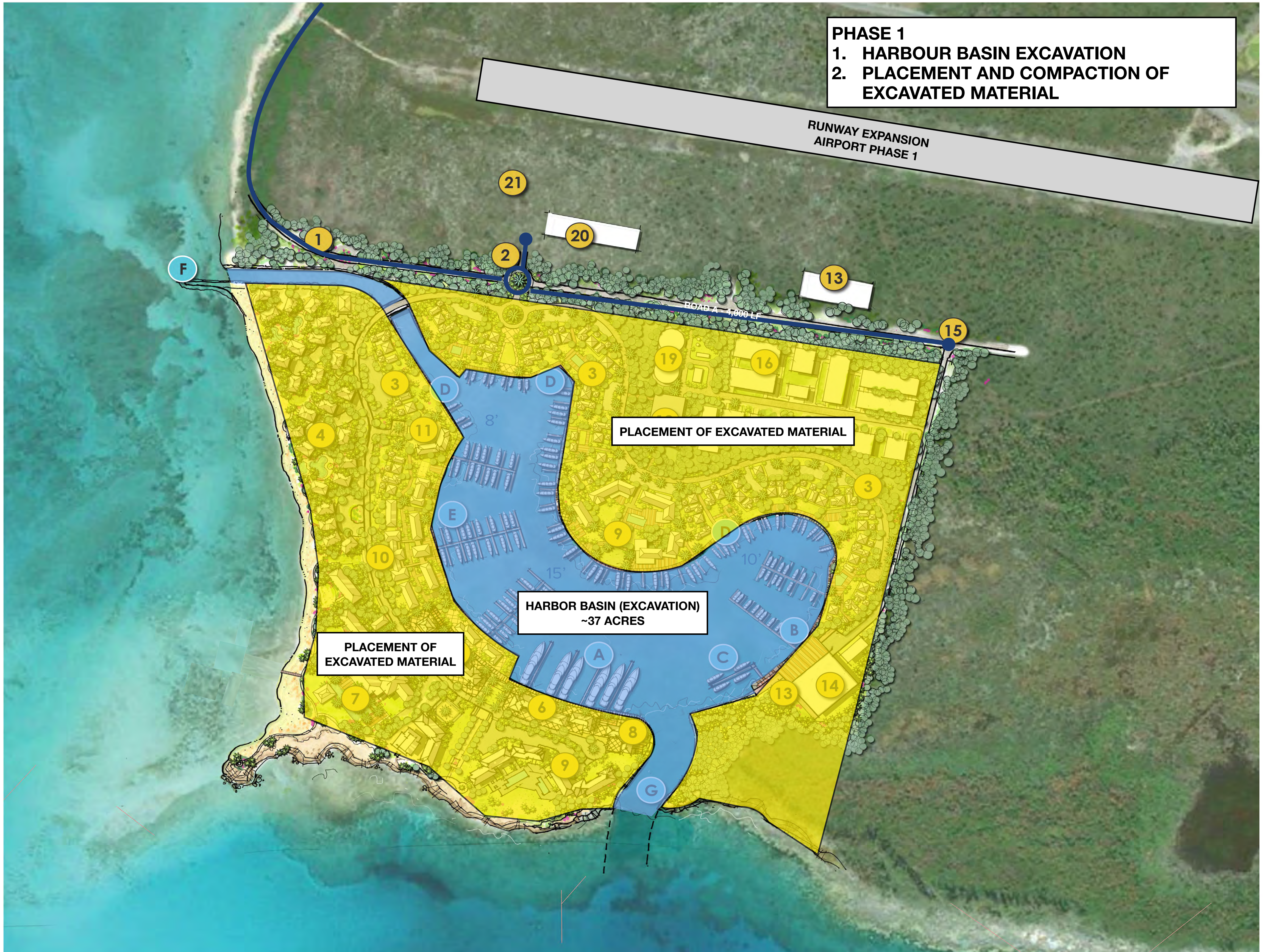
Revised 11.10.21

SETAI HARBOR CLUB

PHASE ONE



LEGEND

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- A SUPER YACHTS
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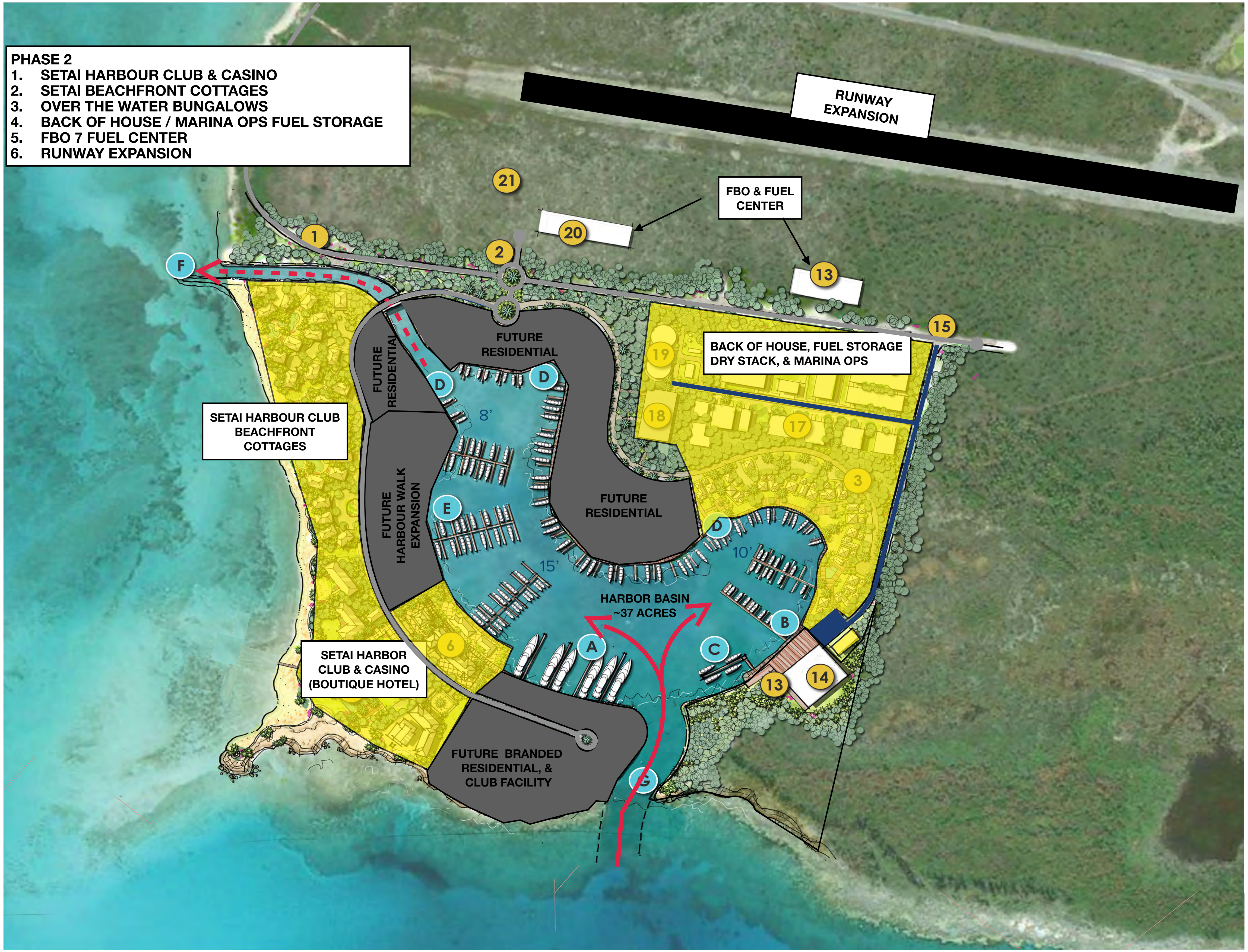
- C FUEL DOCK
- D STERN TO SLIPS (UP TO 80')
- E FLOATING DOCK SLIPS (UP TO 100')
- F FLUSHING CHANNEL
- G ENTRANCE CHANNEL

Revised 11.10.21



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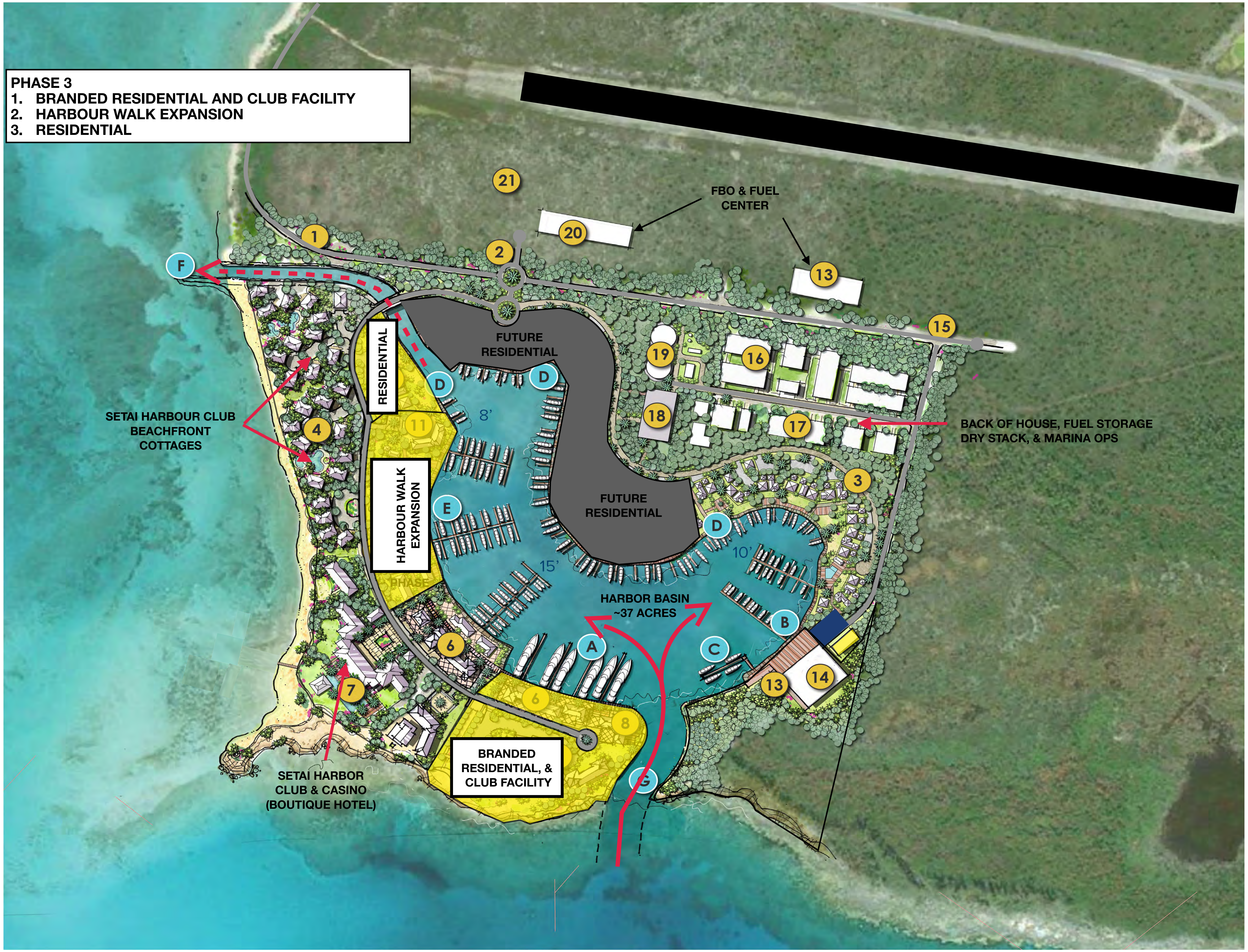
PHASE TWO

Revised 11.10.21

SCALE: 1"=200'-0"
0 50' 100' 200' 400' 800'

LEEWARD HARBOR

PHASE THREE



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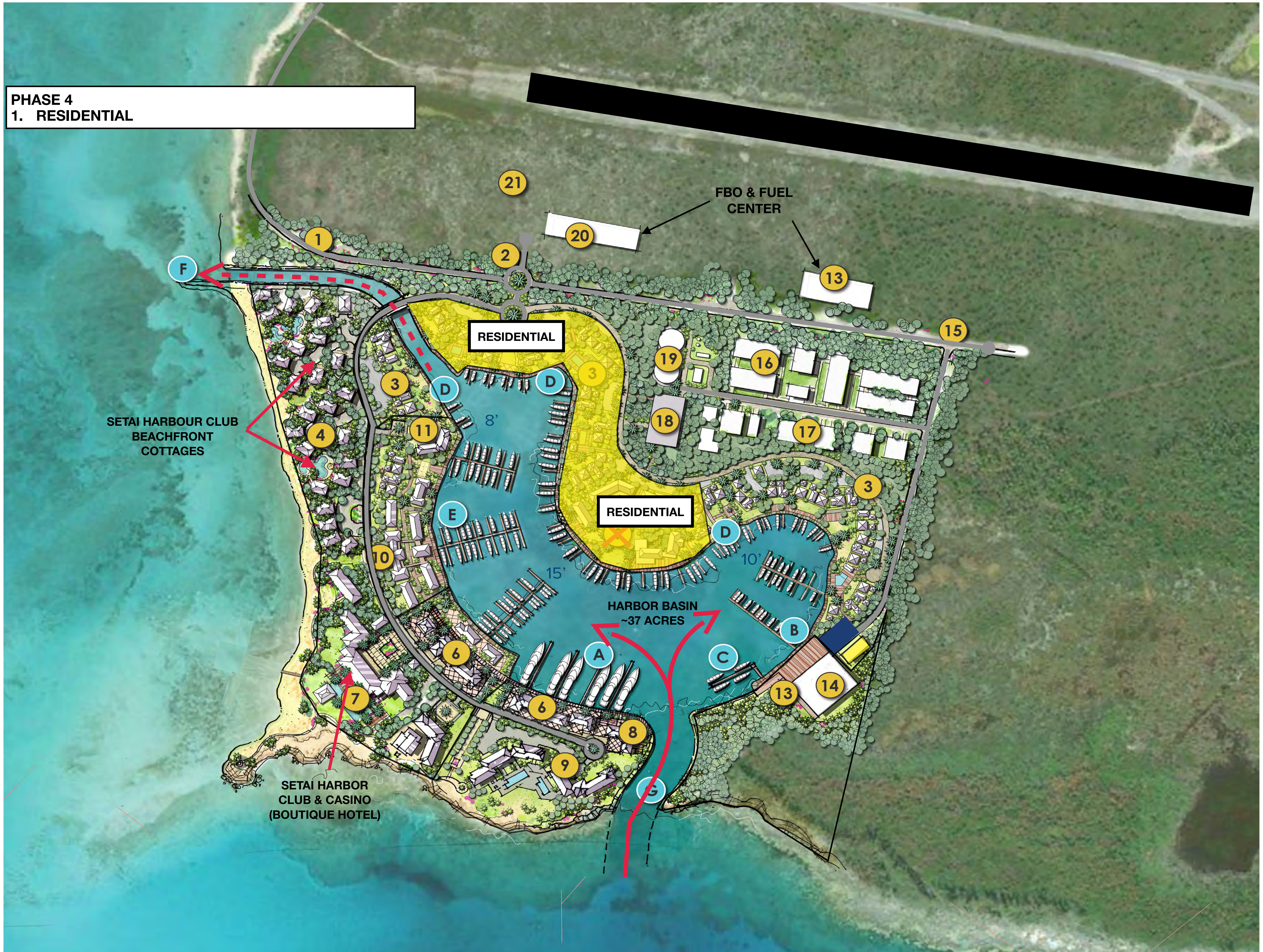
Revised 11.10.21

LEEWARD HARBOR



PHASE FOUR

LEGEND

1. CONNECTS TO MAIN HIGHWAY
2. MAIN ENTRY ROUND ABOUT
3. HARBOURSIDE VILLAS
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APPENDIX D - WATER AND WASTEWATER DEMAND ESTIMATES

THE SETAI SPORTING CLUB

FINANCIAL MODEL

WATER & WASTEWATER DEMAND MATRIX

Flow Projection Assumptions	Units		Units
Real Estate	300 gpd	Employees	20 gpd/employee
Retail Space	100 gpd/1000sf	Public Restroom	200 gpd
Hotel Rooms	350 gpd	Residential Use	100 gpd/bed
Hotel Villas	200 gpd	BOD_5 Waste Strength for Domestic Waste	275 mg/l
Restaurants	30 gpd/seat	BOD_5 Waste Strength for Restaurants	400 mg/l
Restaurant safety factor	25.00%	BOD_5 Waste Strength for Marina Ops	400 mg/l
Spa, Tennis Center, Golf Center	50 gpd/person	Marina Pump Out, Avg	100 gpd/slip

Description	Qty		SF	Total Area	Seats	Factor (gpd)	Flow	Waste Strength BOD_5 (mg/l)	Waste Strength BOD_5 (lb/day)
REAL ESTATE									
Estate Homes	116.00	ea				300 gpd	34,800.00	275.00	79.81
THE SPORTING CLUB			Bedrooms						
Club Cottages	60.00	ea	2.00			300 gpd	18,000.00	275.00	41.28
Club Service Area			Area (sf)						
Entry & Reception	1.00	ls	2,000			100 gpd	200.00	400.00	0.67
Administration	1.00	ls	1,000			100 gpd	100.00	275.00	0.23
Restaurant / Boutique / Lounge / Library	1.00	ls	10,000		100.00	30 gpd	3,750.00	400.00	12.51
Wine Cellar	1.00	ls	2,500		25.00	30 gpd	937.50	400.00	3.13
Pool Bar	1.00	ls	2,000		50.00	30 gpd	1,875.00	400.00	6.26
Kitchen	1.00	ls	3,000		-	100 gpd	1,640.63	400.00	5.47
gaming Area	1.00	ls	10,000			100 gpd	1,000.00	275.00	2.29
Salas, Palapa, Pavillions	1.00	ls	8,500			100 gpd	850.00	275.00	1.95
Beach Bar & Grill	1.00	ls	2,000		50.00	30 gpd	1,875.00	400.00	6.26
Central Housekeeping	1.00	ls	920			100 gpd	92.00	400.00	0.31
MEP, Maintenance & Service Facilities	1.00	ls	1,740			100 gpd	174.00	275.00	0.40
Recreation facilities restrooms	1.00	ls	280			200 gpd	200.00	275.00	0.46

THE SETAI SPORTING CLUB

FINANCIAL MODEL

Description	Qty			SF	Total Area	Seats	Factor (gpd)	Flow	Waste Strength BOD_5 (mg/l)	BOD_5 (lb/day)
Clubs										
Beach Club	1	ls		1,000.00		100.00	30 gpd	3,000.00	275.00	6.88
Beach Club Restrooms	4	ls					200 gpd	800.00	275.00	1.83
Kids Beach Club	1	ls		1,000.00		80.00	30 gpd	2,400.00	275.00	5.50
Kids Beach Club Restrooms	4	ls		0.00		-	200 gpd	800.00	275.00	0.92
Tennis and Racquet Club House	-	ls		0.00		-	100 gpd	-	275.00	-
Racquet Club Restaurant	-	ls		0.00		-	30 gpd	-	400.00	-
Racquet Club Public Restrooms	-	ls		0.00		-	200 gpd	-	275.00	-
Racquet Club Locker Rooms	-	ls		0.00		-	50 gpd	-	275.00	-
Founders Club	-	ls		0.00		-	30 gpd	-	400.00	-
Founders Club Restrooms	-	ls		0.00		-	200 gpd	-	275.00	-
Yacht Club	-	ls		0.00		-	30 gpd	-	400.00	-
Yacht Club Restrooms	-	ls		0.00		-	200 gpd	-	275.00	-
Utility										
Utility Operations Restroom			4.00	ea			200 gpd	800.00	275.00	1.83
Back of House			4.00	ea			200 gpd	800.00	275.00	1.83
Back of House Hotel Laundry	15.00		900.00	lb/day						
Spa	15.00		-	lb/day						
			900.00				3.00 gal/lb	2,700.00	275.00	6.19
CSP Employees			125.00	ea			20 gpd/employee	2,500.00	275.00	5.73
						SubTotal		**79,294.13**	**Total BOD_5 (lb/day)**	**191.75**
									Total BOD_5 (mg/l)	**289.97**

Estimated High Bank Bay Water Demand	Surface Area (sf)	gal lost / day /sf	Qty					
Demand Matrix - Domestic Waste Water						79,294	10%	87,223.54
Pool Evaporation - Hotel	100,000 sf	0.0779				7,790		
Pool Evaporation - Private Homes	600 sf	0.0779	116.00			5,422		
Pool Evaporation - Hotel Cottages	600 sf	0.0779	30.00			1,402		
Water Capacity - Calculated						93,908		
Golf Course Irrigation	400 gpm	6.00 hr/day	144,000 gpd			144,000		
						237,908.17		
				Safety Factor	**10.00%**	23,790.82		
				Resort Wastewater Capacity (Est.) & Reuse Availability		**261,698.98**		

THE SETAI HARBOR CLUB

FINANCIAL MODEL

WATER & WASTEWATER DEMAND MATRIX

Flow Projection Assumptions	Units		Units
Real Estate	300 gpd	Employees	20 gpd/employee
Retail Space	100 gpd/1000sf	Public Restroom	200 gpd
Hotel Rooms	350 gpd	Residential Use	100 gpd/bed
Hotel Villas	200 gpd	BOD_5 Waste Strength for Domestic Waste	275 mg/l
Restaurants	30 gpd/seat	BOD_5 Waste Strength for Restaurants	400 mg/l
Restaurant safety factor	25.00%	BOD_5 Waste Strength for Marina Ops	400 mg/l
Spa, Tennis Center, Golf Center	50 gpd/person	Marina Pump Out, Avg	100 gpd/slip

Description	Qty		SF	Total Area	Seats	Factor (gpd)	Flow	Waste Strength BOD_5 (mg/l)	Waste Strength BOD_5 (lb/day)
REAL ESTATE									
Harbor Front Homes	75.00	ea				300 gpd	22,500.00	275.00	51.60
THE HARBOR CLUB			Bedrooms						
Villas & Cottages	25.00	ea	2.00			300 gpd	7,500.00	275.00	17.20
Harbor Club Service Area			Area (sf)						
Entry & Reception	1.00	ls	2,000			100 gpd	200.00	400.00	0.67
Administration	1.00	ls	1,000			100 gpd	100.00	275.00	0.23
Hotel Restaurant / Boutique / Lounge / Library	1.00	ls	6,000		100.00	30 gpd	3,750.00	400.00	12.51
Roof Terrace Bar	1.00	ls	4,000		50.00	30 gpd	1,875.00	400.00	6.26
Wine Cellar	1.00	ls	0		25.00	30 gpd	937.50	400.00	3.13
Pool Bar	1.00	ls	0		50.00	30 gpd	1,875.00	400.00	6.26
Kitchen	1.00	ls	3,000		-	100 gpd	2,109.38	400.00	7.04
Salas, Palapa, Pavillions	1.00	ls	0			100 gpd	-	275.00	-
Beach Bar & Grill	1.00	ls	3,000		50.00	30 gpd	1,875.00	400.00	6.26
Spa | Wellness	1.00	ls	7,000			100 gpd	700.00	400.00	2.34
Spa Wellness Locker Rooms	1.00	ls	3,000		100.00	50 gpd	5,000.00	275.00	11.47
Central Housekeeping	1.00	ls	920			100 gpd	92.00	400.00	0.31
MEP, Maintenance & Service Facilities	1.00	ls	1,740			100 gpd	174.00	275.00	0.40
Recreation facilities restrooms	1.00	ls	280			200 gpd	200.00	275.00	0.46

THE SETAI HARBOR CLUB

FINANCIAL MODEL

Description	Qty			SF	Total Area	Seats	Factor (gpd)	Flow	Waste Strength BOD$_5$ (mg/l)	BOD$_5$ (lb/day)
Retail										
Grocery Store / Fresh Market	1.00	ls		5,000.00		-	100 gpd	500.00	400.00	1.67
Coffee Shop	1.00	ls		500.00		-	200 gpd	200.00	275.00	0.46
Ice Cream Shop	1.00	ls		500.00		-	100 gpd	50.00	400.00	0.17
Pizza	1.00	ls		1,000.00		-	200 gpd	200.00	275.00	0.92
Italian Restaurant	1.00	ls		1,000.00		25.00	30 gpd	30.00	400.00	0.10
Bahamian Restaurant	1.00	ls		1,000.00		25.00	30 gpd	30.00	400.00	0.10
Fish & Taco Restaurant	1.00	ls		1,000.00		25.00	30 gpd	30.00	275.00	0.07
Ships Chandlary (Marine Supplies)	1.00	ls		1,000.00		-	50 gpd	-	275.00	-
Outdoor Courtyard / Terraces for Retail	1.00	ls		5,000.00		-	100 gpd	500.00	400.00	1.67
Harbor Master - Conditioned	1.00	ls		1,000.00		-	100 gpd	100.00	400.00	0.33
Harbor Master - Terrace	1.00			500.00		-	100 gpd	50.00	400.00	0.17
Customs and Immigration - Conditioned	1.00			1,000.00		-	100 gpd	100.00	400.00	0.33
Customs and Immigration - Terrace	1.00			500.00		-	100 gpd	50.00	400.00	0.17
Office Space - Conditioned	1.00			5,000.00		-	100 gpd	500.00	400.00	1.67
Office Space - Terrace	1.00			2,500.00		-	100 gpd	250.00	400.00	0.83
Loft Residences - Conditioned	1.00			6,000.00		-	100 gpd	600.00	400.00	2.00
Yacht Club	1.00	ls		1,500.00		25.00	30 gpd	45.00	400.00	0.15
Yacht Club Restrooms	1.00	ls		500.00		-	200 gpd	200.00	275.00	0.46
Utility										
Utility Operations Restroom			4.00	ea			200 gpd	800.00	275.00	1.83
Back of House			4.00	ea			200 gpd	800.00	275.00	1.83
Back of House Hotel Laundry	15.00		375.00	lb/day						
Spa	15.00		1,500.00	lb/day						
			1,875.00				3.00 gal/lb	5,625.00	275.00	12.90
Employees			125.00	ea			20 gpd/employee	2,500.00	275.00	5.73
						SubTotal		**62,048**	**Total BOD$_5$ (lb/day)**	**159.67**
									Total BOD$_5$ (mg/l)	**308.57**

SALDCO

Created: 06/10/18

Revised - July 2019

Modified 6/25/23 2:47 PM

Estimated Conch Sound Point Water Demand	Surface Area (sf)	gal lost / day /sf		Qty				
Demand Matrix - Domestic Waste Water						62,048	10%	68,252.66
Pool Evaporation - Hotel	100,000 sf		0.0779			7,790		
Pool Evaporation - Private Homes	600 sf		0.0779	75.00		3,506		
Pool Evaporation - Hotel Cottages	600 sf		0.0779	50.00		2,337		
Water Capacity - Calculated						75,680		
Golf Course Irrigation	400 gpm	.00 hr/day		gpd		-		
						75,680.38		
				Safety Factor	**10.00%**	7,568.04		
				Resort Wastewater Capacity (Est.) & Reuse Availability		**83,248**		

THE SETAI RESIDENCE CLUB

FINANCIAL MODEL

CONCH SOUND POINT - WATER & WASTEWATER DEMAND MATRIX

Flow Projection Assumptions	Units		Units
Real Estate	300 gpd	Employees	20 gpd/employee
Retail Space	100 gpd/1000sf	Public Restroom	200 gpd
Hotel Rooms	350 gpd	Residential Use	100 gpd/bed
Hotel Villas	200 gpd	BOD_5 Waste Strength for Domestic Waste	275 mg/l
Restaurants	30 gpd/seat	BOD_5 Waste Strength for Restaurants	400 mg/l
Restaurant safety factor	25.00%	BOD_5 Waste Strength for Marina Ops	400 mg/l
Spa, Tennis Center, Golf Center	50 gpd/person	Marina Pump Out, Avg	100 gpd/slip

Description	Qty		SF	Total Area	Seats	Factor (gpd)	Flow	Waste Strength BOD_5 (mg/l)	BOD_5 (lb/day)
REAL ESTATE									
Estate Homes	58.00	ea				300 gpd	17,400.00	275.00	39.91
THE HOTEL			Bedrooms						
Villas	24.00	ea	2.00			300 gpd	7,200.00	275.00	16.51
Hotel Service Area			Area (sf)						
Entry & Reception	1.00	ls	2,000			100 gpd	200.00	400.00	0.67
Administration	1.00	ls	1,000			100 gpd	100.00	275.00	0.23
Hotel Restaurant / Boutique / Lounge / Library	1.00	ls	10,000		100.00	30 gpd	3,750.00	400.00	12.51
Japanese Restaurant	1.00	ls	2,500		50.00	30 gpd	1,875.00	400.00	6.26
Wine Cellar	1.00	ls	2,500		25.00	30 gpd	937.50	400.00	3.13
Pool Bar	1.00	ls	2,000		50.00	30 gpd	1,875.00	400.00	6.26
Kitchen	1.00	ls	3,000		-	100 gpd	2,109.38	400.00	7.04
Salas, Palapa, Pavillions	1.00	ls	8,500			100 gpd	850.00	275.00	1.95
Beach Bar & Grill	1.00	ls	2,000		50.00	30 gpd	1,875.00	400.00	6.26
Spa | Wellness	1.00	ls	21,000			100 gpd	2,100.00	400.00	7.01
Spa Wellness Locker Rooms	1.00	ls	3,000		100.00	50 gpd	5,000.00	275.00	11.47
Central Housekeeping	1.00	ls	920			100 gpd	92.00	400.00	0.31
MEP, Maintenance & Service Facilities	1.00	ls	1,740			100 gpd	174.00	275.00	0.40
Recreation facilities restrooms	1.00	ls	280			200 gpd	200.00	275.00	0.46

THE SETAI RESIDENCE CLUB

FINANCIAL MODEL

Description	Qty		SF	Total Area	Seats	Factor (gpd)	Flow	Waste Strength BOD$_5$ (mg/l)	BOD$_5$ (lb/day)
Clubs									
Beach Club	1	ls	1,000.00		100.00	30 gpd	3,000.00	275.00	6.88
Beach Club Restrooms	4	ls				200 gpd	800.00	275.00	1.83
Kids Beach Club	1	ls	1,000.00		80.00	30 gpd	2,400.00	275.00	5.50
Kids Beach Club Restrooms	4	ls	0.00		-	200 gpd	800.00	275.00	0.92
Tennis and Racquet Club House	-	ls	0.00		-	100 gpd	-	275.00	-
Racquet Club Restaurant	-	ls	0.00		-	30 gpd	-	400.00	-
Racquet Club Public Restrooms	-	ls	0.00		-	200 gpd	-	275.00	-
Racquet Club Locker Rooms	-	ls	0.00		-	50 gpd	-	275.00	-
Founders Club	-	ls	0.00		-	30 gpd	-	400.00	-
Founders Club Restrooms	-	ls	0.00		-	200 gpd	-	275.00	-
Yacht Club	-	ls	0.00		-	30 gpd	-	400.00	-
Yacht Club Restrooms	-	ls	0.00		-	200 gpd	-	275.00	-
Utility									
Utility Operations Restroom			4.00	ea		200 gpd	800.00	275.00	1.83
Back of House			4.00	ea		200 gpd	800.00	275.00	1.83
Back of House Hotel Laundry	15.00		360.00	lb/day					
Spa	15.00		1,500.00	lb/day					
			1,860.00			3.00 gal/lb	5,580.00	275.00	12.80
CSP Employees			125.00	ea		20 gpd/employee	2,500.00	275.00	5.73
					SubTotal		**62,417.88**	**Total BOD$_5$ (lb/day)**	**157.68**
								Total BOD$_5$ (mg/l)	**302.91**

Estimated Conch Sound Point Water Demand	Surface Area (sf)	gal lost / day /sf	Qty				
Demand Matrix - Domestic Waste Water					62,418	10%	68,659.66
Pool Evaporation - Hotel	100,000 sf	0.0779			7,790		
Pool Evaporation - Private Homes	600 sf	0.0779	58.00		2,711		
Pool Evaporation - Hotel Cottages	600 sf	0.0779	25.00		1,169		
Water Capacity - Calculated					74,087		
Golf Course Irrigation	400 gpm	.00 hr/day	gpd		-		
					74,087.30		
			Safety Factor	**10.00%**	7,408.73		
			Resort Wastewater Capacity (Est.) & Reuse Availability		**81,496.02**		

APPENDIX E - ELECTRICAL DEMAND ESTIMATES

ELECTRICAL DEMAND MATRIX

Power Assumptions

				kWh/sf
Industrial				28.12
Residential			75.00%	21.09
Commercial			85.00%	23.90
Restaurants			90.00%	25.31

Hours / Year	8,760
kWh / MW	1,000
Peak factor	1.25
Occupancy | Solar Power Adjustment	80.00%

CONCH SOUND POINT	No. of Units	Keys / Unit	No. of Keys	SF		Total SF	Energy Factor kWh/sf	Annual Energy kWh's	Alternative Thermal Savings	Annual Net Energy kWh's	Average Capacity MW	Peak Capacity MW
SPORTING CLUB												
Club Cottages	60.00	1.00	60.00	1,000		60,000	21.09	1,265,400	10%	1,138,860	0.1300	0.1625
Total Lodge Accomodations	**60.00**					**60,000**		**1,265,400**		**1,138,860**	**0.1300**	**0.1625**
Sporting Club Public Areas and BOH												
Club Support Areas	1.00	1.00	1.00	5,500		5,500	23.90	131,461	10%	118,315	0.0135	0.0169
Reception and Great Room	1.00	1.00	1.00	2,000		2,000	23.90	47,804	10%	43,024	0.0049	0.0061
Amenity Areas	1.00	1.00	1.00	57,500		57,500	23.90	1,374,365	10%	1,236,929	0.1412	0.1765
Management Offices	1.00	1.00	1.00	1,000		1,000	23.90	23,902	10%	21,512	0.0025	0.0031
Food & Beverage Areas	1.00	1.00	1.00	10,000		10,000	25.31	253,080	10%	227,772	0.0260	0.0325
The Spa, Fitness and Movement Studio	-	1.00	-	0		-	23.90	-	10%	-	-	-
Central Housekeeping & Laundry	1.00	1.00	1.00	920		920	23.90	21,990	10%	19,791	0.0023	0.0028
MEP, Maintenance & Service Areas	1.00	1.00	1.00	1,740		1,740	28.12	48,929	10%	44,036	0.0050	0.0063
Recreation Areas	1.00	1.00	1.00	100,000		100,000	23.90	2,390,200	10%	2,151,180	0.2456	0.3070
Total Lodge Public Areas and BOH						**178,660**		**4,291,731**		**3,862,558**	**0.4409**	**0.5512**
Residential												
Estate Homes - Tier 1	10.00	1.00	10.00	10,000	20.00%	120,000	21.09	2,530,800	10%	2,277,720	0.2600	0.3250
Estate Homes - Tier 2	13.00	1.00	13.00	10,000	20.00%	156,000	21.09	3,290,040	10%	2,961,036	0.3380	0.4225
Estate Homes - Tier 3	25.00	1.00	25.00	10,000	20.00%	300,000	21.09	6,327,000	10%	5,694,300	0.6500	0.8125
Estate Homes - Preserve	58.00	2.00	116.00	10,001	20.00%	1,392,139	21.09	29,360,216	10%	26,424,194	3.0165	3.7706
Estate Homes - Beachfront Enclave	10.00	3.00	30.00	10,002	20.00%	360,072	21.09	7,593,918	10%	6,834,527	0.7802	0.9752
Total Residential	**116.00**					**576,000**		**12,147,840**		**10,933,056**	**1.248**	**1.560**

Staff & Crew Residences	10.00	1.00	10.00	1000	0.00%	10,000	21.09	210,900	10%	189,810	0.0217	0.0271
Total Staff & Crew Residential	**10.00**					**10,000.00**		**210,900.00**		**189,810.00**	**0.0217**	**0.0271**
Golf Course Pumping	**Stations**		**HP**	**Run Time (hrs/day)**			**kW**	**kWh**				
Pumping Stations	4.00		150.00	6.00			100.00	876,000	0.00%	876,000	0.1000	0.1250
Utilities	**No. of Units**			**SF/pool**		**Total SF**	**Energy Factor kWh/sf**	**Annual Energy kWh's**	**Alternative Thermal Savings**	**Annual Net Energy kWh's**	**Average Capacity MW**	**Peak Capacity MW**
Pools | Spas Pumping												
Cottages	60.00			2500	20.00%	180,000	0.367	66,060	10%	59,454	0.0068	0.0085
Sporting Club	1.00			5000	20.00%	6,000	0.367	2,202	10%	1,982	0.0002	0.0003
Private Residences (Plunge Pool)	108.00			1500	20.00%	194,400	0.367	71,345	10%	64,210	0.0073	0.0092
						380,400	0.367	139,607	10%	125,646	0.0143	0.0179
			Total Golf Carts				**Energy Factor kWh/unit**	**Annual Energy kWh's**	**Alternative Thermal Savings**	**Annual Net Energy kWh's**	**Average Capacity MW**	**Peak Capacity MW**
Golf Cart Charging Allocation			339.00				13.20	31,359,398	60%	12,543,759	1.4319	1.7899
Back of House		lb/rm	lb/day	lbs/ld	lds	kWh/ld	kWh					
Laundry		7.50	600.00	30.00	20.00	4.50	90.00	32,850	10.00%	29,565.00	0.0034	0.0042
Resort Utilities												
Common Area Lighting			500			60		131,400	10%	118,260	0.0270	0.0338
TOTAL ESTIMATED CAPACITY REQUIREMENT								**50,455,126**		**29,817,514**	**3.4173**	**4.2717**

2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036

THE SETAI SPORTING CLUB

FINANCIAL MODEL

ELECTRIC MATRIX

Phasing Demand Matrix		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Residential		kW--->														
Estate Homes	.0241 MW	-	-	-	-	-	-	48.19	168.66	409.59	554.16	457.78	457.78	385.50	313.22	-
Hotel Cottages	.0081 MW	-	-	-	-	40.37	80.73	80.73	-	-	-	-	-	-	-	-
The Setai Sporting Club	.9971 MW	-	-	-	-	-	997.11	-	-	-	-	-	-	-	-	-
Residential Staff and Crew	.0271 MW	-	-	-	-	-	27.08	-	-	-	-	-	-	-	-	-
Common Area Lighting	.0338 MW	-	-	-	-	-	33.75	-	-	-	-	-	-	-	-	-
Pumping Stations	.1250 MW	-	-	-	125.00	-	-	-	-	-	-	-	-	-	-	-
Misc.	.0000 MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ESTIMATED CAPACITY (KW) REQUIRED PER YEAR		-	-	-	125.00	40.37	1,138.68	128.92	168.66	409.59	554.16	457.78	457.78	385.50	313.22	-
CUMULATIVE BASE CAPACITY (DEMAND)		-	-	-	*125.00*	*165.37*	*1,304.04*	*1,432.96*	*1,601.62*	*2,011.22*	*2,565.37*	*3,023.16*	*3,023.16*	*3,023.16*	*3,023.16*	*3,023.16*
INSTALLATION SCHEDULE (Flex Energy)		-	-	-	250.00	250.00	1,500.00	500.00	500.00	500.00	750.00	-	-	-		
CUMULATIVE INSTALLED CAPACITY		-	-	-	*250.00*	*500.00*	*2,000.00*	*2,500.00*	*3,000.00*	*3,500.00*	*4,250.00*	*4,250.00*	*4,250.00*	*4,250.00*	*4,250.00*	*4,250.00*
# OF FLEXENERGY UNITS REQUIRED			0	-	0.19	0.37	1.50	1.87	2.25	2.62	3.19	3.19	3.19	3.19	3.19	3.19
				PHASE 2		PHASE 3		PHASE 4		PHASE 5						

THE SETAI HARBOR CLUB

FINANCIAL MODEL

ELECTRICAL DEMAND MATRIX

Power Assumptions				kWh/sf
Industrial				28.12
Residential			75.00%	21.09
Commercial			85.00%	23.90
Restaurants			90.00%	25.31

Hours / Year	8,760
kWh / MW	1,000
Peak factor	1.25
Occupancy | Solar Power Adjustment	80.00%

Leeward Harbor	No. of Units	Keys / Unit	No. of Keys	SF		Total SF	Energy Factor kWh/sf	Annual Energy kWh's	Alternative Thermal Savings	Annual Net Energy kWh's	Average Capacity MW	Peak Capacity MW
HOTEL												
Villas & Cottages	25.00	1.00	25.00	900		22,500	21.09	474,525	10%	427,073	0.0488	0.0609
Total Lodge Accomodations	**25.00**					**22,500**		**474,525**		**427,073**	**0.0488**	**0.0609**
Hotel Public Areas and BOH												
Club Suite Support Areas	1.00	1.00	1.00	2,500		2,500	23.90	59,755	10%	53,780	0.0061	0.0077
Reception and Great Room	1.00	1.00	1.00	2,000		2,000	23.90	47,804	10%	43,024	0.0049	0.0061
Amenity Areas	1.00	1.00	1.00	25,000		25,000	23.90	597,550	10%	537,795	0.0614	0.0767
Management Offices	1.00	1.00	1.00	1,000		1,000	23.90	23,902	10%	21,512	0.0025	0.0031
Food & Beverage Areas	1.00	1.00	1.00	3,000		3,000	25.31	75,924	10%	68,332	0.0078	0.0098
The Spa, Fitness and Movement Studio	1.00	1.00	1.00	7,000		7,000	23.90	167,314	10%	150,583	0.0172	0.0215
Central Housekeeping & Laundry	1.00	1.00	1.00	920		920	23.90	21,990	10%	19,791	0.0023	0.0028
MEP, Maintenance & Service Areas	1.00	1.00	1.00	1,740		1,740	28.12	48,929	10%	44,036	0.0050	0.0063
Recreation Areas	1.00	1.00	1.00	5,300		5,300	23.90	126,681	10%	114,013	0.0130	0.0163
Total Lodge Public Areas and BOH						**48,460**		**1,169,848**		**1,052,863**	**0.1202**	**0.1502**
Harbor												
Circulation	1.00	N/A	1.00	5112	10.00%	5,112	21.09	107,812	10%	97,031	0.0111	0.0138
Office space	1.00	N/A	1.00	9000	10.00%	9,000	23.90	215,118	10%	193,606	0.0221	0.0276
Marina Retail	1.00	N/A	1.00	11000	10.00%	11,000	23.90	262,922	10%	236,630	0.0270	0.0338
Restaurant Space	1.00	N/A	1.00	5000	10.00%	5,000	25.31	126,540	10%	113,886	0.0130	0.0163
Customs & Immigration	1.00	N/A	1.00	1500	10.00%	1,500	23.90	35,853	10%	32,268	0.0037	0.0046
Recreation Features	1.00	N/A	1.00	200	10.00%	200	21.09	4,218	10%	3,796	0.0004	0.0005
Residential	1.00	N/A	1.00	7800	10.00%	7,800	21.09	164,502	10%	148,052	0.0169	0.0211
Total Harbor						**39,612**		**916,965**		**825,269**	**0.0942**	**0.1178**

Residential												
Harbor Front Homes - A Lots (Beachfront)	75.00	1.00	75.00	3,000	20.00%	270,000	21.09	5,694,300	10%	5,124,870	0.5850	0.7313
Total Residential	**75.00**					**270,000**		**5,694,300**		**5,124,870**	**0.585**	**0.731**
Staff & Crew Residences	10.00	1.00	10.00	1000	0.00%	10,000	21.09	210,900	10%	189,810	0.0217	0.0271
Total Staff & Crew Residential	**10.00**					**10,000.00**		**210,900.00**		**189,810.00**	**0.0217**	**0.0271**
Golf Course Pumping	**Stations**		**HP**	**Run Time (hrs/day)**			**kW**	**kWh**				
Pumping Stations	-		75.00	6.00			56.00	0	0.00%	0	-	-
Utilities	**No. of Units**			**SF/pool**		**Total SF**	**Energy Factor kWh/sf**	**Annual Energy kWh's**	**Alternative Thermal Savings**	**Annual Net Energy kWh's**	**Average Capacity MW**	**Peak Capacity MW**
Pools | Spas Pumping												
Spa	1.00			2500	20.00%	3,000	0.367	1,101	10%	991	0.0001	0.0001
Harbor Club	1.00			5000	20.00%	6,000	0.367	2,202	10%	1,982	0.0002	0.0003
Private Residences (Plunge Pool)	100.00			1500	20.00%	180,000	0.367	66,060	10%	59,454	0.0068	0.0085
						189,000	0.367	69,363	10%	62,427	0.0071	0.0089
			Total Golf Carts				**Energy Factor kWh/unit**	**Annual Energy kWh's**	**Alternative Thermal Savings**	**Annual Net Energy kWh's**	**Average Capacity MW**	**Peak Capacity MW**
Golf Cart Charging Allocation			158.00				13.20	14,615,885	60%	5,846,354	0.6674	0.8342
Back of House		lb/rm	lb/day	lbs/ld	lds	kWh/ld	kWh					
Laundry		7.50	337.50	30.00	11.25	4.50	50.63	18,478	10.00%	16,630.31	0.0019	0.0024
Resort Utilities												
Common Area Lighting			500			60		131,400	10%	118,260	0.0270	0.0338
TOTAL ESTIMATED CAPACITY REQUIREMENT								**22,384,699**		**12,838,287**	**1.4791**	**1.8488**

THE SETAI HARBOR CLUB

FINANCIAL MODEL

ELECTRIC MATRIX

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Phasing Demand Matrix		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Residential		kw--->														
Harbor Front Homes	.0204 MW	-	-	-	-	-	61.19	101.98	142.77	101.98	-	-	-	-	-	-
Hotel Villas, Cottages	.0078 MW	-	-	-	-	7.80	46.81	70.22	78.02	39.01	-	-	-	-	-	-
Harbor Club	.4329 MW	-	-	-	-	432.87	-	-	-	-	-	-	-	-	-	-
Retail / Office	.0660 MW	-	-	-	-	-	0.0660	-	-	-	-	-	-	-	-	-
Restaurants	.0163 MW	-	-	-	-	-	0.0163	-	-	-	-	-	-	-	-	-
Residential Lofts	.0355 MW	-	-	-	-	-	7.80	15.60	23.41	-	-	-	-	-	-	-
Harbor Slips	5.6400 MW	-	-	-	1,000.00	1,000.00	1,500.00	1,500.00	1,000.00	-	-	-	-	-	-	-
Residential Staff and Crew	.0271 MW	-	-	-	-	-	27.08	-	-	-	-	-	-	-	-	-
Common Area Lighting	.0338 MW	-	-	-	-	-	33.75	-	-	-	-	-	-	-	-	-
Pumping Stations	.0000 MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ESTIMATED CAPACITY (KW) REQUIRED PER YEAR		-	-	-	1,000.00	1,440.68	1,676.72	1,687.80	1,244.20	140.99	-	-	-	-	-	-
CUMULATIVE BASE CAPACITY (DEMAND)		*-*	*-*	*-*	*1,000.00*	*2,440.68*	*4,117.40*	*5,805.20*	*7,049.40*	*7,190.39*						
INSTALLATION SCHEDULE (Flex Energy)		-	-	-	1,000.00	1,500.00	1,500.00	2,000.00	1,250.00	-	-	-	-	-		
CUMULATIVE INSTALLED CAPACITY		*-*	*-*	*-*	*1,000.00*	*2,500.00*	*4,000.00*	*6,000.00*	*7,250.00*	*7,250.00*	*7,250.00*	*7,250.00*	*7,250.00*	*7,250.00*	*7,250.00*	*7,250.00*
					Phase 1	Phase 2		Phase 3								

CONCH SOUND POINT - ELECTRICAL DEMAND MATRIX

Power Assumptions				kWh / sf
Industrial				28.12
Residential			75.00%	21.09
Commercial			85.00%	23.90
Restaurants			90.00%	25.31

Hours / Year	8,760
kWh / MW	1,000
Peak factor	1.25
Occupancy | Solar Power Adjustment	80.00%

CONCH SOUND POINT	No. of Units	Keys / Unit	No. of Keys	SF		Total SF	Energy Factor kWh/sf	Annual Energy kWh's	Alternative Thermal Savings	Annual Net Energy kWh's	Average Capacity MW	Peak Capacity MW
HOTEL												
Villas	5.00	1.00	5.00	1,000		5,000	21.09	105,450	10%	94,905	0.0108	0.0135
Total Lodge Accomodations	**5.00**					**5,000**		**105,450**		**94,905**	**0.0108**	**0.0135**
Hotel Public Areas and BOH												
Hotel Suite Support Areas	1.00	1.00	1.00	2,500		2,500	23.90	59,755	10%	53,780	0.0061	0.0077
Reception and Great Room	1.00	1.00	1.00	2,000		2,000	23.90	47,804	10%	43,024	0.0049	0.0061
Amenity Areas	1.00	1.00	1.00	106,000		106,000	23.90	2,533,612	10%	2,280,251	0.2603	0.3254
Management Offices	1.00	1.00	1.00	1,000		1,000	23.90	23,902	10%	21,512	0.0025	0.0031
Food & Beverage Areas	1.00	1.00	1.00	22,000		22,000	25.31	556,776	10%	501,098	0.0572	0.0715
The Spa, Fitness and Movement Studio	1.00	1.00	1.00	24,000		24,000	23.90	573,648	10%	516,283	0.0589	0.0737
Central Housekeeping & Laundry	1.00	1.00	1.00	920		920	23.90	21,990	10%	19,791	0.0023	0.0028
MEP, Maintenance & Service Areas	1.00	1.00	1.00	1,740		1,740	28.12	48,929	10%	44,036	0.0050	0.0063
Recreation Areas	1.00	1.00	1.00	5,300		5,300	23.90	126,681	10%	114,013	0.0130	0.0163
Total Lodge Public Areas and BOH						**165,460**		**3,993,096**		**3,593,787**	**0.4102**	**0.5128**
Residential												
Estate Homes - A Lots (Beachfront)	18.00	1.00	18.00	10,000	20.00%	216,000	21.09	4,555,440	10%	4,099,896	0.4680	0.5850
Estate Homes - Hillside Lots	23.00	1.00	23.00	10,000	20.00%	276,000	21.09	5,820,840	10%	5,238,756	0.5980	0.7475
Estate Homes - Hilltop Estate Lots	17.00	1.00	17.00	10,000	25.00%	212,500	21.09	4,481,625	10%	4,033,463	0.4604	0.5756
Total Residential	**58.00**					**704,500**		**14,857,905**		**13,372,115**	**1.526**	**1.908**

THE SETAI RESIDENCE CLUB

FINANCIAL MODEL

Staff & Crew Residences	10.00	1.00	10.00	1000	0.00%	10,000	21.09	210,900	10%	189,810	0.0217	0.0271
Total Staff & Crew Residential	**10.00**					**10,000.00**		**210,900.00**		**189,810.00**	**0.0217**	**0.0271**
Golf Course Pumping	**Stations**		**HP**	**Run Time (hrs/day)**			**kW**	**kWh**				
Pumping Stations	1.00		75.00	6.00			56.00	122,640	0.00%	122,640	0.0140	0.0175
Utilities	**No. of Units**			**SF/pool**		**Total SF**	**Energy Factor kWh/sf**	**Annual Energy kWh's**	**Alternative Thermal Savings**	**Annual Net Energy kWh's**	**Average Capacity MW**	**Peak Capacity MW**

Pools | Spas Pumping

Spa	1.00			2500	20.00%	3,000	0.367	1,101	10%	991	0.0001	0.0001
Hotel	1.00			5000	20.00%	6,000	0.367	2,202	10%	1,982	0.0002	0.0003
Private Residences (Plunge Pool)	63.00			1500	20.00%	113,400	0.367	41,618	10%	37,456	0.0043	0.0053
						122,400	0.367	44,921	10%	40,429	0.0046	0.0058
			Total Golf Carts				**Energy Factor kWh/unit**	**Annual Energy kWh's**	**Alternative Thermal Savings**	**Annual Net Energy kWh's**	**Average Capacity MW**	**Peak Capacity MW**
Golf Cart Charging Allocation			197.00				13.20	18,223,603	60%	7,289,441	0.8321	1.0402
Back of House		lb/rm	lb/day	lbs/ld	lds	kWh/ld	kWh					
Laundry		7.50	187.50	30.00	6.25	4.50	28.13	10,266	10.00%	9,239.06	0.0011	0.0013
Resort Utilities												
Common Area Lighting			500			60		131,400	10%	118,260	0.0270	0.0338
TOTAL ESTIMATED CAPACITY REQUIREMENT								**37,700,181**		**24,830,625**	**2.8480**	**3.5601**

THE SETAI RESIDENCE CLUB

FINANCIAL MODEL

Phasing Demand Matrix		YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10	YEAR 11	YEAR 12	YEAR 13	YEAR 14	YEAR 15
Residential		kW--->														
Estate Homes	.0435 MW	-	-	-	-	304.80	478.98	609.61	653.15	304.80	130.63	-	-	-	-	-
Hotel Villas	.0081 MW	-	-	88.81	80.73	32.29	-	-	-	-	-	-	-	-	-	-
The Setai Residence Club	.9158 MW	-	-	915.83	-	-	-	-	-	-	-	-	-	-	-	-
Residential Staff and Crew	.0271 MW	-	-	27.08	-	-	-	-	-	-	-	-	-	-	-	-
Common Area Lighting	.0338 MW	-	-	33.75	-	-		-	-	-	-	-	-	-	-	-
Pumping Stations	.0175 MW	-	-	17.50	-	-	-	-	-	-	-	-	-	-	-	-
Misc.	.0000 MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL ESTIMATED CAPACITY (KW) REQUIRED PER YEAR		-	-	1,082.98	80.73	337.10	478.98	609.61	653.15	304.80	130.63	-	-	-	-	-
CUMULATIVE INSTALLED CAPACITY		-	-	*1,082.98*	*1,163.71*	*1,500.81*	*1,979.78*	*2,589.39*	*3,242.55*	*3,547.35*	*3,677.98*	*3,677.98*	*3,677.98*	*3,677.98*	*3,677.98*	*3,677.98*
INSTALLATION SCHEDULE (Flex Energy)		-	250.00	1,000.00	-	1,000.00	-	1,000.00	500.00	-	-	-	-	-		
CUMULATIVE INSTALLED CAPACITY	*ELECTRIC MATRIX*	-	*250.00*	*1,250.00*	*1,250.00*	*2,250.00*	*2,250.00*	*3,250.00*	*3,750.00*	*3,750.00*	*3,750.00*	*3,750.00*	*3,750.00*	*3,750.00*	*3,750.00*	*3,750.00*
# OF FLEXENERGY UNITS REQUIRED			0.25	1	1.75	0	2	2.5	3	3.25						
			PHASE 1		**PHASE 2**		**PHASE 3**									

SALDCO

Appendix F - Project Utility Supplement

Kakona

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TABLES

EXHIBITS

Disclaimer: Valencia Capital Group, SALDCO and its affiliate companies reserve the right to update, modify, change and substitute technologies within this Utility Supplement without notice and as needed, to reflect use of the latest and technology best suited for use within the Kakona development.

Kakona

I. INTRODUCTION

The Project consists of three distinct and independent parcels, Conch Sound Point (CSP), High Bank Bay (HBB), and Leeward Harbour (LH). CSP and HBB, progressing north to south respectively, are located on the east coast of Great Abaco approximately six miles and four miles respectively, north of the lighthouse at Hole in the Wall on the southern tip of Abaco. LH is located on the western most tip of South Abaco adjacent to the existing Sandy Point airport, and approximately sixteen miles (straight line distance) from Hole in the Wall. Please see Exhibit 1 – South Abaco Parcel Summary.

The parcels are connected via a common master planned development known as Kakona. It is intended that these parcels have a common integrated infrastructure to the extent possible. To accomplish this task, a complete description of the property and its surroundings must be understood.

II. LOCATION, PHYSICAL ATTRIBUTES AND CHARACTERISTICS

A. Conch Sound Point (CSP) and High Bank Bay (HBB)

CSP is approximately 375 acres and HBB is approximately 500 acres. Currently SALDCO owns 300 acres at CSP and 400 acres at HBB, with the balance under contract to purchase between SALDCO and the properties current owner. Both of the CSP and HBB tracts are bound to the east by the Atlantic Ocean, and to the west by approximately 22,000 acres of Bahamian National Park land managed by the Bahamas National Trust (BNT. The northern side of Conch Sound is bound by BNT property as well. A privately held parcel separates Conch Sound Point from High Bank Bay.

Access to the CSP and HBB parcels is via an existing graded / unimproved road known as the Lighthouse Road, that runs generally southeast from the Queen's Highway to the existing lighthouse at The Hole in the Wall, a distance of approximately twelve (12) miles. At approximately eight and three tenths (8.3) miles inland on Lighthouse Road, an old logging road known as Road 50, turns generally east toward the coast. Road 50 ends approximately three and one-half (3-1/2) miles west of the beach and almost midway between CSP and HBB (see Exhibit 1). Currently, Road 50 is the main access to High Bank Bay (HBB) and Conch Sound Point (CSP). Continuing on lighthouse road beyond the CSP/HBB Connector (road 50) for an additional four (4) miles, will lead to Lantern Head and to the lighthouse.

Both parcels are currently unimproved with naturally occurring vegetation comprised of medium trees and shrubs, low lying bushes, ornamental plants, coastal grasses and plants as well as the valued Coppice. The eastern beaches are bound by dunes, which act to provide protection to the delicate coppice directly to the west. A small part of the shoreline on both properties has exposed limestone rock at the ocean / land interface, commonly referred to as "Iron Shore". This single feature provides the sound, look and feel, like no other.

Both properties have special features that set them apart from your typical tropical paradise. High Bank Bay has the highest elevation change from sea level to almost 90 feet on its southern end. A central ridge runs the entire length of the property from north to south, approximately one-third its distance inland when measuring east to west. This ridgeline provides breath taking views of the ocean along its entire path while its coastal dunes allow for panoramic views of the coastline. HBB has a crescent shaped beach on its southern most boundary, commonly referred to as Barque Bay, where the iron shore meets this beautifully shaped natural beach. The peninsula that creates the beach is where it is planned to locate Kakona's #17 signature golf hole.

Conch Sound Point, as with High Bank Bay, has a central ridge, and spectacular view planes, but its distinct centerpiece is its natural, limestone-protected lagoon, at its southern end. This feature, created through years of wave and wind, provides a natural-protected quiescent swimming area, for children and guests of all ages.

The property to the west of the ridge on both parcels, paints a picture of the central lowland covered in native vegetation such as Mahogany, Horseflesh, Saw Palmetto, Olivewood, Orchids, Guana Berry, Red Cedar and many other species, all of which to be covered in greater detail in the field investigation portion of the Environmental Impact Assessment (EIA). Further to the west of both parcels and adjacent to each parcels western boundary is the much-celebrated Bahamas National Park managed by the Bahamas National Trust. This park, as mentioned contains approximately 22,000 acres of pristine forest.

Both parcels are located within the primary and secondary flyways for the Abaco Parrot, making South Abaco and this property home for these one of a kind parrots, the only parrots that nest in the ground.

In addition to the parrot, the property celebrates the return, each season, with its share of migratory fowl that approaches 130 different species annually. Beyond the natural beauty of south Abaco, this is indeed a bonus and treasure to be preserved.

B. Leeward Harbour (LH)

Leeward Harbour is comprised of approximately 103 contiguous acres, with SALDCO having the parcels under two separate purchase agreements. The property is located at the end of the Queen's highway, adjacent to and south of the existing Sandy Point airport. The property is currently unimproved with naturally occurring vegetation comprised of medium trees and shrubs, low lying bushes, with some ornamental plants and coastal grasses. The land ranges in elevation from 0' to 10' on its southern coastal boundary in one isolated location. The property is bounded by the Sandy Point airport to the north, Crown land to the east, and ocean to the south and west. The western beaches are minimal in size, with intermittent breaks of vegetation and rocky coastline. A small part of the shoreline to the south has exposed limestone rock at the ocean / land interface, commonly referred to as "Iron Shore". Unlike the rocky shore at CSP and HBB, the rocky shore at LH is quiet with less energy due to its leeward location thus its name. These features act to provide the perfect foundation for a marina location.

III. DEVELOPMENT PROGRAM

The Master Plan for Kakona is provided on three distinct and separate plans that are presented together as the basis for the total development known as Kakona.

The Conceptual Site Plans were produced by EDSA dated October 2018 and revised by BLUR Workshop in 2021. This was all done as a collaborative effort by and between the entire Kakona Development Team that includes HKS, David McLay Kidd, TDS, Fountainhead Studio, Harris-Kalinka, Spine, Alchemist, The Partnership, and Woodhouse Architects, EDSA, BLUR and Setai.

The Plans are as shown in Exhibit 2: Conceptual Master Plans for Conch Sound Point, High bank Bay and Leeward Harbour.

The development program is as follows:

A. <u>Conch Sound Point</u>

1. 375 acres +/- bounded to the north and west by the Bahamas National Park, to the east by the Atlantic Ocean, and to the south by private land
2. Beach frontage - approximately 1.75 miles
3. One Hundred (100) custom home estate lots (average finished home-10,000 sf) with Two-10,000 sf model homes
4. The Residence Club is comprised of the following:
   a) Twenty-Five Hotel Villas,
   b) Spa / Fitness
   c) Beach Club / Beach Bar & Grill
   d) Pool, deck and outdoor amenity space
5. Golf Practice Area designed by David McLay Kidd
6. Founders Club
7. Road Surface – 30,153 lf (~5.71 miles)
8. Pedestrian Paths and Cart Paths
9. Central services area for site security, fire department, transportation, On-site medical clinic and resort administrative operations

10. Helicopter landing area
11. Security Entrance with Guard House and Gates
12. Boundary Security Wall and fence
13. Approximately six miles of roads and utility infrastructure
14. Back of House (BOH), maintenance and support buildings
15. Landscape and hardscape along road aprons, right of ways, Residence Club, and entrance

B. <u>High Bank Bay</u>

1. 503 +/- acres bounded to the north by private land, to the east by the Atlantic Ocean, to the south by private land, and to west by the Bahamas National Park.
2. Beach frontage - approximately 2.0 miles.
3. Resort and Golf Club
    a) Resort and Golf Club
    b) Beach Club / Golf Club
    c) 10 - Beach & Golf Club Villas
    d) Beach and Golf Club facility
    e) Pool, deck and outdoor amenity space
    f) Restaurants, boutiques, Salon, shops and cafés
    g) Fitness / Spa
    h) Branded Golf and Tennis Center
4. Spa / Fitness
5. David McLay Kidd - 18-hole golf course
    a) Links style Golf Course
    b) Eighteen (18) hole, 7,355-yard, Par 72
6. Branded Sound Studio with outdoor Amphitheater & music venue
7. Public Amenity Areas (includes spa & sound studio)
8. Residential
    a) 96 Custom Home Private Estate Lots (average home size ~7,500 sf)
    b) 25 Golf Course Preserve Lots

c) 45 Golf Course two- and three-bedroom Villas

d) 123 Garden Villas fronting the Golf Course

e) 15 Private Beachfront Villas

9. Full-service destination spa and wellness center.

10. Branded sports facility with 69 Villas (Future) set up and managed for sports medicine rehabilitation

11. Central services area for site security, fire department, transportation, On-site medical clinic and resort administrative operations

12. Helicopter landing area

13. Security Entrance with Guard House and Gates

14. Boundary Security Wall and fence

15. Approximately eight and one-half (8-1/2) miles of roads and utility infrastructure

16. Back of House (BOH), maintenance and support buildings

17. Landscape and hardscape along road aprons, right of ways, Resort, Beach & Golf Club, and entrance

18. Pedestrian Paths and Cart Path

C. <u>Leeward Harbour</u>

1. Leeward Harbour Marina

Monohull	**Catamaran**	**Dry Stack**
30’ to 49’ – 16%	50’ to 60’ – 5%	400 units up to 50’
50’ to 79’ – 33%	61’ to 80’ – 4%	
80’ to 99’ – 18%		
100’ to 149’ – 14%		
150’ to 200’ – 10%		

Table 1: Leeward Harbour Marina Slip Mix

Designed specifically to attract the sport fishing enthusiast, the marina is 32.55 wet acres that will accommodate a variety of vessels, monohull and catamarans, ranging in size from 30 feet to 200 feet with 225 wet slips and 400 dry slip as shown in the following Table 1-Leeward Harbour Slip Mix.

The total available slippage, upon completion, is planned to be 17,230 lf. The Marina will provide full service as it relates to utilities (fuel, water, wastewater pump out, electricity, phone, internet access and satellite TV), 24/7 concierge service, small engine repair, electrician services and Port of Entry clearance.

The nautically inspired shape to the breakwater and inner marina, provides aesthetics as well as functionality. The shape allows for laminar flow throughout which aides in flushing but it also provides ease of access and egress.

2. Leeward Harbour Property

a) 103 +/- acres bounded to the North by the Sandy Point airport property, to the east by vacant Government owned land, to the south by the Atlantic Ocean and to the west by the Atlantic Ocean.

b) Beach frontage - approximately 2,000 lineal feet.

c) Harbour Club Hotel and Café (Branded)

(1) 40 Core hotel units

(2) 25 Beachfront Bungalows

(3) Pool, deck and outdoor amenity space

d) Residential

(1) 50 Harbour Front Residences

(2) 50 Harbour Front / Beachfront Condos

(3) 10 Private Villas

(4) 10 Lofts over Harbour retail

e) Harbour Marina Village – 35,000sf of Harbour retail & commercial space to include:

(1) Restaurants, boutique shops, cafes, fishmonger, Fresh market, liquor, beer & wine, sundry, and ships chandlery

(2) Customs House / Harbour Master / operations

(3) Charter and sales office

(4) Leasing office

f) Central services area for site security, fire department, transportation, On-site medical clinic and resort administrative operations

g) Proposed Boutique casino located on east side of the marina

h) Back of house support and distribution center (18.24 ac) for all three properties to include dry storage, cold storage and freezer storage, Roll on – roll off dock, Container storage for all three properties

i) Security Entrance with Guard House and Gates

j) Boundary Security Wall and fence

k) Approximately four and one-half (4-1/2) miles of roads and utility infrastructure

l) Landscape and hardscape along road aprons, right of ways, beach and entrance

D. Utilities

Due to the location of each property, there are no publicly available utility services available. This, coupled to the quality of power, the intermittent service that has plagued south Abaco, and the level of service that our owners and guests expect, mandates the construction and use of private utilities.

All three properties will have the necessary state of the art utilities to support and deliver those services necessary.

The utilities will be owned by a single utility company with multiple distinct divisions as follows:

1. Division #1 – Power
2. Division #2 - Water and Wastewater Treatment
3. Division #3 – Geothermal
4. Division #4 – Communications and Security
5. Division #5 – Natural Gas

The company will be a privately held utility company per the submitted Heads of Agreement, in cooperation with the Government of the Bahamas and the various existing utility providers as required.

A detailed discussion of these items can be found under the Utility section of this document.

E. Exterior Area Improvement

1. Kakona (Sandy Point) Airport

The existing Sandy Point Airport improvements are planned to include the necessary physical expansion to accommodate private jets and turboprops. The existing runway is currently planned to be extended from 4,500lf to 7,000lf with all associated electronics and lighting. A Fixed Based Operations (FBO) building with Customs and Immigration will be available. The FBO will have a 10 acres apron area for plane storage and parking with fueling capability.

Kakona will have available a 10-passenger helicopter for owners and guests at each of the properties as part of the amenity package. It is planned that the helicopter will provide dual use in the event of a medical emergency, either at the Resort or within the South Abaco / Sandy Point Community.

2. Exterior Roads

Per the current plan, the Lighthouse Road, Road 50, the new Coastal Road, and the access roads are to be graded, widened, fully constructed and paved as appropriate. This work encompasses approximately twenty-seven and one-half miles (~27.5) of work,

With the exception of the Lighthouse Road, the roads will be privately owned for their entire width and length. All roads will be maintained and can be used by the public except for the property access roads which will designated private use only.

The roads are proposed to be have a forty-foot (40’) right of way designed with a ten foot (10’) wide landscaped apron on each side and a twenty foot (20’) wide paved road.

3. Ferry Dock

It is proposed to use the old and currently not used ferry dock located south and west of the Sandy Point landfill for off-loading of materials and supplies related to the Kakona development.

a) Improvements to this dock would include the following tasks:

(1) Demolition of unstable structures

(2) Reconstruction of the dock as required

(3) Widening of the off-loading, apron and approach areas

(4) Construction of a staging area

4. Construction and Staff Housing

A construction man camp is planned to be located generally north of the old ferry dock. This facility will be self-contained and capable of housing up to 300 workers. The facility will include a dining facility, recreation area, lounges, and administrative office space. Contractors will be provided areas for construction site offices.

Staff Housing is planned to be located in the existing subdivision just north of Sandy Point. This housing component will be phased to accommodate up to 400 Kakona staff as the development grows, via a combination of multifamily style units and single-family homes for management.

A staff village is planned to accentuate the ambiance and atmosphere that is naturally Abaco through all that is Bahamian, its architecture, its landscape, and its people. Via the open-air central square, all the shops are easily accessed by pedestrian walkways. The Village is planned to include retail / commercial space, restaurants, boutique shops, grocery store, convenience store / gas station, drug store, local bank, ice cream shop, tobacco shop and a salon.

IV. SITE WORK, ROADS AND INFRASTRUCTURE

A. Site Clearing and Grading

The site clearing and grading portion of this project is one of the most important aspects involved in this development. Looking only at the proposed network of interior and exterior roads and the Harbour footprint, it is estimated that 35 acres will be disturbed. By taking the time on the front end to carefully plan and implement correctly, the areas exterior to the development as well as those inside its boundary will benefit via disturbance minimalization. The roads, residences, commercial facilities and amenities will appear to have been in place for years rather than being newly constructed.

Each contractor and their respective employees will be reminded of our commitment to this position and deviation from the approved plan will not be accepted. For this to be successful, it is imperative that detailed Clearing and Grading Guidelines (CGG) supplemented by a detailed Sediment and Erosion Control Plan (SECP) be drafted, approved and adopted that are applicable to each particular aspect and task ahead of any construction activity.

1. Clearing and Grading Guidelines (CGG)

The Owners and Developer of Kakona have adopted this policy approach. It is presented in part, as follows:

a) All cleared organic material will be shredded in place with track grinding equipment. The material will then be loaded and hauled to a designated area for stockpiling and conversion into mulch or slope stabilizing material. Once development operations begin, it is intended that this mulch be mixed with the resulting product from the organic dehydrators to produce a nutrient rich inert soil amendment that can be spread throughout the property.

b) The clearing guidelines will specify in detail where equipment and hand labor should be utilized to clear the survey lines so construction activity can proceed. This is more clearly outlined as follows:

(1) Equipment used to clear survey lines:

(a) The property boundaries of Conch Sound Point, High Bank Bay and Leeward Harbour.

(b) Roads exterior to the development namely Road 50, and the Leeward Harbour-Airport Loop Road.

(c) Interior roads of each of the three properties

(2) Hand labor utilized to clear survey lines:

(a) CSP & HBB access roads

(b) Residential lot lines

(c) Commercial lot lines

(d) Anywhere it is known, an expectation exists or there is a possibility that ruins or sites of historical interest may exist. This method will act to insure the protection of any possible historical areas not earlier found.

(e) In the case of HBB where it is known that ruins exist, hand labor will be utilized to remove the vegetation from around the perimeter of the site for a minimum of ten feet. Once a clean perimeter has been established, then the vegetation from the interior areas will be surgically removed to expose any structures and areas of interest.

c) The clearing guidelines will address what is to be done prior to any clearing operation beginning as it relates to the Abaco Parrot and potential nesting areas. In association with private and government experts, the valued and delicate parrot nesting areas will be identified and relocated out of the path of disturbance thus preserving this precious resource.

2. Sediment and Erosion Control Plan (SECP)

a) A detailed and comprehensive Sediment and Erosion Control Plan (SECP) will be drafted and submitted along with the civil-site plans for approval. With average rainfall in Abaco approaching 42 inches annually, the amount of disturbance that is planned even though it has been minimized, a comprehensive SECP is a priority.

b) The SECP will specify areas in which silt fence will be utilized. The use of silt fence is required to prevent the transmission of sediment and debris to waterways or sensitive areas. The prescribed silt fence will, at a minimum, be 36" tall with a wire back for strength, trenched a minimum of 6" in the ground, and held in place with metal tee posts. Certainly, the approved plans outlining what is to be built will be followed. The fence will be continuously monitored and maintained. In the event of damage or "blow out", a report will be made and the area repaired, replaced or added to immediately to prevent sediment travel and possible deposition in sensitive areas or outside the work zone. Any sediment buildup of noticeable quantity will be removed and stockpiled for later use as fill or bedding material within the resort.

c) The SECP will specify the use of Tensar™ tree safe material for use in any of the following activities:

d) To outline any area selected for non-disturbance

e) To outline the interior area of disturbance for any lot or land parcel boundary to protect against excess clearing.

f) To protect selected trees and vegetation for non-disturbance or for replanting within the Resort boundary

g) To clearly define grading and clearing activities

h) Any damaged Tree Save material or silt fence, upon replacement will be placed in a designated area within the construction lay down yard and designated for proper disposal.

i) As a companion and cooperative natural product to silt fence, we will employ the use of natural check-dams, small non-intrusive sediment basins and natural vegetated or rubble waterways to assist in controlling and directing the flow of surface storm water. These items, acting together, provide an aesthetic solution for an otherwise unsightly means of sediment control. The materials of construction can be but are certainly not limited to the following:

j) Natural Rubble Check Dams: 8" to 12" in size, placed in a mound across the width of the waterway, with #57 size stone equivalent on the mounds up-gradient surface. These mounds are placed periodically along the waterways flow path. The water is allowed to flow through the crevices in the mound but sediment is trapped on the up-gradient side. These check dams can also be supplemented with silt fence material in the center of the dam thus further restricting the transmission of sediment downstream.

k) Natural Vegetated Waterways: This item provides a natural filter mechanism assisting in the removal of trapped sediment. The entire length and width of the waterway is planted with a prescribed application of grass seed, fertilizer and mulch. The type of seed for this application is based on the area, climate and germination time. A fast emergence product is preferred to protect the site from silt deposition down gradient.

l) Natural Sediment Basins: These basins are utilized as a safety mechanism and backup for all of the above items. They are strategically placed along waterways, at the base of steep grades, along a roadway or path, or simply as needed. The materials of construction are virtually the same as the check dams and it is common to use the existing natural vegetation as camouflage so as to conceal the basins from view while still allowing for them to be periodically maintained.

m) These natural methods of sediment and erosion control practices, have been implemented and utilized in many places, by many people, and on many projects. First-hand experience by this group provides actual field knowledge that it works. These methods, as one example, were implemented successfully at The Reserve on Lake Keowee, South Carolina in conjunction with two Jack Nicklaus Signature Golf Courses, spanning some 3,600 acres along one of the most pristine lakes in North America. It only seems relevant that these methods be implemented and employed on this delicate and most treasured site. By early adoption and implementation of these types of programs, as well as mitigation methods, the development team will be able to identify and protect sensitive areas, any vegetation that will be selected for non-disturbance or replanting, and maintain the look and feel of a mature property by only removing that which is necessary and protecting that which remains.

B. Storm Water Management

The average annual rainfall for Abaco is approximately 40”. To put this in perspective, 40” of annual rainfall equates to approximately 1.06 billion gallons of water falling on the surface of Kakona over the course of one year or the equivalent of 3.3 feet deep on 981 acres. An adequately engineered network of storm water piping collection and conveyance features is a necessity.

Based on the current land plan, Conch Sound Point, High Bank Bay, and Leeward Harbour have a combined land disturbance during construction over the life of the project of 562.50 ac, with 429.67 ac being revegetated and landscaped with a final impermeable hard surface footprint, comprised of roads and rooftops of approximately 127.91 acres (see Exhibit 3: Kakona Program Density). The 128 acres of total impermeable surface, is made up of approximately 75 acres of internal road and 53 acres of rooftops. It is our intent, to capture and collect the runoff water from roofs for irrigation (~60.5 million gallons annually) and the road runoff (~84.5 million gallons annually), and direct it to our primary irrigation lakes and other water features throughout the properties. By managing this resource, it is estimated that we will be able to supply approximately one-quarter of the irrigation demand for both golf courses annually understanding that not all storm water can be captured.

A storm water collection and conveyance system is made up of two primary components, piping and manholes. The pipe system that will be deployed at Kakona will utilize High Density Poly-Ethylene (HDPE) pipe and fittings. The manholes will be concrete precast, of varying diameters and heights with HDPE linings, or HDPE manholes.

Besides the use of piping, other measures can be employed to manage water and assist in recharging the local aquifer. Instead of providing solid impermeable concrete surfaces for pedestrian walkways and driveways, our design guidelines will closely follow those exhibited in “A Living Tradition: Architecture of the Bahamas” by Stephen A. Mouzon. A variety of pavers, as well as grass and paver strips will be utilized to allow maximum percolation and recharge to continue.

As an added precaution, each of the storm manholes will have an insert specifically designed to separate sediment and any oily residue that could be collected from the road system. These types of manholes will require periodic maintenance, especially after a rain event. Therefore, as part of the environmental management plan, a section will be provided that clearly and adequately addresses the procedures necessary for maintaining and disposing of any recovered solids or oily residue. By employing such standards, we have furthered our commitment to being good stewards of the environment and maintaining a sustainable development.

C. Pond Lining

a) Due to the porous nature of the underlying sub strata, it will be necessary to provide some type of lining system for the many lakes, ponds and decorative water features planned throughout the resort property. These liners not only act to keep the water from gradually seeping into the porous substrata so maximum benefit can be realized for water reuse irrigation and ambiance, but they also act to prevent any undesirable constituents from migrating into the native strata and causing a potential contamination issue. This is specifically important as it relates to golf courses and the use of fertilizers, pesticides and insecticides. The protection of the existing aquifer is first and foremost.

b) Liners come in a variety of forms. Our liners will either be 60-mil HDPE, as manufactured by several internationally recognized suppliers, or soil admixture that is turned into the upper six inches of soil or spray applied to a prepared soil surface. All three provide equal protection and containment, and can be amended for aesthetic presentation. The modified spray applied concrete products are salt resistant, flexible and crack resistant.

D. Exterior and Interior Roads

To construct this exclusive luxury resort, approximately 27.5 miles of exterior road improvements will have to be made that include improvements to the existing lighthouse road, construction of Road 50 and approximately 2 miles of new road constructed as main access roads at the end of road 50 to afford access to Conch Sound Point & High Bank Bay. The work scope is broken down as follows:

1. Lighthouse road (8.5 miles) – currently passable but rough.

2. Road 50 (~3.5 miles) – used as an old logging road, this road, although passable with an ATV, is severely over grown.

3. Coastal Road (~12 miles) – This road is a combination of narrow dirt roads and paths that will need to be constructed. The planned routing is from the airport to the intersection of Road 50 and the Lighthouse road.

4. Leeward Harbour / Airport Access Rd - ~1 mile – This road has to be constructed for access to the south side of the airport and Leeward Harbour. The road is currently planned to run from the main highway between the beach and west end of the airport, around the south side of the airport tying into the current landfill road and then back to the main highway.

5. Landfill road to old Ferry Dock - ~1 mile. This road currently exists in a rough graded condition.

6. CSP & HBB Access Roads (~1.5 miles) – These roads would begin at the end of Road 50 and travel to each respective property (see Exhibit 1). The roads lie within the Bahamas National Park and have to be constructed.

7. Work to be performed:

   a) Surveying and staking of the right of way

   b) Clearing, grinding / mulching and haul off of all cleared vegetation

   c) Grading, filling of low areas, and compacting

   d) Paving – Base and Final

   e) Landscaping of aprons

   f) Maintenance and upkeep

For the purposes of this narrative and the budget and per discussions with the Government and the Bahamas National Trust, it was assumed that existing roads would be utilized and improved where possible to minimize disturbance within the National Park. The stated width of the existing easement along the Lighthouse Road is 100 feet. The planned new road, beginning at the Queen's Highway and progressing south to the Lighthouse will consist of one 12-foot wide lane in each direction, a 10-foot wide planted / landscaped center median strip with periodic breaks in the median, and a 13-foot wide vegetated apron on each outer edge for a total edge to edge boundary of 60'. The apron will be used for small storm waterways, landscaped buffers and planters along its full length.

As part of the overall plan for Kakona and South Abaco, we propose to construct a road with a forty-four feet' edge to edge width made up of two 12' lanes and two 10' aprons, following a path generally along the coast from the Sandy Point airport to the intersection of Road 50 and Lighthouse Road. Since adding Leeward Harbour to the project, this road has become a priority as it would cut off the travel time required between the properties. An added benefit is that it would open up an otherwise hidden coastline for everyone to visit and enjoy.

A 60-foot wide crown easement currently exists between the BNT property and the western boundary edge of the Conch Sound Point & High Bank Bay property. The easement, as approved and represented, extends from its intersection of the Lighthouse Road to the south at the southwest corner of Lantern Head, to the northwest property corner at Conch Sound Point. It is within this easement that the main property access roads will be constructed. Generally speaking, and as shown on Exhibit 1, the two access roads will begin from a Roundabout to be constructed at the end of Road 50 and run northeast to Conch Sound Point and southeast to High Bank Bay. These will be private access roads with gates and security. The approximate length of each new road is 1 mile. As proposed width of the easement is forty-four feet as described previously. The planned new road will be one twelve-foot wide lane in each direction with a ten-foot wide vegetated apron on each outer edge. The apron will be used for small storm waterways, landscaped buffers and planters along its full length.

With direct access considered, the only roads remaining are the interior roads needed to service the resort property. Based on the current plan, the interior roads equal approximately fourteen (14) miles. It is currently estimated that these roads will consist of two (2), twelve-foot wide lanes in each direction with a ten (10) foot vegetated aprons on either side matching the access road widths. With the exception of construction related traffic, only golf carts and service vehicles will utilize the interior roads.

The service road to the ferry dock and the road providing access to Leeward Harbour and the perimeter of the airport are as described previously. These roads will be constructed early in the project as they are integral to construction at Leeward Harbour and the delivery, and receipt of materials for the project.

The western property boundary interface with the road easement, along both parcels, is planned to have a 100-foot wide (deep) undisturbed vegetated buffer. This buffer will act to deflect and mute interior resort noise, provide a buffer to any road noise, segregate the Resort for privacy, preserve green space and provide a continuous north south flyway for the Abaco Parrot. Within this buffer, a stacked stone column and wall with a decorative metal fence will be erected. The fence will run the entire boundary of the properties and be approximately eight feet tall.

The exterior road surface will be an asphaltic base, binder and finish course common to the island and matching the specification typically used in this application. It will be finished to a designated thickness that will provide a good driving experience, a good wear surface and durability as well as longevity. Quarry materials for the road grading operation, will be locally obtained. The roads will have a base course until construction is complete at which time the final two inches surface finished course will be placed in service.

Besides providing a means of access to and from the resort, the road corridors will be utilized as utility corridors as well. All of the water and wastewater piping, direct bury electrical, gas line, communications / fiber network conduit and reuse irrigation piping will be buried within the road right-of-way in a manner conducive to the proper horizontal and vertical separation convention.

E. Utilities

Due to the complexity that surrounds establishing a reliable utility to support the needs of this development, taking into consideration the distance between the properties and cost to affect a reasonable solution, much thought has been given to this task. One thought is to establish a facility that would service Conch Sound Point and High Bank Bay with a second to service Leeward Harbour. The second would be to consolidate as much as possible to potentially reduce the cost associated with the facility. Another factor being considered is increase the power capacity of the facility nearest to Leeward Harbour to provide power to the grid for benefit to South Abaco in cooperation with Bahamas Power and Light (BPL).

To arrive at the solution a cost to benefit analysis will be prepared that analyzes each proposed solution objectively. Whatever solution is determined to be the best and economical, understanding that cost is not the only determining factor, there will be incorporation of benefit for South Abaco outside of the development. No matter the location, each property will have sufficient utility services provided. Table 2 on the next page shows the estimated capacity for each property component within Kakona.

The Conch Sound Point and High Bank Bay Utility Centralized Facility will be located in the vicinity of the northwest corner of High Bank Bay in a designated and isolated area that minimizes the distance to Conch Sound Point and central to High Bank Bay. This facility will be comprised of the components shown in the Matrix above. The Golf Course irrigation component will be installed on that particular property.

The Leeward Harbour Utility Centralized Facility proposed location will be to the southeast of the Sandy Point airport at position 16 and 18 on the Location aerial provided as Exhibit 1. As shown, position 16 is the Utility Centralized Facility (UCF) and position 18 is the existing Sandy Point Landfill (SPL) with an additional acreage allocation. The facility will consolidate the utilities for Leeward Harbour, and as with the CSP and HBB facility, it will be comprised of the components shown in the Matrix above.

If the cost to benefit analysis proves that it is more cost effective and provides a greater benefit to consolidate the utilities into a centralized facility at location 16 nearest Leeward Harbour, then, with the exception of the wastewater treatment facility for CSP and HBB, the utilities would be placed at the LH location. To support CSP and HBB, utility lines for power, water, natural gas and network fiber would be installed along the proposed Coastal Road to Road 50 to the respective properties, an estimated distance of 15.5 miles.

Utility operations will be centralized with a control / ops center where all aspects of the utilities can be continuously monitored and controlled, no matter the physical location. The system will allow for outside monitoring from remote computers to allow professionals in other areas to insure compliance in every aspect of the operation. All system pumps, valves, and production equipment will be automated to facilitate complete remote operations. A comprehensive process control network of energy efficient equipment and logic controls will support the system. This will allow for the constant monitoring of energy usage and providing a means to reduce energy consumption. The individual water and electric meters at each of the proposed residential units as well as each commercial user to include the hotels, will have a fully automated and wireless metering system that accommodates a real-time read out all via the planned Resort Wireless Network. All pool controls will be linked to the system for efficient water filtration, disinfection and level adjustment. The individual golf course irrigation systems as well as the ornamental Resort irrigation systems controls, as provided by TORO, will interface with the central operations system to insure irrigation lake levels are adequate or in need of water, system pressure is maintained and zone irrigation conducted on a priority basis with central system override provided. Moisture sensors and rain measurement equipment will assist in determining irrigation needs on a real time basis. The interior of each unit will be provided with the latest Smart Home technology as designed and implemented by Johnson Controls to insure the ability of remote unit control and adjustment. These functions will be provided via a proprietary dashboard developed specific for Kakona that can be accessed via strict password protocol by operations personnel, owners, and to a lesser more restricted degree, guests on property. Systems integration will be facilitated by Johnson Controls and Crestron.

The ability to monitor usage in real time provides system integrity assurances and the ability to make system adjustments to reduce system loads during peak times or when unit space is not in use. For example, when a unit is unoccupied, the central operations area will be notified and will be able to adjust the interior environment to reduce energy consumption during those times of non-use. We will also be able to apply emergency procedures and operations to each unit in preparation for inclement weather. This could even mean the deployment of automated hurricane shutters reducing a substantial manpower requirement during a time when time and labor are critical.

Table 2: Utility Matrix

	Conch Sound Point	High Bank Bay	Leeward Harbour	Total
Power (kWh)	3.09/3.87	7.08/8.86	4.96/6.20	15.13/18.93
Water Demand (gpd)	103,822	323,390	310,683	737,895
Wastewater Capacity (gpd)	80,000	225,000	268,121	573,121
Golf Course Irrigation Demand (gpd)	144,000	684,000	N/A	828,000
Geothermal	Yes	Yes	Yes	N/A
Network Fiber / Communications	Yes	Yes	Yes	N/A

Note: See Exhibit 4: Water and Wastewater Matrix for detailed capacity calculations.

1. Domestic Water Supply

The island of Abaco is blessed with one of the largest subsurface bodies of fresh water in the Bahamas. It is not our intention to exploit this resource. If we are reckless in our plan of usage and recharge, the draw down caused by the Resort due to its proximity to the southern end of the island and its projected demand, could possibly cause the lens to shrink or be the cause of saltwater intrusion. With this ever present in our design and planning for the development, we are exploring a combined approach through the use of intake structures and wells. No formal studies have been conducted to prove or disprove the above points, but internally we are posturing on the side of a more conservative, sustainable and responsible development. We have a valuable untapped resource located adjacent to the property by way of the Atlantic Ocean. It seems only appropriate that we carefully utilize the bountiful supply.

Table 2 reveals a daily domestic demand for all sources of 695,046 gallons per day (gpd). The irrigation demand for each golf course, during the grow-in cycle is estimated at 828,000 gpd with golf course irrigation demand leveling out at 600,000 gpd after the grow-in cycle. The typical grow-in period lasts for one year. Ornamental irrigation demand is projected to approach 400,000 gpd for Conch Sound Point and High Bank Bay and 100,000 gpd for the Leeward Harbour. As the landscape plan matures and the golf course plans are finalized, this estimate will be adjusted as necessary to guarantee that water production exceeds demand by a reasonable factor of safety. Not included in the above figures and the storm water filtering and recovery system which is estimated to approach one quarter of the daily golf course irrigation need. Additionally, the wastewater reuse for subsurface irrigation of landscape boundaries and golf course areas adds available capacity of

695,046 per day. Private irrigation demands for residential needs has been accounted for in the estimate. As part of the demand estimate, we have planned on using native vegetation coupled with a carefully designed landscape plan implemented alongside a "best practices" irrigation plan, will act to minimize total water use.

a) Reverse Osmosis Plant - The domestic water treatment / production facility is planned to be a Reverse Osmosis system with a production capacity sufficient with a contingency capacity to adequately support the three properties that comprise Kakona. The production unit will be fully enclosed in a building designed for appearance and functionality of operations. The production equipment will be as supplied by company who is familiar with and has experience in the Bahamas. The source of water for the water facilities depends on a few factors, (1) if the facilities are combined near Leeward Harbour or (2) if the facilities will be separate. If separate, the intake for CSP and HBB will be via deep wells located on each property supporting golf course irrigation and domestic water use. The intake for the Leeward Harbour facility will be built into the bulkhead of the Harbour, whether stand alone or as a combined facility. An HDPE pipe of sufficient size will deliver the fresh saltwater through a filtration system to a day tank on the influent side of the plant. Additional filtration will occur prior to being delivered to the RO system.

The RO plants regardless of location, being separate or combined, will have the following components:

(1) Front end fine screening at the intake,

(2) Ultra-fine screening at the plant prior to entering the RO system,

(3) RO system, and

(4) Disinfection via Ozone, and UV sterilization and Chlorine disinfection.

(5) Storage tanks will be glassed lined as manufactured by AquaStore™.

b) The plant storage specifications if combined, are as follows:

(1) If combined into one facility near Leeward Harbour – 1.5 million gallons of finished water capacity.

(2) If separate, 500,000 gallons at Leeward Harbour, and 1 million gallons at CSP / HBB with an additional 500,000-gallon storage tank at CSP.

2. Storage

Adequate storage acts to support Resort water needs at a desired pressure and provides compensation for fluctuations in pressure. Energy recovery will be introduced into the RO plant for

South Abaco via a recovery turbine. This will assist in increasing the recovery efficiency and lowering the overall energy costs per gallon of water produced.

The finished water in both tanks will be stirred on a regular basis and circulated through a UV Disinfection unit to insure complete and continuous disinfection. System pressure will be maintained via duplex in-line booster pumps sized for complete system functionality. Each tank will be complemented with a booster system. It is our intent to position the tank on Conch Sound Point so as to provide maximum benefit and lowest public exposure. As required, individual pressure reducing valves will be implemented to maintain the proper system delivery pressure at each residential unit or commercial space.

3. Brine Disposal

Brine disposal from RO water production, no matter the location, will be handled in an environmentally safe and sensitive manner. Current systems utilize deep well injection to dispose of brine. We will utilize this method as well at the CSP / HBB and Leeward Harbour. However, at Leeward Harbour we are investigating the possibility of discharging produced brine into a mixing system with a set mix ratio with subsequent diffused discharge along the marina bulkhead. This action will assist in flushing the marina. At CSP and HBB a similar system could be deployed where the produced brine is combined with sea water and diffused into the saltwater ponds along the front of the property. The majority of the flushing will occur with the tidal fluctuations. This method of brine disposal will provide a mix ratio with no chance of aquifer contamination or marine habitat disturbance or damage. A model to prove this method will be prepared and submitted for review prior to construction the facility.

4. Wastewater Treatment

To compliment the other sustainable aspects of this project, we have chosen a path of treatment that insures the highest quality effluent more than suitable for reuse irrigation. Per Exhibit 4, the incoming waste is characterized as normal domestic waste with the following levels:

a) BOD5 -300 mg/L (Normal domestic sewage ranges from 250 mg/L to 300 mg/L)

b) TSS - 275mg/L

c) TKN - 67 mg/L

d) Ammonia Nitrogen 25 mg/L

e) pH – 6 to 9 standard units.

The wastewater will be treated to a stringent reuse standard as outlined in the Georgia Guidelines for Reuse Irrigation, which only allow:

a) BOD5 - 5mg/L

b) TSS - 5mg/L

c) Fecal – 23 mpn

d) Turbidity <3ntu.

The wastewater treatment capacity necessary for this resort is currently estimated to be 695,000 gpd. This figure is subject to change once a firm design has been completed. Treatment plants will be located at Conch Sound Point / High Bank Bay and Leeward Harbour.

The proposed treatment process involves the use of many proven process technologies, combining them into an integrated system, four of which are listed below.

a) Soneera Water Treatment Technology

b) Filtration

c) Disinfection via Ozone and / or UV

d) Sludge disposal via Organic dehydration

As mentioned previously, information on the Soneera Water Treatment Technology is included as Exhibit 6. Information on the components within the wastewater treatment system are provided below:

a) Step 1: Screening - The plant will have front end course and fine screening to remove to remove all large materials such as trash and undesirable material, followed by a fine screen to remove solids of a much finer nature. Recovered solids will be collected, compressed to remove water and then further handled for disposal.

b) Step 2: Equalization - Influent flow is directed into a tank that compensates for fluctuations in flow to account for peak conditions.

c) Step 3: Electro-flocculation - This step is the core behind the entire treatment process. It involves the use of the Soneera Treatment Technology based on electro-flocculation in a submerged process (see Exhibit 6 – Soneera Water – Water and Wastewater Treatment). The process utilizes electricity and plate technology to separate wastewater constituents causing them to float out as flocculant while the clean water is discharged as treated water where it is further filtered for reuse. The system is a flow through process and can be modular allowing for phased expansion. Sludge produced from the process can be landfilled however our sludge will be mixed with organics from the MSW to produce a nutrient rich soil amendment that will be mixed and used as mulch throughout the property.

A system like we are proposing, has low maintenance, very few moving parts, and lower initial cost.

d) Step 4: Disinfection - The use of chlorine is the method by which effluent has been disinfected for decades. This is not the forum to get into why it is that way but due to the harmful and corrosive effects of chlorine not to mention the potential long-term medical reasons, we have chosen to use Ozone and UV with subsurface drip irrigation. The use of Ozone and UV as disinfectants is proven and leaves no lingering residual components in the effluent stream that could potential accumulate in the ecosystem, be ingested by a living creature or to a lesser extent cause corrosion of equipment. It also guarantees no special chemical handling training and storage as with chlorine. Vendors to provide the UV and Ozone systems have yet to be determined.

e) Step 5: Reuse Irrigation - Once the effluent has completed the disinfection stage, it will be conveyed to either tank storage in the case of Leeward Harbour or to the golf course irrigation lakes on either property via an HDPE force main in the case of Conch Sound Point and High Bank Bay. The ornamental irrigation for each property will pull water from either tank storage or the lakes. The lake water will be stirred and continuously aerated to prevent "dead zones". Achieving proper mixing can be performed in several manners, such as decorative fountains, waterfalls and water features. Other measures involve diffusers or venturi injectors. The exact combination of components for this step has not been designed, however the end result will be maintained.

Irrigation lake levels will be monitored remotely from the main operations area so water can be directed as needed. A combination of irrigation systems will be utilized throughout the resort. TORO will supply all spray and related controls. A supplier to provide the drip irrigation products and controls has not been determined.

f) Step 6: Sludge Handling - Sludge produced from the treatment process will be collected and further processed with MSW organics through organic digestion facilitated by the BioNova Waterless Digester (see Exhibit 7 – BioNova waterless Digester. Once the process is complete the resulting material will be mixed with shredded wood material to produce a nutrient rich mulch for use in landscaped areas. Clayton County Georgia Water and Sewer Authority Land Application System have successfully utilized a similar process since the mid 1960's.

The wastewater treatment facility will be contained in a structure that is aesthetically pleasing and designed for functionality, and noise reduction. Facilities will be isolated and out of the publics daily view.

Although this process and method of treatment has no odor associated with it, measures will be employed in the building in case odors are generated.

The wastewater treatment plant will be state of the art with full remote monitoring capability. Field valves, pump stations, individual home pump stations, as well as the irrigation systems will be able to be monitored and controlled from a central operations area. Access will be provided, through restricted access levels, passwords and codes so vendors if necessary can achieve internet access and monitoring.

The facilities will be built in phases as the project matures. Phase one will comprise the structure and the foundation equipment and tankage necessary for the complete plant. The ancillary support equipment will not be provided until required by anticipated demand. A benefit to the selected method of treatment is that expansion is made possible through delivery of a new module. The system is virtually plug and play.

An onsite laboratory will be integrated into the building so that basic chemistry can be monitored as required by industry standards. A full operation plan will be written outlining sampling procedures and testing. An independent laboratory, for analytical integrity will be utilized.

Waste treatment for the Village area will be provided by the Leeward Harbour facility. A pretreatment system will be implemented for the restaurant waste stream and then combined with the normal domestic waste from the staff housing area and construction man camp for transmission via force main to the central plant.

As an adjunct to the main treatment facility, small independent units will be employed for specialty situations. For example, at all equipment wash down areas, a collection system will be constructed with an oily water filtration component. Systems are available that use natural materials that are recyclable as in the case of peat systems. These systems use natural media and are in used internationally. Oil is naturally absorbed by Peat therefore making it perfect for oil / water separation areas. Once the peat’s useful life is reached the material can then be used as a soil amendment when mixed with other organics as mulch.

5. Power Production and Supply

The energy demand for this Resort is extensive once fully constructed. Load calculations have been prepared based on the current Conceptual Plan, with values inclusive of Conch Sound Point, High Bank Bay and Leeward Harbour (see Exhibit 5). Current estimates indicate a base load requirement when fully built out of 15MW and a peak capacity requirement of 18MW. It is intended to construct additional capacity at the central power plant to service both the Resort, and with excess provided to the South Abaco grid through an agreement with BP&L. In addition to the central power plant,

we will maximize the amount of renewable energy generated through use of select solar opportunities. Any power not required for the development will be made available to the grid.
The energy program that we are proposing is by far the most sustainable program ever attempted in the Bahamas. It comprises the use of the following components:

a) The main power facility located at Leeward Harbour, whether supplying all development power or just the Leeward Harbour component, will incorporate excess generation to back feed the Abaco grid under agreement with BP&L. The facility is being planned as a joint venture by and between SALDCO and a leading provider of liquified natural gas (LNG) and power generation facilities in the Caribbean. The liquified natural gas will be delivered to the old ferry dock, in LNG ISO containers where it will then be utilized in the power plant(s). This allows for plant location flexibility. The type of power generation equipment to be installed has not yet been decided however we are investigating the use of Capstone CHP Micro turbines that fulfill a dual role of (1) production and supply of power to the properties and (2) through Combined Heat and Power (CHP), capture the heat that is typically lost from the power generation process and use it to produce hot water and thus air conditioning for some or all of the commercial and residential units planned at Leeward Harbour. Calculations to determine the viability of this option and the amount of resulting air conditioning are in process.

b) Wind – no wind will be utilized due to the Abaco Parrot as agreed with the BNT.

c) Solar - we are currently working with an independent group to design, build, own and operate a fixed land based solar farm of at least one megawatt (1MW) as supplemental power adjacent to Leeward Harbour. The site will be approximately 7 to 10 acres in size and will provide a sustainable source of usable power for the development and south Abaco.

d) Backup power units will be designed into all commercial and hospitality components as well as residential units within Kakona.

e) Alternative Energy - The Resort power component will be supplemented with solar panels for ornamental lighting, EV charging, accent lighting, street lighting, maintenance & pump station supplemental power. The estimated reduction to the normal base load through sustainable operations is 10%. The solar ornamental, accent and street lighting systems will be hidden within the landscape to illuminate the many walks and pathways in the evening. Timers will be set to turn the system on and off as people approach and pass by. These systems will be integrated so as not to create an aesthetics issue.

f) Point of Use Hot Water - Hot water heating systems are typical gluttons of energy in any system. At Kakona our intent is to utilize natural gas to all commercial facilities and each residential unit allowing for the energy efficient heating of water where required.

6. Geothermal Facility - This type of facility has already been debuted in Abaco at Schooner Bay. A geothermal system utilizes deep wells, pumps for circulation of a low flash point fluid, a network of buried primary delivery and secondary effluent piping and a network of heat pumps inside the structures where it is being utilized. The USEPA stated in a report (EPA Report 430-R-93-004) that, “Geothermal Systems are the most energy efficient, environmentally clean, and cost-effective space conditioning systems available.” The operating premise behind the Geothermal System is very simple as follows:

a) The low flash point fluid is cooled as it is circulated at depth in the primary closed system piping.

b) Each residential unit or commercial space will have a specific number of heat pumps that facilitate cooling.

c) The heat pump removes the heat from the interior space and transfers it into the geothermal piping network where it is then cooled through transmission within the buried piping network and at depth and the process begins again. The system is a closed loop so no fluid exchange occurs.

d) Two geothermal plants will be constructed and placed in use, one at Leeward Harbour and one for Conch Sound Point and High Bank Bay. The plants will be centrally located to conserve space and maximize efficiency.

7. Network Fiber

Currently we propose to enter into an agreement with the local cable and wireless provider to facilitate internet connectivity throughout Kakona. To do this it will be necessary to tie into the fiber that lands at Leeward Harbour. A network of fiber conduit will be installed for each of the three properties facilitating the connectivity to a centralized servicing point. This plan mandates that conduit be run in the right of way of the new coastal road, and down road 50 for delivery and distribution through Conch Sound Point and High Bank Bay. Conduit will also be installed to and through Leeward Harbour as well as the FBO at the airport. Currently it is not known who will be responsible for the actual fiber installation but Johnson Controls will provide the design and oversight for this to insure a quality and trouble-free system upon its completion.

8. Piping Systems: Collection and Conveyance

As discussed previously in the storm water management section of this document, HDPE pipe, fittings and related products will be utilized throughout the resort for all underground piping. It is anticipated that an HDPE system for vertical construction interior pipe systems will also be implemented. The benefits of using HDPE are numerous and are listed below for reference:

a) HDPE provides a plastic butt-fused joint so upon completion, there are no joints therefore no opportunity for leaks

b) The pipe has tremendous elastic qualities that allow it to bend and give which reduces the need for fittings

c) HDPE is inert and will not degrade or corrode

d) HDPE is UV resistant and therefore will not breakdown in sunlight as with PVC

e) HDPE pipe comes in 40’ and 50’ lengths so installation is quicker

f) HDPE is plastic and fully certified for buried service in pressure and non-pressure systems

g) HDPE has no steel components therefore it is not affected by a salt laden environment.

h) With regard to the HDPE lined manholes, this system provides for the pipe to be welded to the manhole providing a sealed system

i) An HDPE system allows no infiltration into the system, and no exfiltration to the surrounding environment.

j) Due to its inherent properties and smooth surface, HDPE does not promote any type of growth on its surface so it affords a clean conveyance system.

k) Repairs are relatively easy, even in a pressure situation.

l) HDPE pipe can be placed in less than desirable and somewhat rocky conditions without consequence to the system.

Different situations require different grades of pipe and fittings, gravity conveyance versus forced or pressure conveyance. Gravity pipe systems are installed to gain benefit from nature and the ever-present force of gravity. This is only applied to sanitary and storm sewer applications. Gravity systems typically start with shallow burial depths and can become quite deep depending on the length of the pipe run and terrain. Because of this, knowing our site and the type of systems to be employed, we will limit the design of any gravity conveyance piping to only the storm water collection and conveyance system. All other piping will be forced or a pressure application.

Pressure piping is used in the following situations:

a) Domestic water supply

b) Fire main

c) Low pressure wastewater transmission system piping

d) Irrigation reuse water distribution piping

e) Golf Course and ornamental irrigation piping

f) Geothermal cooling transmission main

g) Intake piping for the reverse osmosis plant

h) Cooling water intake for power generation plant

The pipe chosen for each of the above applications will be of the PE 4710 specification, with a Standard Dimension Ratio (sdr) selected for the specific application and working pressure. The Ductile Iron Pipe Size (DIPs) or Iron Pipe Size (IPS) parameters are selected based on the application. The use of the PE4710 resin in lieu of the PE3408 allows for a higher density pipe, with the same pressure rating at a higher sdr, all for the same or less money as with PE3408.

The gravity storm system and the irrigation systems will use IPS pipe and fittings. The domestic water, fire main, wastewater transmission and reuse supply main will be designed for DIPs pipe and fittings. The purpose for the differentiation in the two pipe specifications allows for standard AWWA fittings and materials applicable to the water and waste industry to be utilized in conjunction with the HDPE pipe. This is not as important in a gravity application or in irrigation.

The Resort sewage collection and conveyance system will be made up of several components. Due to the conditions that exist, an extensive gravity collection system will not be practical nor economical. Therefore, the system will be comprised of a low-pressure step collection system. Each residential unit or series of units, will feed to a small grinder pump station from a standard septic tank where the sewage will be pumped via a small HDPE service lateral to the sewage force main. It will then be conveyed to the wastewater treatment plant or to a larger, centralized pump station where it will be conveyed to the treatment plant. All commercial locations, such as the hotels, restaurants, and spa(s), will be equipped with a primary grease interceptor that will require periodic maintenance. Depending on the anticipated strength of the waste from the commercial area, some pretreatment may be necessary.

All fittings will be HDPE. All valves will be compression or fused, molded plastic with stainless steel internal parts. A complete specification will be provided with the design plans.

As for the small satellite pump stations mentioned previously, it has not been decided what make or model these will be but we do know that they will be from one manufacturer for system continuity. This will apply to the larger pump stations as well. The wet wells will be HDPE or HDPE lined concrete. The pump cans for the small pump stations will be HDPE.

9. Pipe Fusion

This is an important aspect in any infrastructure project utilizing HDPE. The completed system is only as good as the technician and equipment provided to complete the fusion. The choice of fusion equipment as well as operator training is very important. This one aspect is why we have aligned with best manufacturers, known leaders in fusion technology and suppliers of HDPE products. All of our fusion equipment will be as manufactured by McElroy. All fusion equipment will be equipped with data logging system capability to insure the integrity of each weld. This logging system provides a generated file and print out of every weld documenting time of day, ambient temperature, weld temperature, weld time, fusion pressure, fusion time and weld completion time. Via this system we can provide complete quality control of all fusion welds. Complimenting the logging program will be a daily coupon cut that physically demonstrates the integrity of the weld for quality control. These coupons are kept until the end of the project at which time they are discarded and disposed of properly. Lastly, each weld is marked with a stamp that indicates time, initials of technician and date. This is important so that as the project progresses an as-built is made which indicates all this data and if a leak is discovered all information pertaining to that joint can be pulled and used for reference. Each day, prior to starting any new fusion work, the previous days' work is reviewed with the technicians and any questionable joint is cut and re-welded. This guarantees system integrity. This type of procedure was employed successfully by our team in Dalton Georgia on the installation and fusion of over 1 million lineal feet of pipe. Our team has successfully fused over 2 million feet of pipe on projects in the United States, installed in excess of 3 million feet of pipe and consulted on projects globally.

F. Municipal Solid Waste (MSW)

Currently South Abaco has a landfill located to the south and east of the airport and labeled point 18 on the plan in Exhibit 1. The amount of MSW delivered to this site on a daily basis or who currently maintains it is currently unknown. Per our Heads of Agreement, it is proposed to take over the management of this landfill and add additional acreage for expansion and proper operation. Prior to this occurring a detailed comprehensive operations plan will be submitted for comment and approval. This plan will provide details on the following:

1. The current state of the landfill,
2. Estimated daily incoming waste in tons per day,
3. General waste characterization
4. Description of operations outlining required staff and equipment

5. Assessment of the existing site with recommendations for remediation of the site and the estimated time to complete or a plan for site closure with no further landfilling in the old site and the commissioning of a new minimal landfill with active recycling.

6. It will be the policy at Kakona to separate all MSW into its various constituents of aluminum, ferrous metal, plastic, glass, and organics. An estimate of the waste produced at completion is provided as Exhibit 8 – Kakona MSW Projections. Each residential unit and commercial space and restaurants will be provided the necessary receptacles for ease of separation. A small fleet of specialized small collection vehicles will be placed in service and all collected material will be delivered to the landfill processing area.

7. Delivered recycled material will be processed and placed in shipping containers. Once the containers are full, shipping will be arranged for transport of the recycled materials to our JV Partner in Florida.

8. The organic materials that are collected (food waste, paper and sludge) will be placed in a BioNova Waterless Digester (see Exhibit 7) where it is processed into a high quality, nutrient rich soil amendment. This material will be incorporated with shredded wood waste to create nutrient rich mulch for use in the property landscape operations.

9. We are proposing, once the facility is placed into operation, to process incoming MSW first and then systematically begin to reclaim, process and clean up the old landfill. It is too early to fully describe how this operation will proceed but prior to its start up a full long-term operational plan will be submitted for review and approval.

V. BENEFITS

The summary of benefits of our system proposal, are many and we have listed a few of them below as follows:

A. LNG Power Production:

1. By producing excess power and back feeding the grid, overall grid system efficiency will increase.

2. Once in operation, the low voltage conditions and power outages currently experienced in South Abaco should go away.

3. Reducing stress on the Wilson City facility

4. Possible solution for the use of natural gas as an alternative fuel in lieu of bunker.

5. The effect of the energy efficient lighting, appliances, geothermal cooling systems, energy efficient building materials, ceramic coatings as insulation, the interior environmental control and

monitoring and the efficient heavy process equipment will make Kakona and South Abaco the most sustainable and environmentally conscious property development and Resort Community in the Caribbean.

B. Geothermal System Cooling

1. By utilizing a central geothermal cooling system, the following benefits will be realixed:

a) Reduction in energy consumption for cooling as much as 70%

b) Quiet inside and outside operation as there are no condensing units outside

c) Reduced maintenance – In the absence of the condensing units at each residence or commercial space, there is no system exposure to the elements ie no rust which equates to no replacement and thus reduced cost.

d) Uses clean renewable energy

e) This type of system is reliable and long lasting with an anticipated life expectancy of at least 50 years.

C. MSW / Landfill

1. The MSW problem on Abaco will be managed and in time, alleviated by instituting the policies and procedures mentioned.

2. The local landfill could be remediated over time eliminating a potential environmental issue.

3. Kakona becomes a zero-discharge resort development

4. This landfill could become a showcase and an example of what to do for other out island communities and then through outside funding sources these other out island landfills could begin operating in a partnership with and like South Abaco.

D. Employment

One key item to success in the Bahamas and most especially is the incorporation of its culture and its people into the fabric of the development. The jobs that will be produced and available, both during construction and after, both direct and indirect, will act to boost the economic wellbeing of this region. Residents, men and women alike, will have an opportunity to work within their chosen field or be trained for a new skill that could elevate their standard of living by providing a sustainable long-term opportunity for employment close to their community.

Jobs will be offered to all Bahamians whether from South Abaco or any of the other major out island communities. Our main focus however is to stimulate the economy of South Abaco for the people of South

Abaco. Jobs will in scope and complexity and with an increased skill set and experience comes increased wages and salaries as well as increased responsibilities and expectations from management.

It is common knowledge that not all jobs can be filled by Bahamas residents. However, our pledge is to maximize local opportunity and employment.

E. IT Infrastructure

The IT portion of this project is by far the most complex and most detailed. It is a collaborative effort by the owner and developer SALDCO, Johnson Controls and many others, involving the design, installation and operation of an intricate and elaborate network of high-tech equipment connected via a labyrinth of fiber optic cable. The system planned will be fully integrated with wireless connectivity anywhere in the resort, fast-access internet, video on demand, satellite TV, cell access, smart home technology and what we now refer to as the iExperience™. It will include:

1. Full concierge services via the iPhone, iPad and Smartphones
2. Central Business services platform
3. Building and Energy Infrastructure management
4. Building, structure, site and perimeter security so that any space can be continuously monitored for guest peace of mind and protection.
5. Life safety, Fire Detection, and Security
6. Energy efficient appliances
7. Airport communications and equipment
8. Access control with access hardware provided by SALTO
9. CCTV, and video streaming
10. Emergency Communication Systems
11. Property wide wireless network
12. Wayfinding

The intent is to have a system that is fully integrated so that all resort systems can be monitored from a central location from within the Resort, to include at a minimum water and wastewater treatment, BOH, Energy production and usage, fuel availability, geothermal performance, irrigation control and performance. The system will also allow for complete concierge service via resort wireless web access, iPhone and iPad, and Smartphone, so that guests can plan their visit prior to leaving for the airport and having the peace of mind knowing that it will be provided per their request at their convenience.

The system will allow for monitoring of all structures for energy consumption so that any unit not being used can be adjusted to provide savings. Each unit will have its own electric, reuse and water meter capable of providing real time monitoring via internet access and thus providing valve or circuit control. This system will have the capability of monitoring all of the pools on the property for level, and status of equipment as well as disinfection.

The above description of the Kakona central system of services is provided as an overview of the design but is in no way complete. What we wish to convey is a desire on the part of the Owners / developer and their team to construct a very technically advanced non-intrusive IT infrastructure guest friendly, almost magical luxury destination experience capable of providing a level of service unmatched in this market so that the guest leaves Kakona and the experience forever engrained memory with the only question remaining to be answered is …"When can we return".

F. Summary

The development program and the infrastructure plan presented herein is a starting point from which we begin the process of shaping and molding this project into a luxury destination. It is imperative that this destination and its artisans be cognoscente of the delicate ecosystem in which we intend to build, but more, be respectful of what is here now, what has passed through here, the history that it represents and what is to come. It is only with this understanding that a true feeling of place can be established and conveyed into the finished product. It is only with this feeling instilled in the finished product that all residents, visitors and guests, alike will leave with a true sense of environmental awareness and what steps were taken to construct the destination ever imprinted on their hearts and in their minds. To forever place in the forefront the fact that many dedicated groups worked to preserve and not destroy the native flora and fauna, the commitment to environmental stewardship, and it is through this stewardship, that South Abaco.org is formed to promote education and environmental awareness. It is the "giving back" to Abaco, the land that has already given so much, that provides the true underlying meaning and basis for our project.

Kakona…Many Blessings from all that is the Bahamas.

EXHIBIT 1: SOUTH ABACO PARCEL SUMMARY AND LOCATION MAP

EXHIBIT 2: KAKONA CONCEPTUAL MASTER PLANS

- **CONCH SOUND POINT**
- **HIGH BANK BAY**
- **LEEWARD HARBOUR**

EXHIBIT 3: KAKONA PROGRAM DENSITY

EXHIBIT 4: WATER AND WASTEWATER MATRIX

EXHIBIT 5: ENERGY MATRIX

EXHIBIT 6: SONEERA WATER – WATER AND WASTEWATER TREATMENT

- **WATER AND WASTEWATER TREATMENT PRESENTATION**
- **TECHNICAL PAPER**
- **SYSTEM SCHEMATIC**

EXHIBIT 7: BIONOVA WATERLESS DIGESTER

- **BIONOVA PRESENTATION**
- **BIONOVA AIR QUALITY EMISSIONS**

EXHIBIT 8: KAKONA MSW MATRIX

APPENDIX G - SOLID WASTE ESTIMATE

MUNICIPAL SOLID WSTE PRODUCTION ESTIMATE

KAKONA

CONCH SOUND POINT

RESIDENTIAL	GSF		UNITS				FACTOR	ANNUAL PRODUCTION TONS/YR	ANNUAL PRODUCTION LBS/YR	MONTHLY LBS/MO	DAILY LBS/DAY
Estate Homes	10,000.00		100.00				2.55	254.70	509,400.00	42,450.00	1,395.62
The Kakona Club Villa and Condos	179,040.00		60.00				2.55	152.82	305,640.00	25,470.00	837.37
TOTAL RESIDENTIAL	**189,040.00**	**-**	**160.00**					**407.52**	**815,040.00**	**67,920.00**	**2,232.99**
HOSPITALITY	**Keys**		**GSF**	**Amenity Deck (sf)**							
The Kakona Club	60.00	-	52,806.00	100,000.00			0.0011	55.45	110,892.60	9,241.05	303.82
Spa, Treatment Rooms, Yoga and Fitness			7,900.00				0.0011	8.30	16,590.00	1,382.50	45.45
TOTAL HOSPITALITY	**60.00**	**-**	**60,706.00**					**63.74**	**127,482.60**	**10,623.55**	**349.27**
OFFICE	**GSF**	**NRSF**									
Management Offcies	1,200						0.0013	1.56	3,120.00	260.00	8.55
TOTAL OFFICE	**1,200**	**-**	**-**	**-**	**-**			**1.56**	**3,120.00**	**260.00**	**8.55**
RESTAURANT	**1st Level - GSF**	**2nd Level - GSF**	**1st Level Outdoor Space**	**2nd Level Outdoor Space**	**Seats**	**TYPE**					
Waterfront Bar & Grill / Beach Bar	888.00		-		40.00		0.0057	5.06	10,123.20	843.60	27.73
Grill	1,000.00				40.00		0.0057	5.70	11,400.00	950.00	31.23
Grill Bar / Lounge	768.00				24.00		0.0057	4.38	8,755.20	729.60	23.99
Garden Dining Room	768.00				32.00		0.0057	4.38	8,755.20	729.60	23.99
Garden Terrace Dining			1,152.00		36.00		0.0057	6.57	13,132.80	1,094.40	35.98
Owner's Wine Room	400.00						0.0057	2.28	4,560.00	380.00	12.49
Private Dining	480.00						0.0057	2.74	5,472.00	456.00	14.99
Café	624.00				24.00		0.0057	3.56	7,113.60	592.80	19.49
TOTAL RESTAURANT	**4,928.00**	**-**	**1,152.00**	**-**	**196.00**			**34.66**	**69,312.00**	**5,776.00**	**189.90**
COMMERCIAL	**GSF**										
Golf Course Maintenance	5,000						0.0016	8.00	16,000.00	1,333.33	43.84
BOH & Public Areas	24,722						0.0011	25.96	51,916.20	4,326.35	142.24
TOTAL COMMERCIAL	**29,722.00**	**-**	**-**	**-**	**-**	**-**		**33.96**	**67,916.20**	**5,659.68**	**186.07**
TOTAL CONCH SOUND POINT MSW ESTIMATE								**541.44**	**1,082,870.80**	**90,239.23**	**2,966.77**

	ORGANIC WASTE LBS/DAY	PAPER LBS/DAY	GLASS LBS/DAY	METALS LBS/DAY	PLASTICS LBS/DAY	WOOD LBS/DAY	LANDSCAPE DEBRIS LBS/DAY	NON-RECYCLABLE: RUBBER, LEATHER, & TEXTILES LBS/DAY	OTHER LBS/DAY	TOTAL LBS/DAY
Estate Homes	210.74	361.46	61.41	127.00	182.83	86.53	185.62	-	180.03	1,395.62
The Kakona Club Villa and Condos	126.44	216.88	36.84	76.20	109.70	51.92	111.37	1.00	108.02	838.37
TOTAL RESIDENTIAL	**337.18**	**578.34**	**98.25**	**203.20**	**292.52**	**138.45**	**296.99**	**1.00**	**288.06**	**2,233.99**
The Kakona Club	45.88	78.69	13.37	27.65	39.80	18.84	40.41		39.19	303.82
Spa, Treatment Rooms, Yoga and Fitness	6.86	11.77	2.00	4.14	5.95				14.73	45.45
TOTAL HOSPITALITY	**52.74**	**90.46**	**15.37**	**31.78**	**45.75**	**18.84**	**40.41**	**-**	**53.92**	**349.27**
Management Offcies	1.29	2.21	0.38	0.78	1.12				2.77	8.55
TOTAL OFFICE	**1.29**	**2.21**	**0.38**	**0.78**	**1.12**	**-**	**-**	**-**	**2.77**	**8.55**
Waterfront Bar & Grill / Beach Bar	4.19	7.18	1.22	2.52	3.63				8.99	27.73
Grill	4.72	8.09	1.37	2.84	4.09				10.12	31.23
Grill Bar / Lounge	3.62	6.21	1.06	2.18	3.14				7.77	23.99
Garden Dining Room	3.62	6.21	1.06	2.18	3.14				7.77	23.99
Garden Terrace Dining	5.43	9.32	1.58	3.27	4.71				11.66	35.98
Owner's Wine Room	1.89	3.24	0.55	1.14	1.64				4.05	12.49
Private Dining	2.26	3.88	0.66	1.36	1.96				4.86	14.99
Café	2.94	5.05	0.86	1.77	2.55				6.31	19.49
TOTAL RESTAURANT	**28.67**	**49.18**	**8.36**	**17.28**	**24.88**	**-**	**-**	**-**	**61.53**	**189.90**
Golf Course Maintenance	6.62	11.35	1.93	3.99	5.74	2.72	5.83		5.65	43.84
BOH & Public Areas	21.48	36.84	6.26	12.94	18.63	8.82	18.92		18.35	142.24
TOTAL COMMERCIAL	**28.10**	**48.19**	**8.19**	**16.93**	**24.38**	**11.54**	**24.75**	**-**	**24.00**	**186.07**
TOTAL CONCH SOUND POINT MSW ESTIMATE	**447.98**	**768.39**	**130.54**	**269.98**	**388.65**	**168.82**	**362.14**	**1.00**	**430.27**	**2,967.77**

MUNICIPAL SOLID WSTE PRODUCTION ESTIMATE

KAKONA

HIGH BANK BAY

								ANNUAL PRODUCTION		MONTHLY	DAILY	ORGANIC WASTE	PAPER	GLASS	METALS	PLASTICSS	WOOD	LANDSCAPE DEBRIS	RUBBER, LEATHER, & TEXTILES	OTHER	TOTAL
RESIDENTIAL	**GSF**		**UNITS**				**FACTOR**	**TONS/YR**	**LBS/YR**	**LBS/MO**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**
Estate Homes	7,500.00		115.00				2.55	292.91	585,810.00	48,817.50	1,604.96	242.35	415.68	70.62	146.05	210.25	99.51	213.46		207.04	1,604.96
Golf & Beach Club Villas	13,500.00	9,000.00	9.00				0.91	8.19	16,380.00	1,365.00	44.88	6.78	11.62	1.97	4.08	5.88	2.78	5.97		5.79	44.88
Private Enclave Beachfront Villas	50,000.00	20,000.00	10.00				0.91	9.10	18,200.00	1,516.67	49.86	7.53	12.91	2.19	4.54	6.53	3.09	6.63		6.43	49.86
Grand Ana Villas	105,000.00	56,800.00	30.00				0.91	27.30	54,600.00	4,550.00	149.59	22.59	38.74	6.58	13.61	19.60	9.27	19.90		19.30	149.59
Total	**176,000.00**	**85,800.00**	**164.00**	-	-	-		**337.50**	**674,990.00**	**56,249.17**	**1,849.29**	**279.24**	**478.97**	**81.37**	**168.29**	**242.26**	**114.66**	**245.96**	-	**238.56**	**1,849.29**
HOSPITALITY	**Keys**	**Condo**	**GSF**	**Amenity Deck (sf)**																	
The Grand Ana				100,000.00																	
Sound Studio			2,520.00				0.0011	2.65	5,292.00	441.00	14.50	2.19	3.76	0.64	1.32	1.90				4.70	14.50
Public areas & BOH			40,193.00				0.0016	64.31	128,617.60	10,718.13	352.38	53.21	91.27	15.50	32.07	46.16				114.17	352.38
Conference / Banquet Facilities			7,680.00				0.0011	8.06	16,128.00	1,344.00	44.19	6.67	11.44	1.94	4.02	5.79				14.32	44.19
Spa, Treatment Rooms, Yoga and Fitness			13,944.00				0.0011	14.64	29,282.40	2,440.20	80.23	12.11	20.78	3.53	7.30	10.51				25.99	80.23
Beach & Golf Club			16,678.00				0.0011	17.51	35,023.80	2,918.65	95.96	14.49	24.85	4.22	8.73	12.57				31.09	95.96
Studio Suites	8.00		6,400.00	1,920.00			0.0011	6.72	13,440.00	1,120.00	36.82	5.56	9.54	1.62	3.35	4.82				11.93	36.82
Beach & Golf Club Villas	10.00		12,840.00				0.0011	13.48	26,964.00	2,247.00	73.87	11.15	19.13	3.25	6.72	9.68				23.94	73.87
Over the Water Bungalows	-		-				0.0011	-	-	-	-	-	-	-	-	-				-	-
Total	**18.00**	-	**100,255.00**	**101,920.00**	-	-		**127.37**	**254,747.80**	**21,228.98**	**697.94**	**105.39**	**180.77**	**30.71**	**63.51**	**91.43**	-	-	-	**226.13**	**697.94**
OFFICE	**GSF**	**NRSF**																			
Reception / Back Offices	1,160						0.0013	1.51	3,016.00	251.33	8.26	1.25	2.14	0.36	0.75	1.08				2.68	8.26
Executive & Admin	980						0.0013	1.27	2,548.00	212.33	6.98	1.05	1.81	0.31	0.64	0.91				2.26	6.98
Total	**2,140**							**2.78**	**5,564.00**	**463.67**	**15.24**	**2.30**	**3.95**	**0.67**	**1.39**	**2.00**	-	-	-	**4.94**	**15.24**
RESTAURANT	**1st Level - GSF**	**2nd Level - GSF**	**1st Level Outdoor Space**	**2nd Level Outdoor Space**	**Seats**	**TYPE**															
Specialty Restaurant	3,000.00		1,536.00		168.00	Fine Dining	0.0057	25.86	51,710.40	4,309.20	141.67	21.39	36.69	6.23	12.89	18.56				45.90	141.67
Bar Lounge	896.00		672.00		56.00		0.0057	8.94	17,875.20	1,489.60	48.97	7.39	12.68	2.15	4.46	6.42				15.87	48.97
Café / Bar / Lounge / entertainment	2,880.00				120.00		0.0057	16.42	32,832.00	2,736.00	89.95	13.58	23.30	3.96	8.19	11.78				29.14	89.95
Waterside / Beach Grill	1,824.00				78.00		0.0057	10.40	20,793.60	1,732.80	56.97	8.60	14.75	2.51	5.18	7.46				18.46	56.97
Total	**8,600.00**	-	**2,208.00**	-	**422.00**	-		**61.61**	**123,211.20**	**10,267.60**	**337.56**	**50.97**	**87.43**	**14.85**	**30.72**	**44.22**	-	-	-	**109.37**	**337.56**
HIGH BANK BAY												PAGE 2									
Retail	**1st Level - GSF**	**2nd Level - GSF**																			
Retail shops	2,750.00						0.0045	12.38	24,750.00	2,062.50	67.81	10.24	17.56	2.98	6.17	8.88				21.97	67.81
Total	**2,750.00**	-	-	-	-	-		**12.38**	**24,750.00**	**2,062.50**	**67.81**	**10.24**	**17.56**	**2.98**	**6.17**	**8.88**	-	-	-	**21.97**	**67.81**
Commercial / Industrial	**GSF**																				
Golf Course Maintenance	5,000.00						0.0016	8.00	16,000.00	1,333.33	43.84	6.62	11.35	1.93	3.99	5.74	2.72	5.83		5.65	43.84
Total	**5,000.00**	-	-	-	-	-		**8.00**	**16,000.00**	**1,333.33**	**43.84**	**6.62**	**11.35**	**1.93**	**3.99**	**5.74**	**2.72**	**5.83**	-	**5.65**	**43.84**
TOTAL HIGH BANK BAY MSW ESTIMATE								**549.63**	**1,099,263.00**	**91,605.25**	**3,011.68**	**454.76**	**780.02**	**132.51**	**274.06**	**394.53**	**117.37**	**251.79**	-	**606.63**	**3,011.68**

MUNICIPAL SOLID WSTE PRODUCTION ESTIMATE

KAKONA

LEEWARD HARBOR

								ANNUAL PRODUCTION		MONTHLY	DAILY	ORGANIC WASTE	PAPER	GLASS	METALS	PLASTICS	WOOD	LANDSCAPE DEBRIS	RUBBER, LEATHER, & TEXTILES	OTHER	TOTAL
RESIDENTIAL	**GSF**		**UNITS**				**FACTOR**	**TONS/YR**	**LBS/YR**	**LBS/MO**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**	**LBS/DAY**
R1 - Townhomes	144,000.00	96,480.00	48.00				0.91	43.68	87,360.00	7,280.00	239.34	36.14	61.99	10.53	21.78	31.35	14.84	31.83	-	30.88	239.34
R2 - Villas	114,600.00	76,782.00	58.00				0.91	52.78	105,560.00	8,796.67	289.21	43.67	74.90	12.73	26.32	37.89	17.93	38.46	-	37.31	289.21
R3 - Condos	323,136.00	115,060.00	132.00				0.91	120.12	240,240.00	20,020.00	658.19	99.39	170.47	28.96	59.90	86.22	40.81	87.54	-	84.91	658.19
Total	**581,736.00**	**288,322.00**	**238.00**	-	-	-		**216.58**	**433,160.00**	**36,096.67**	**1,186.74**	**179.20**	**307.37**	**52.22**	**107.99**	**155.46**	**73.58**	**157.84**	-	**153.09**	**1,186.74**
RESIDENTIAL OVER RETAIL	**1st Level - GSF**	**2nd Level - GSF**	**Units**																		
M1A - Loft Over Retail	9,000.00	9,000.00	10.00				0.91	9.10	18,200.00	1,516.67	49.86	7.53	12.91	2.19	4.54	6.53	3.09	6.63	-	6.43	49.86
M1B - Loft Over Retail	18,000.00	18,000.00	15.00				0.91	13.65	27,300.00	2,275.00	74.79	11.29	19.37	3.29	6.81	9.80	-	-	-	24.23	74.79
Total	**27,000.00**	**27,000.00**	**25.00**	-	-	-		**22.75**	**45,500.00**	**3,791.67**	**124.66**	**18.82**	**32.29**	**5.48**	**11.34**	**16.33**	**3.09**	**6.63**	-	**30.67**	**124.66**
HOSPITALITY	**Keys**		**GSF**																		
S2 - Harbor House Inn & Cafe	42.00		41,285.00				0.0011	43.35	86,698.50	7,224.88	237.53	35.87	61.52	10.45	21.62	31.12	14.73	31.59		30.64	237.53
Over the Water Villas	-		-				0.0011	-	-	-	-	-	-	-	-	-				-	-
Total	**42.00**	-	**41,285.00**	-	-	-		**43.35**	**86,698.50**	**7,224.88**	**237.53**	**35.87**	**61.52**	**10.45**	**21.62**	**31.12**	**14.73**	**31.59**	-	**30.64**	**237.53**
OFFICE	**1st Level - GSF**	**2nd Level - GSF**																			
Harbor Master / Marina Ops	1,000.00	500.00					0.0013	1.95	3,900.00	325.00	10.68	1.61	2.77	0.47	0.97	1.40				3.46	10.68
Customs House & Immigration	1,000.00	500.00					0.0013	1.95	3,900.00	325.00	10.68	1.61	2.77	0.47	0.97	1.40				3.46	10.68
Port Security	750.00						0.0013	0.98	1,950.00	162.50	5.34	0.81	1.38	0.24	0.49	0.70				1.73	5.34
Charter & Yacht Sales	1,000.00						0.0013	1.30	2,600.00	216.67	7.12	1.08	1.84	0.31	0.65	0.93				2.31	7.12
Property Leasing & Sales	2,500.00						0.0013	3.25	6,500.00	541.67	17.81	2.69	4.61	0.78	1.62	2.33				5.77	17.81
Development Offices		2,000.00		500.00			0.0013	2.60	5,200.00	433.33	14.25	2.15	3.69	0.63	1.30	1.87				4.62	14.25
Total	**6,250.00**	**3,000.00**	-	**500.00**	-	-	**0.01**	**12.03**	**24,050.00**	**2,004.17**	**65.89**	**9.95**	**17.07**	**2.90**	**6.00**	**8.63**	-	-	-	**21.35**	**65.89**
RESTAURANT	**1st Level - GSF**	**2nd Level - GSF**	**1st Level Outdoor Space**	**2nd Level Outdoor Space**	**Seats**	**TYPE**															
Dining - Sit Down (2 levels)	2,000.00	1,500.00	1,000.00	1,500.00			0.0057	34.20	68,400.00	5,700.00	187.40	28.30	48.54	8.25	17.05	24.55				60.72	187.40
Dining - Sit Down (2 levels)	2,000.00	1,500.00	1,000.00	1,500.00			0.0057	34.20	68,400.00	5,700.00	187.40	28.30	48.54	8.25	17.05	24.55				60.72	187.40
Bahamas Style Restaurant	750.00		500.00				0.0057	7.13	14,250.00	1,187.50	39.04	5.90	10.11	1.72	3.55	5.11				12.65	39.04
Harbor House - Mariner's Inn & Café	3,706.00																				
Sports Bar & Grill	1,500.00		500.00				0.0057	11.40	22,800.00	1,900.00	62.47	9.43	16.18	2.75	5.68	8.18				20.24	62.47
Seafood Grill	980.00		400.00				0.0057	7.87	15,732.00	1,311.00	43.10	6.51	11.16	1.90	3.92	5.65				13.96	43.10
Café - Coffee & Pastries	1,000.00		500.00				0.0057	8.55	17,100.00	1,425.00	46.85	7.07	12.13	2.06	4.26	6.14				15.18	46.85
Deli, Sandwiches, Pizza, etc	750.00		500.00				0.0057	7.13	14,250.00	1,187.50	39.04	5.90	10.11	1.72	3.55	5.11				12.65	39.04
Juice Bar	750.00		-				0.0057	4.28	8,550.00	712.50	23.42	3.54	6.07	1.03	2.13	3.07				7.59	23.42
Ice Cream / Gelato	750.00		-				0.0057	4.28	8,550.00	712.50	23.42	3.54	6.07	1.03	2.13	3.07				7.59	23.42
Total	**14,186.00**	**3,000.00**	**4,400.00**	**3,000.00**	-	-	**0.05**	**119.02**	**238,032.00**	**19,836.00**	**652.14**	**20.04**	**34.38**	**5.84**	**12.08**	**17.39**	-	-	-	**43.01**	**132.74**
LEEWARD HARBOR												PAGE 2									
RETAIL	**1st Level - GSF**	**2nd Level - GSF**																			
Fresh Market	2,500.00	-					0.0045	11.25	22,500.00	1,875.00	61.64	9.31	15.97	2.71	5.61	8.08				19.97	61.64
Fish Munger / Butcher	1,500.00	-					0.0045	6.75	13,500.00	1,125.00	36.99	5.58	9.58	1.63	3.37	4.85				11.98	36.99
Liquor / Beer / Wine	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66	3.72	6.39	1.08	2.24	3.23				7.99	24.66
Tobacco & Humidor	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66	3.72	6.39	1.08	2.24	3.23				7.99	24.66
Womens Clothing Boutique	1,750.00	-					0.0045	7.88	15,750.00	1,312.50	43.15	6.52	11.18	1.90	3.93	5.65				13.98	43.15
Mens Clothing Boutique	1,750.00	-					0.0045	7.88	15,750.00	1,312.50	43.15	6.52	11.18	1.90	3.93	5.65				13.98	43.15
Bahamas Art Gallery	1,250.00	-					0.0045	5.63	11,250.00	937.50	30.82	4.65	7.98	1.36	2.80	4.04				9.99	30.82
Salon - hair & nails	1,250.00	-					0.0045	5.63	11,250.00	937.50	30.82	4.65	7.98	1.36	2.80	4.04				9.99	30.82
Sundry	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66	3.72	6.39	1.08	2.24	3.23				7.99	24.66
Chandlary / Marine Store / Sport Fishing and Fly Fishing	2,500.00	-					0.0045	11.25	22,500.00	1,875.00	61.64	9.31	15.97	2.71	5.61	8.08				19.97	61.64
Jewelry Store	1,000.00	-					0.0045	4.50	9,000.00	750.00	24.66	3.72	6.39	1.08	2.24	3.23				7.99	24.66
Fitness Center	-	2,000.00					0.0045	9.00	18,000.00	1,500.00	49.32	7.45	12.77	2.17	4.49	6.46				15.98	49.32
Scuba Diving, Rental (scooters, kayaks, parasailing, day sailing etc)	1,500.00						0.0045	6.75	13,500.00	1,125.00	36.99	5.58	9.58	1.63	3.37	4.85					
Marina Laundry	1,000.00						0.0045	4.50	9,000.00	750.00	24.66	3.72	6.39	1.08	2.24	3.23					
Total	**19,000.00**	**2,000.00**	-	-	-	-	**0.06**	**94.50**	**189,000.00**	**15,750.00**	**517.81**	**78.19**	**134.11**	**22.78**	**47.12**	**67.83**	-	-	-	**147.80**	**456.16**
COMMERCIAL	**1st Level - GSF**	**2nd Level - GSF**	**SLIPS**																		
BOH, Central Receiving & Housekeeping	7,480.00						0.0016	11.97	23,936.00	1,994.67	65.58	9.90	16.98	2.89	5.97	8.59	4.07	8.72		8.46	65.58
Maintenance & Service Area	7,860.00						0.0013	10.22	20,436.00	1,703.00	55.99	8.45	14.50	2.46	5.10	7.33	3.47	7.45		7.22	55.99
Admin Space	1,700.00						0.0013	2.21	4,420.00	368.33	12.11	1.83	3.14	0.53	1.10	1.59	0.75	1.61		1.56	12.11
Circulation	5,112.00						0.0013	6.65	13,291.20	1,107.60	36.41	5.50	9.43	1.60	3.31	4.77	2.26	4.84		4.70	36.41
FBO	2,250.00						0.0013	2.93	5,850.00	487.50	16.03	2.42	4.15	0.71	1.46	2.10	0.99	2.13		2.07	16.03
				OCCUPANCY																	
Marina			225.00	100%			2.55	573.08	1,146,150.00	95,512.50	3,140.14	474.16	813.30	138.17	285.75	411.36				1,017.40	3,140.14
Total	**24,402.00**	-	**225.00**	**1.00**	-	-		**607.04**	**1,214,083.20**	**101,173.60**	**3,326.26**	**502.26**	**861.50**	**146.36**	**302.69**	**435.74**	**11.54**	**24.75**	-	**1,041.41**	**3,326.26**
TOTAL LEEWARD HARBOR MSW ESTIMATE								**1,115.26**	**2,230,523.70**	**185,876.98**	**6,111.02**	**922.76**	**1,582.76**	**268.89**	**556.10**	**800.54**	**102.94**	**220.81**	-	**1,636.25**	**6,049.38**
TOTAL KAKONA MSW								**2,206.33**	**4,412,657.50**	**367,721.46**	**12,089.47**	**1,825.51**	**3,131.17**	**531.94**	**1,100.14**	**1,583.72**	**389.13**	**834.74**	**1.00**	**2,673.15**	**12,028.83**

APPENDIX H - COASTAL ENGINEERING REPORT

KAKONA DEVELOPMENT
THE ABACOS, BAHAMAS

COASTAL ENGINEERING REPORT

Prepared by:

moffatt & nichol

KAKONA DEVELOPMENT
THE ABACOS, BAHAMAS

COASTAL ENGINEERING REPORT

Prepared for:

KAKONA

Rev No	A	B	–	–	–
Issue Purpose	Draft	Final			
Date	6/12/2019	6/21/2019			
By	NP	NP			
Checked	MAP	MAP			
Approved	NMP	NMP			

moffatt & nichol

EXECUTIVE SUMMARY

Moffatt & Nichol (M&N) has prepared this Coastal Engineering Report to support the environmental permitting and design of the Kakona Development (Project) located in South Abaco, the Bahamas. The development comprises three properties: Leeward Harbor (LH), Conch Sound Point (CSP), and High Bank Bay (HBB). This report was prepared as an appendix to the Environmental Impact Assessment (EIA), prepared by others.

General and Offshore Metocean Conditions

The following meteorological and oceanographic (metocean) conditions were collected to evaluate the site-specific conditions for each site and establish design parameters for the planned waterfront developments.

- The great tidal range in South Abaco is approximately 0.9 m (2.95 ft) while the mean tidal range is in the order of 0.7 m (2.3 ft). The MHW is approximately 0.4 m (1.31) above MSL and the MLLW 0.4 m (1.31 ft) below MSL.

- NOAA's 2017 Intermediate Sea Level Rise Scenario projects a future SLR of 0.57 m (1.87 ft) in 50 years (2070).

- The prevailing offshore winds east of the Abaco Islands are from east-northeast to the south-southeast directions. Stronger winds are from the east-northeast direction. The 1% annual exceedance wind is approximately 25 knots (kt).

- The 1-minute duration design extreme wind speed in the vicinity of the Project varies from approximately 119 kt to 137 kt for the 25- to 100-year return periods. The respective extreme central pressure varies from 943 to 918 hPa.

- The majority of the prevailing offshore waves, east of the Abaco Islands, range from 1 m to 2 m (3.28 ft to 6.56 ft) with a period between 7 and 9 seconds. The 1% annual exceedance offshore significant wave height is 3.9 m (12.8 ft).

- The design extreme offshore wave heights east of the Abaco Islands vary from 11.6 m to 15.2 m (38.0 ft to 49.9 ft) for 25- to 100-year return periods while the corresponding peak wave periods vary from 14.6 s to 16.8 s.

Leeward Harbor

The marina basin at Leeward Harbor was evaluated for nearshore prevailing winds, extreme water levels and waves, and water quality to support the design of the marina, marina entrance channel, and identify preliminary flood elevations at the shoreline. The results of the analyses were as follows:

- The nearshore transformed prevailing waves are generally from SE with significant wave heights near the marina entrance of less than 0.30 m (0.98 ft). The annual 1% exceedance significant wave height is 1.05 m (3.44 ft).

- The 100-yr storm maximum significant wave height is 3.21 m (10.53 ft) near the marina entrance channel and 1.39 m (4.55 ft) near the flushing channel. These extreme wave heights were used to define the flood elevations and will be used to develop harbor entrance design structures in the next phase.

- 100-year flood elevations at the shoreline are between 2.93 m (9.61 ft) and 4.93m (16.18 ft) above MSL. The combination wind and wave conditions used to develop the flood elevations are conservative and should only be used as guidance. The selection of first floor elevations for building structures should be based on the 100-year flood elevation as a boundary condition and refined using a coastal inundation analysis, final site grading, and local building codes (foundation design).

- The agitation study indicated that an entrance structure was required to reduce wave heights inside the basin to an average significant wave height of 0.84 m (2.76 ft) with a maximum significant wave height of 1.4 m (4.59 ft), the latter observed near the entrance channel. The final alignment and configuration of the jetty will be evaluated during the final phase of the project to further reduce wave agitation in the basin.

- Flushing and water exchange analyses were performed to evaluate marina spill response conditions and overall marina water quality, respectively. The results of the flushing analysis indicate the harbor meets the guidelines provided by the BEST commission (concentration reduction to 10% of the original spill in 24 hours). The results of the overall water exchange analysis showed that 90% of the water in the basin exchanged within 5 to 6 days which is consistent with industry guidelines for marinas.

Conch Sound Point and High Bank Bay

The lagoons at Conch Sound Point (CSP) and High Bank Bay (HBB) were evaluated for extreme water levels and overall water quality.

- The nearshore transformed prevailing waves are generally from ENE and E with a significant wave height of less than 1.5 m (4.92 ft) and 1.10 m (3.60 ft) for CSP and HBB, respectively.

- The 100-year storm maximum significant wave height at the lagoon entrances is 1.91 m (6.27 ft) CSP and 1.58 m (5.19 ft) at HBB.

- The 100-year flood elevations near the shoreline range from 3.23 m (10.61 ft) to 3.67 m (12.03 ft) above MSL.

- The results of the water exchange analysis for the lagoons showed that 90% of the water of the lagoon is exchanged in approximately 6 days.

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1.0 INTRODUCTION

Moffatt & Nichol (M&N) was retained by South Abaco Land Development Company (Saldco-USA) to conduct a Coastal Engineering Study to support the proposed marine infrastructure at the Kakona Development (Project) located in South Abaco, the Bahamas as shown in Figure 1-1.

Kakona Development comprises three properties: Leeward Harbor (LH), Conch Sound Point (CSP), High Bank Bay (HBB). This report was prepared as an appendix to the Environmental Impact Assessment (EIA), prepared by others. Methodology and results presented in this report are intended to support the final design and environmental permitting for the waterfront development at the three proposed sites.

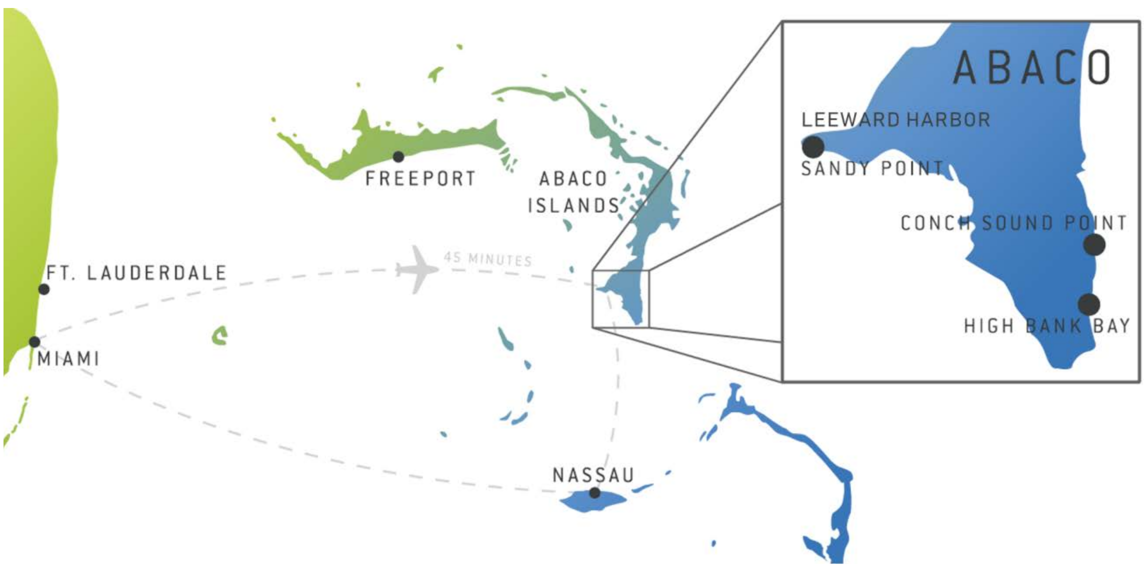


Figure 1-1: Project Location[1]

The report begins with the description of the metocean conditions at the Project location which are essential to developing design parameters for the marine works. The meteorological and oceanographic (metocean) conditions for the three proposed sites were evaluated including the determination of design conditions (winds, wave, and water levels) and the development of a resiliency framework.

The report is structured to discuss the hydrodynamic and spectral wave model development that serves as the foundation for the remaining analyses which include flushing, nearshore wave transformation (LH only), and storm surge. The report concludes with the optimization of the marina entrance channel to minimize harbor wave agitation.

[1] https://www.kakona.com/executive-summary/

2.0 METOCEAN DATA

M&N conducted a statistical analysis based on available wind and offshore wave data at the locations presented in Figure 2-1. Winds and waves for operational (prevailing) conditions were evaluated and extreme conditions were determined through an extreme value analysis (EVA). Nearshore waves and storm surges were obtained from the regional hydrodynamic and wave model results. See Section 3.0 for more information on the model setup and execution. Tides and sea level rise data is also presented.

Figure 2-1: Location of Offshore Waves and Winds Data

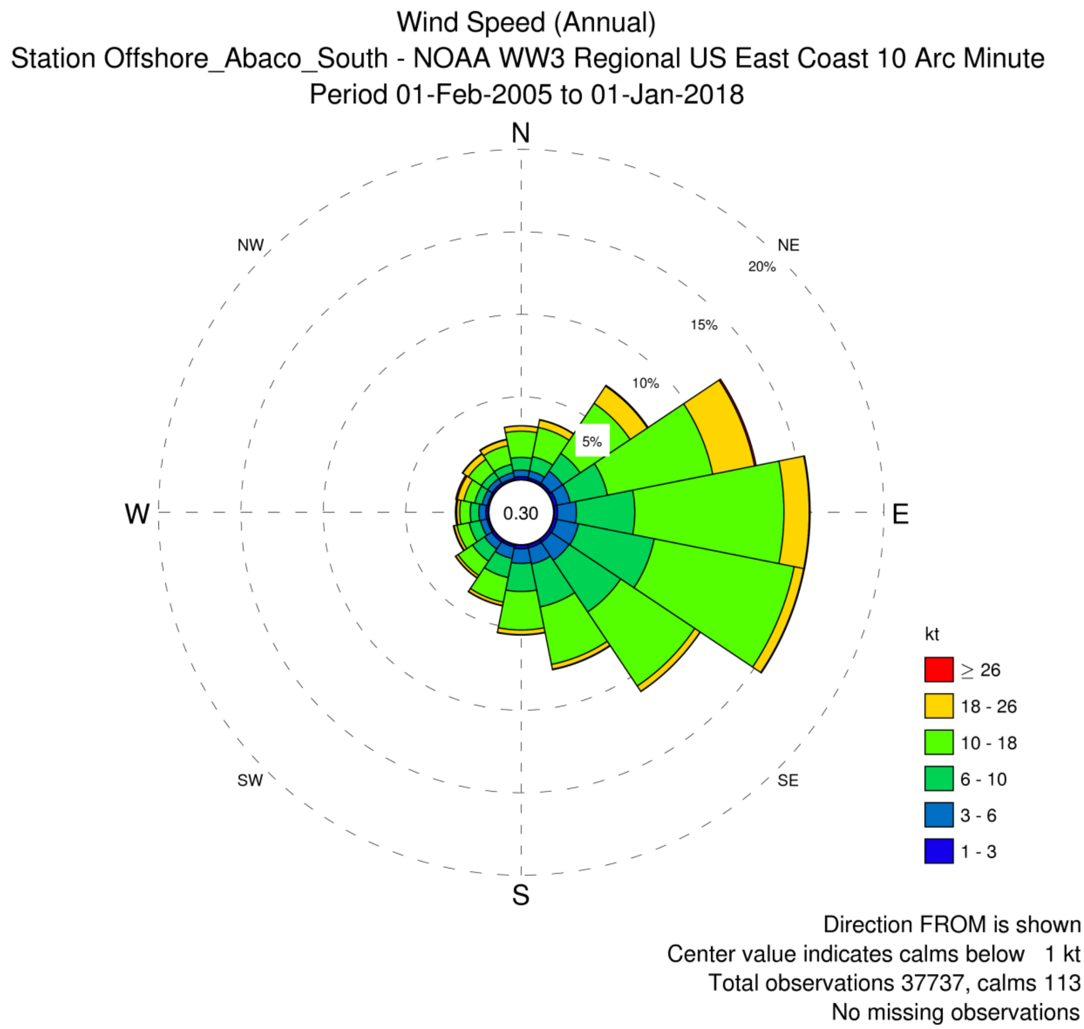
2.1 Wind

Wind data was extracted from the WAVEWATCH III® (WW3) model to evaluate operational conditions and develop the annual wind rose and exceedance chart. An EVA assessment of the maximum sustained 1-minute, 30-minute and 1-hour average wind speed associated with the 1, 25, 50 and 100-year return periods was performed using data from the National Hurricane Center (NHC) Hurricane Database (HURDAT2), maintained by NOAA.

2.1.1 Operational (Prevailing) Wind Conditions

Thirteen years of 1-minute averaged wind data were extracted from the WW3 Production Hindcast, Multigrid Model at a point located approximately 20 kilometers south of the Abaco Islands (see Figure 2-1) to perform statistical analysis of wind in the site vicinity. The WW3 wind data is obtained from the operational Global Forecast System and represents the wind fields at 10 m elevation with at 1/2 degree resolution and 3 hour intervals.

The analyzed annual wind rose and exceedance probability for the WW3 wind data are illustrated in Figure 2-2 and Figure 2-3. The prevailing winds are from east-northeast to the south-southeast directions. Stronger winds are from the east-northeast direction. The analyzed monthly and seasonal wind roses are showed in Appendix A.



Percentage of Occurrence

Wind Speed, kt	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	3.25	3.73	7.26	12.53	15.52	15.52	11.07	7.73	5.44	3.78	2.80	2.20	1.99	2.05	2.30	2.52	99.70
26 –				0.10													0.69
18 – 26	0.32	0.46	1.26	2.59	1.54	0.59	0.39	0.30	0.28	0.20	0.17	0.18	0.19	0.41	0.41	0.36	9.63
10 – 18	1.59	1.80	3.65	6.51	9.05	8.66	5.40	3.55	2.33	1.52	1.05	0.76	0.64	0.67	0.94	1.16	49.29
6 – 10	0.77	0.89	1.29	2.31	3.54	4.69	3.77	2.66	1.70	1.18	0.89	0.70	0.53	0.46	0.47	0.51	26.34
3 – 6	0.39	0.43	0.87	0.81	1.14	1.34	1.30	1.00	0.89	0.71	0.51	0.40	0.42	0.32	0.32	0.35	11.21
1 – 3	0.17	0.13	0.14	0.21	0.20	0.20	0.19	0.19	0.21	0.14	0.16	0.11	0.15		0.14	0.10	2.54

Figure 2-2: Annual Wind Rose South of the Abaco Islands

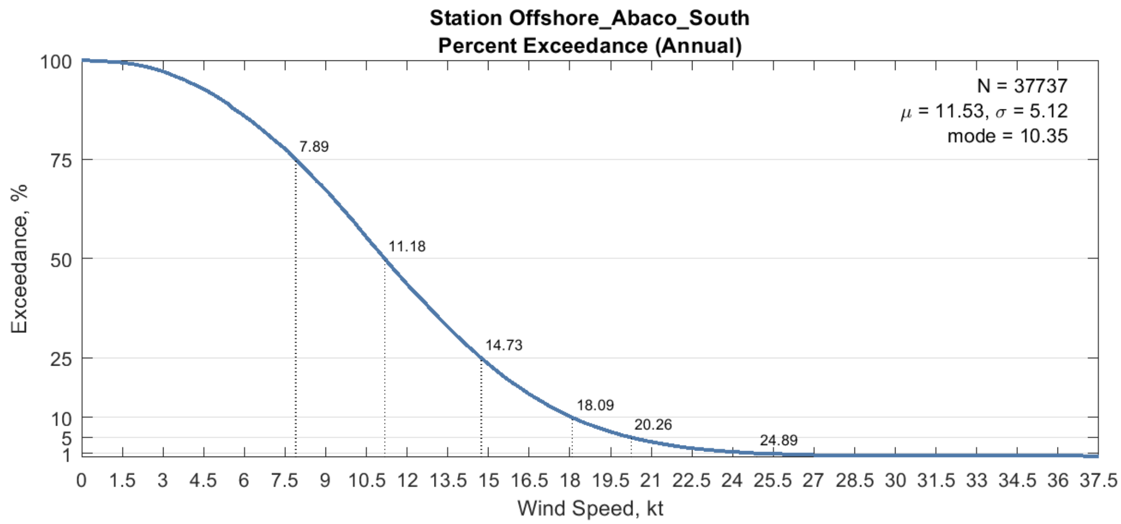


Figure 2-3: Wind Percent Exceedance South of the Abaco Islands

Table 2-1 presents the exceedance wind speeds and the percent exceedance of specified wind speeds based on WW3 wind model data south of the Abaco Islands.

Table 2-1: Operational Wind Conditions South of Abaco Islands

Annual Wind Speed Exceedance		Annual Percentages of Exceedance	
6 kt	86%	**75%**	7.89 kt
15 kt	23%	**50%**	11.18 kt
18 kt	10%	**25%**	14.73 kt
21 kt	4%	**10%**	18.09 kt
24 kt	1%	**5%**	20.26 kt
36 kt	<0.1%	**1%**	24.89 kt

2.1.2 Extreme Wind Conditions

Hurricane wind data was obtained from the HURDAT2, which contains tropical storm and hurricane information from 1851 to 2017, and the NOAA hurricanes website[2]. Available information from these databases include storm tracks, minimum central pressures, maximum sustained wind speeds (1-minute average, 10 m elevation), and wind radii (distance to specific wind speed from the storm center).

According to the NOAA Historical Hurricane Tracks Tool, a total of 91 storms have passed within a 120 km (65 nautical miles) radius of the project location since 1851 (Figure 2-4). Table 2-3 presents those hurricanes and storms and associated maximum wind speed, central pressure, and category observed when passing through the analyzed radius (see

[2] From: https://coast.noaa.gov/hurricanes/

Table 2-2 for reference). Values are given to the nearest 10 kt for the years 1851 through 1885 and to the nearest 5 kt from 1886 onward. This dataset was used for the EVA.

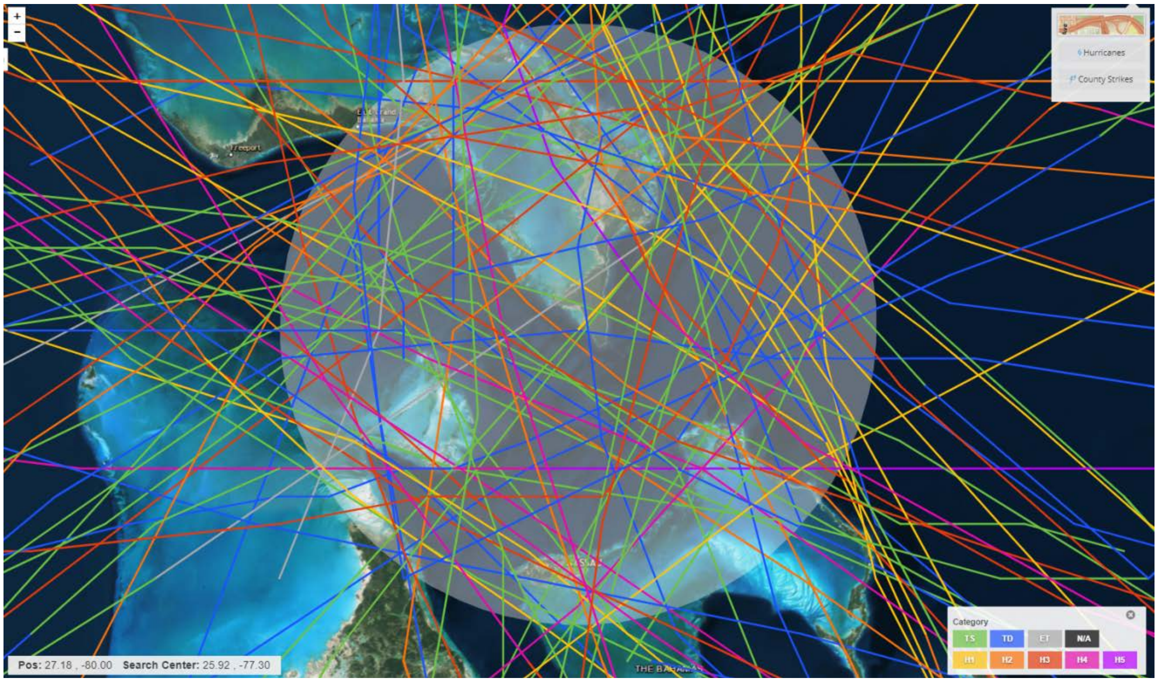


Figure 2-4: Hurricane Tracks at Project Site

Table 2-2: Saffir-Simpson Hurricane Wind Scale[3]

Saffir-Simpson Category	Maximum Sustained Wind Speed		
	mph	km/h	knots
1	74–95	119-153	64–82
2	96–110	154-177	83–95
3	111–129	178–208	96–112
4	130–156	209-251	113–136
5	>157	>252	>137

The analysis was performed following the methodology by Goda (2000). The extreme values were used to find the best-fit extreme value probability distribution from several distributions.

Figure 2-5 shows the Weibull (k=2) extreme value probability distribution, which is the best-fit to the analyzed maximum sustained surface wind, defined as the maximum 1-min average wind at an elevation of 10 m with an unobstructed exposure. The largest wind speeds are associated with Hurricanes Andrew (Aug. 1992) and Unnamed (Sept. 1932).

[3] https://www.nhc.noaa.gov/pdf/sshws.pdf

Table 2-3: Historical Hurricanes and Storms (1851-2018) within a 120 km Radius

#	Date	Name	Wind Speed (kt)	Central Pressure (hPA)	Cat.
1	7-Sep-1854	UNNAMED	110	938	H3
2	16-Oct-1859	UNNAMED	60	-	TS
3	2-Oct-1866	UNNAMED	120	938	H4
4	12-Oct-1870	UNNAMED	90	-	H2
5	16-Aug-1871	UNNAMED	100	952	H3
6	24-Aug-1871	UNNAMED	90	-	H2
7	26-Sep-1877	UNNAMED	40	-	TS
8	25-Aug-1878	UNNAMED	40	996	TS
9	17-Aug-1879	UNNAMED	80	-	H1
10	18-Aug-1881	UNNAMED	50	-	TS
11	9-Sep-1883	UNNAMED	90	-	H2
12	22-Aug-1887	UNNAMED	105	-	H3
13	8-Sep-1888	UNNAMED	45	1002	TS
14	27-Aug-1893	UNNAMED	105	954	H3
15	11-Oct-1893	UNNAMED	105	955	H3
16	21-Oct-1893	UNNAMED	40	-	TS
17	3-Oct-1895	UNNAMED	50	-	TS
18	22-Oct-1895	UNNAMED	90	-	H2
19	5-Sep-1896	UNNAMED	100	956	H3
20	19-Oct-1897	UNNAMED	55	-	TS
21	23-Oct-1897	UNNAMED	50	-	TS
22	27-Sep-1898	UNNAMED	45	-	TS
23	13-Aug-1899	UNNAMED	105	-	H3
24	15-Oct-1899	UNNAMED	30	-	TD
25	9-Aug-1901	UNNAMED	40	-	TS
26	11-Sep-1903	UNNAMED	75	976	H1
27	21-Oct-1904	UNNAMED	20	-	TD
28	1-Oct-1908	UNNAMED	95	-	H2
29	28-Aug-1909	UNNAMED	40	-	TS
30	12-Oct-1909	UNNAMED	90	957	H2
31	15-Sep-1914	UNNAMED	35	-	TS
32	4-Sep-1916	UNNAMED	35	-	TS
33	16-Nov-1916	UNNAMED	50	1006	ET
34	29-Sep-1923	UNNAMED	65	-	H1
35	22-Oct-1924	UNNAMED	60	986	TS
36	26-Jul-1926	UNNAMED	115	-	H4
37	16-Sep-1926	UNNAMED	35	-	TS
38	2-Nov-1927	UNNAMED	35	-	TS
39	16-Sep-1928	UNNAMED	135	929	H4
40	25-Sep-1929	UNNAMED	135	924	H4
41	14-Oct-1931	UNNAMED	30	-	TD
42	5-Sep-1932	UNNAMED	140	-	H5
43	29-Jul-1933	UNNAMED	70	-	H1
44	3-Sep-1933	UNNAMED	120	945	H4
45	5-Oct-1933	UNNAMED	105	-	H3
46	6-Sep-1934	UNNAMED	70	-	H1
47	22-Sep-1934	UNNAMED	25	-	TD
48	4-Nov-1935	UNNAMED	90	964	H2
49	15-Jun-1936	UNNAMED	40	1002	TS

#	Date	Name	Wind Speed (kt)	Central Pressure (hPA)	Cat.
50	21-Aug-1936	UNNAMED	35	-	TS
51	4-Aug-1937	UNNAMED	35	-	TS
52	29-Aug-1937	UNNAMED	40	-	TS
53	27-Sep-1937	UNNAMED	30	-	TD
54	19-Oct-1938	UNNAMED	35	-	TS
55	11-Aug-1939	UNNAMED	65	-	H1
56	13-Sep-1943	UNNAMED	35	-	TS
57	13-Sep-1946	UNNAMED	65	975	H1
58	16-Sep-1947	UNNAMED	105	954	H3
59	6-Oct-1947	UNNAMED	35	-	ET
60	26-Aug-1949	UNNAMED	110	954	H3
61	14-Aug-1956	BETSY	105	960	H3
62	7-Oct-1958	JANICE	65	987	H1
63	12-Sep-1961	UNNAMED	30	-	TD
64	7-Sep-1965	BETSY	110	952	H3
65	18-Jul-1966	CELIA	25	-	TD
66	29-May-1969	UNNAMED	25	-	TD
67	6-Sep-1969	GERDA	25	1014	TD
68	12-Sep-1970	FELICE	25	-	TD
69	29-Aug-1971	UNNAMED	25	-	TD
70	22-Jul-1980	UNNAMED	30	-	TD
71	24-Nov-1984	UNNAMED	25	-	TD
72	30-May-1987	UNNAMED	30	-	TD
73	10-Aug-1987	ARLENE	25	1009	TD
74	13-Oct-1987	FLOYD	50	994	TS
75	13-Aug-1988	UNNAMED	30	-	TD
76	29-Jun-1991	ANA	20	1012	TD
77	23-Aug-1992	ANDREW	140	923	H5
78	1-Jun-1993	UNNAMED	30	999	TD
79	1-Aug-1995	ERIN	75	985	H1
80	28-Aug-1999	DENNIS	75	976	H1
81	14-Sep-1999	FLOYD	110	930	H3
82	5-Nov-2001	MICHELLE	75	980	H1
83	3-Sep-2004	FRANCES	95	956	H2
84	25-Sep-2004	JEANNE	100	956	H3
85	22-Jul-2005	FRANKLIN	45	1006	TS
86	25-Aug-2005	KATRINA	50	997	TS
87	2-Nov-2007	NOEL	70	980	H1
88	6-Aug-2011	EMILY	30	1011	TD
89	25-Aug-2011	IRENE	90	950	H2
90	26-Oct-2012	SANDY	70	968	H1
91	6-Oct-2016	MATTHEW	120	937	H4

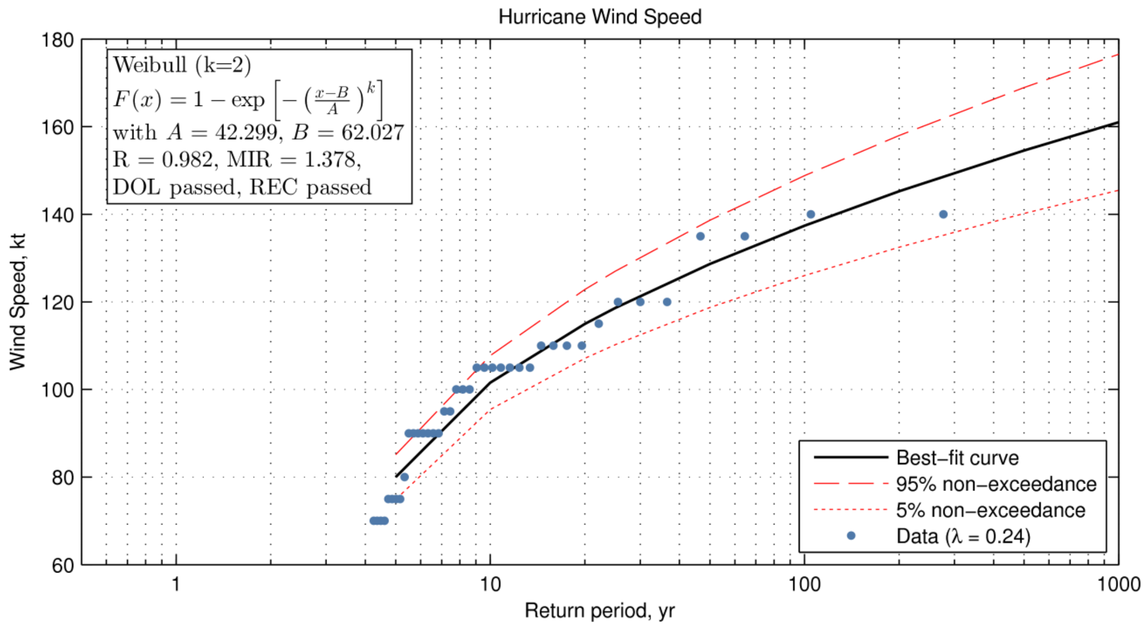


Figure 2-5: Extreme Maximum Sustained Surface Wind Speeds[4]

The best-fit, 5% non-exceedance and 95% non-exceedance maximum sustained surface wind values for selected return periods are given in Table 2-4. A correction of wind speed was performed using ISO 19901-1:2005(E) formulations or method outlined in Coastal Engineering Manual (Fig II-2-1) to obtain the 30-minutes and 1-hour duration wind speeds.

Table 2-4: Extreme Wind Speeds

Return Period, years	Wind Speed (1-min), kt			Hurricane Category††	Wind Speed (30-min), kt	Wind Speed (1-hour), kt
	Best-fit	95% non-exc.	5% non-exc.†	Saffir-Simpson	Best-Fit†	Best-Fit†
5	79.99	85.11	74.87	1	65.10	64.31
10	101.56	107.71	95.41	3	82.66	81.65
25	118.62	127.01	110.22	4	96.54	95.36
50	128.68	138.65	118.71	4	104.73	103.45
100	137.41	148.83	126.00	5	111.84	110.47

† Converted with ISO 19901-1:2005(E) formulation
†† Based on the maximum sustained wind (1-min) best-fit (see also, Table 2-2)

[4] The following parameters are shown in figure: λ is the mean rate of extreme events, R is the correlation coefficient, MIR is the "goodness of fit" test (MInimum Ratio of residual correlation coefficient), DOL is the Deviation of OutLier test, and REC is the REsidue of Correlation coefficient test (Goda, 2000)

The extreme winds from this analysis were used to establish the extreme wave heights and storm surge at the project vicinity by using the coupled hydrodynamic and spectral wave model as presented further in this report.

2.1.3 Extreme Central Pressures

In order to determine the pressure setup for the storm surge analysis, the extreme central pressures were evaluated using the same methodology as the extreme winds analysis. Hurricane minimum central pressure data was obtained from the same HURDAT2 database as described in section 2.1.2 and is presented in Table 2-3.

Similar to the offshore wind and waves extreme analysis, the methodology by Goda (2000) was adopted. The extreme values were used to find the best-fit extreme value probability distribution from several distributions.

Figure 2-6 shows the Weibull (k=2) extreme value probability distribution, which is the best-fit to the analyzed minimum central pressure. The lowest pressures are associated with Hurricanes Andrew (Aug. 1992), and Unnamed (Sept. 1929).

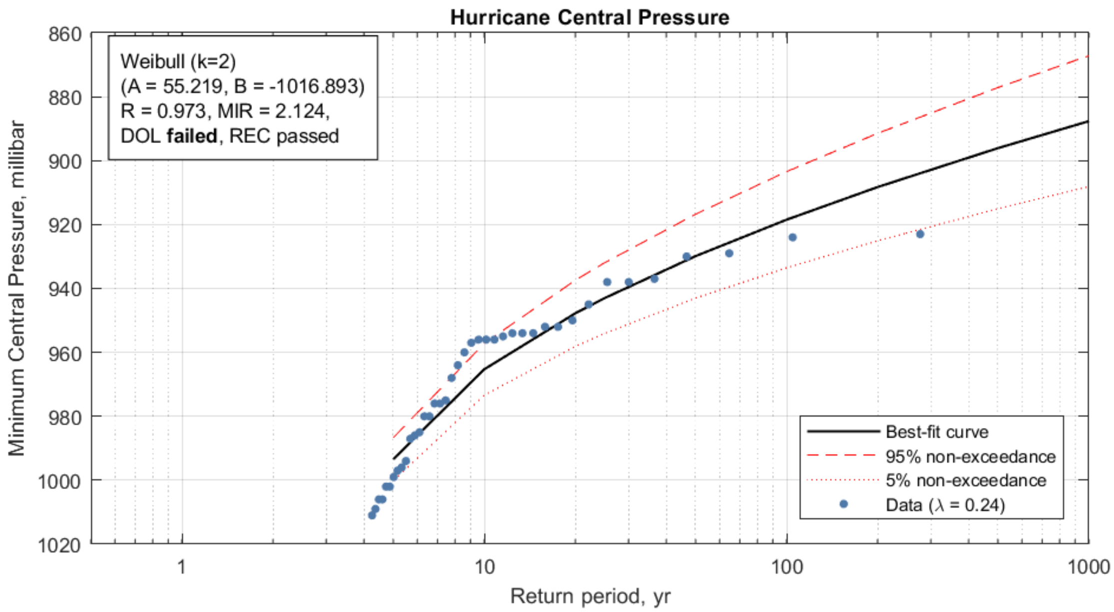


Figure 2-6: Extreme Minimum Hurricane Central Pressure[5]

The best-fit, 5% non-exceedance and the 95% non-exceedance central pressure values for selected return periods are given in Table 2-5.

[5] The following parameters are shown in figure: λ is the mean rate of extreme events, R is the correlation coefficient, MIR is the "goodness of fit" test (MInimum Ratio of residual correlation coefficient), DOL is the Deviation of OutLier test, and REC is the REsidue of Correlation coefficient test (Goda, 2000)

Table 2-5: Extreme Central Pressures

Return Period, years	Central Pressure (hPa)		
	Best-fit	95% non-exc.	5% non-exc.†
5	993.44	986.7	1000.19
10	965.29	957.18	973.39
25	943.02	931.96	954.08
50	929.88	916.74	943.02
100	918.48	903.44	933.53

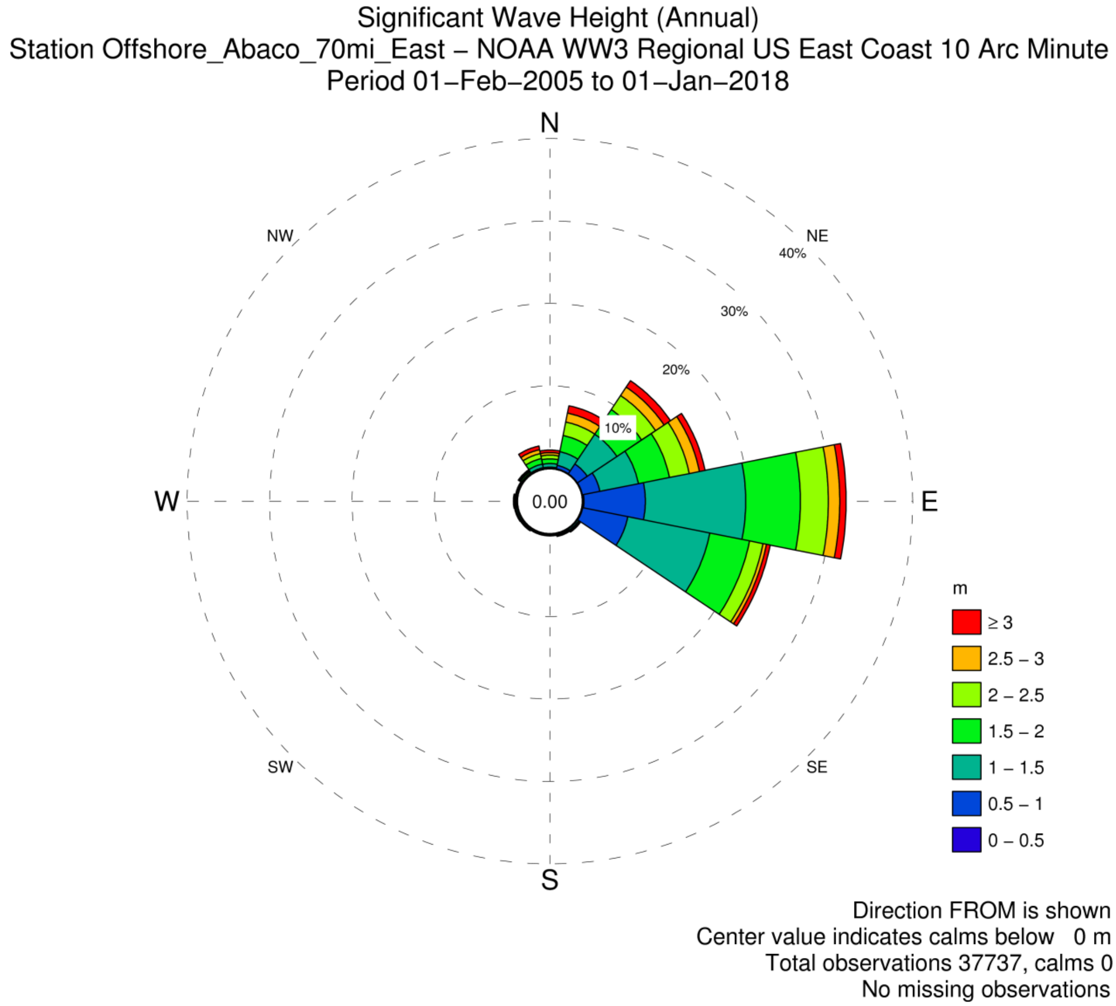
Similar results could be obtained based on a fitted relationship between atmospheric pressure and wind speeds. For instance, the central pressures of actual storms with approximately the same wind speed as the 128.68 kt 50-year return period wind (storms number 39 and 40 in Table 2-3) are 929 and 924 hPa respectively, which is comparable to the 929.88 hPa result obtained from the central pressure extreme analysis for the same return period.

2.2 Waves

Wave data from the NOAA WW3 Model were used to perform statistical analysis of operational and extreme waves offshore the Project site. Approximately thirteen years of wave data (Feb/2005 to Jan/2018) were extracted from the WW3 Production Hindcast, Multigrid Regional US East Coast 10 Arc Minute Model results at a point located approximately 112 km (70 mi) east of the Abaco Islands (see Figure 2-1). The data include a time series of bulk wave parameters (significant wave heights, peak wave periods, and peak wave directions for sea and swell) at 3-hour intervals. It is important to note that the production hindcast data set consists of 13 years of data and may therefore over predict the high return period events.

2.2.1 Operational Offshore Waves

The annual wave rose and the exceedance chart were developed for evaluating the operational conditions. The analyzed annual wave rose at the offshore location is illustrated in Figure 2-7. Based on the statistics, generally the prevailing waves are from E and ESE. The analyzed monthly and seasonal wave roses are showed in Appendix B.



Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total	2.21	7.81	13.58	15.18	31.93	23.25	0.49	0.36	0.20	0.20	0.32	0.37	0.42	0.24	0.61	2.83	100.00
≥ 3	0.32	0.91	0.93	0.69	0.77	0.47	0.12									0.46	4.87
2.5 – 3	0.30	1.10	1.23	1.26	1.39	0.41										0.48	6.44
2 – 2.5	0.46	1.66	2.05	2.45	3.39	1.67									0.14	0.62	12.82
1.5 – 2	0.57	2.01	3.60	3.84	6.63	4.91							0.12		0.17	0.67	23.04
1 – 1.5	0.43	1.69	4.33	4.76	12.18	10.14	0.18	0.11			0.11	0.17	0.14		0.10	0.45	34.95
0.5 – 1	0.14	0.42	1.44	2.16	7.44	5.57										0.15	17.63
0 – 0.5					0.14												0.24

Figure 2-7: Annual Wave Rose East of Abaco

The exceedance chart is illustrated in Figure 2-8 and Table 2-6 summarizes the offshore operational wave conditions.

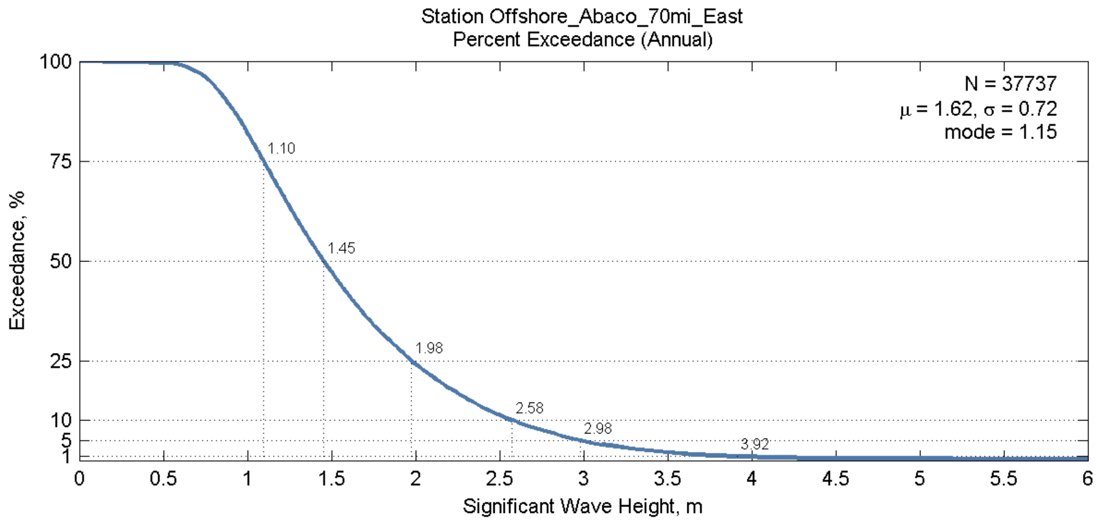


Figure 2-8: Percent Exceedance Wave Heights East of Abaco

Table 2-6: Operational Wave Conditions East of Abaco

Annual Significant Wave Height Exceedance		**Annual Percentages of Exceedance**	
1.0 m	82%	**75%**	1.1 m
1.5 m	47%	**50%**	1.5 m
2.0 m	24%	**25%**	2.0 m
3.0 m	5%	**10%**	2.6 m
4.0 m	1%	**5%**	3.0 m
5.5 m	<0.1%	**1%**	3.9 m

The significant wave heights and associated peak wave periods were analyzed, and the annual joint histogram is presented in Figure 2-9. The majority of the waves range from 1 to 2 m with a period between 7 and 9 seconds.

The nearshore wave operational conditions were derived from the offshore wave data transformation by using the regional wave propagation model presented further on this report.

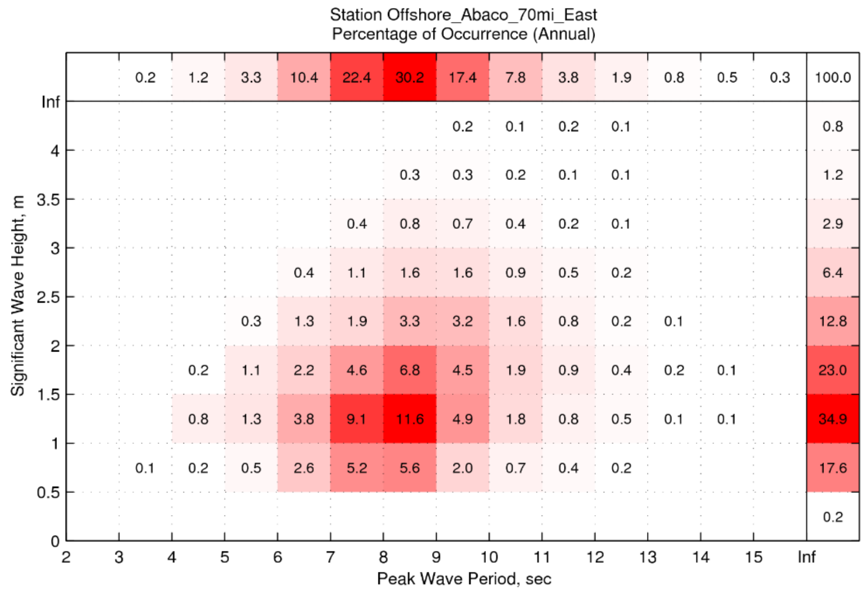


Figure 2-9: Joint Histogram – Offshore Significant Wave Height and Period

2.2.2 Extreme Offshore Waves

The extreme wave heights for the 1, 25, 50 and 100-year return period events were derived from the WW3 hindcast data. The analysis was performed following the methodology by Goda (2000). A set of peak values were identified using the peak-over-threshold method. The method identifies events using a threshold (a 99.5-percentile value was used). A maximum for each event was identified as the peak value. The extreme values were used to find the best-fit extreme value probability distribution from several distributions. Figure 2-10[6] shows the Weibull (k=0.75) extreme value probability distribution, which is the best-fit to the analyzed data.

The peak period was estimated based on a fitted Weibull (k=0.75) distribution between the extreme significant wave heights and peak wave periods, which is presented in Figure 2-11.

[6] The following parameters are shown in figure: λ is the mean rate of extreme events, *R* is the correlation coefficient, MIR is the "goodness of fit" test (MInimum Ratio of residual correlation coefficient), DOL is the Deviation of OutLier test, and REC is the REsidue of Correlation coefficient test (Goda, 2000)

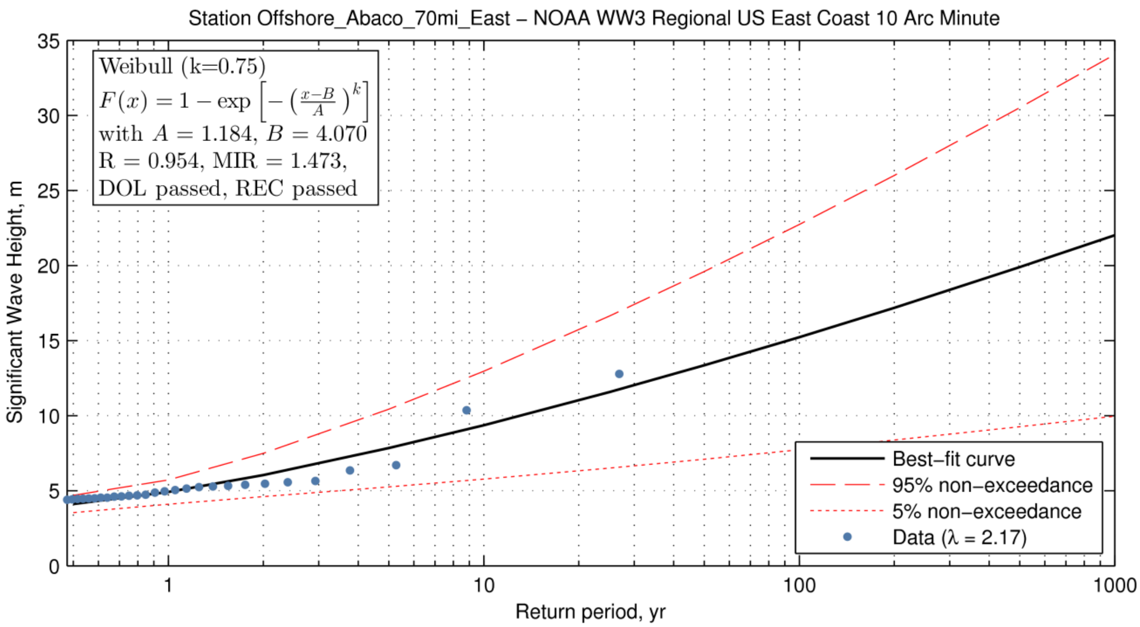


Figure 2-10: Extreme Significant Wave Height Curve East of Abaco

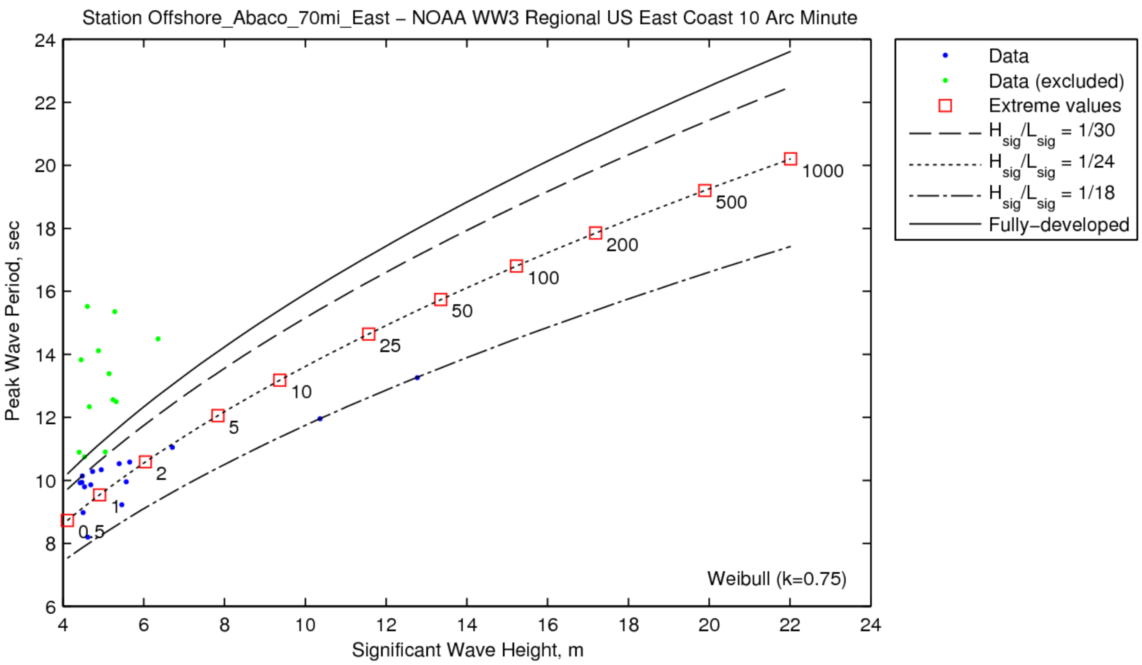


Figure 2-11: Joint Extreme Significant Wave Height and Peak Wave Period Curves

The estimated extreme wave heights at Offshore 1 location and the associated peak period are presented in Table 2-7.

Table 2-7: Estimated Extreme Significant Wave Height East of Abaco

Return Period (year)	Significant Wave Height (m)	Peak Wave Period (sec)
1	4.9	9.5
10	9.4	13.2
25	11.6	14.6
50	13.4	15.7
100	15.2	16.8

The extreme analysis was also performed for the NOAA WW3 reanalysis data set which consists of 30 years of data (1979 to 2009). However, the hindcast data set is recommended for design as it captures the recent increase in storm intensity and frequency, to include hurricanes Irene, Sandy and Matthew that impacted the area after 2009. The longer data set (reanalysis) would provide lower wave heights, in the order of 20% for the greater return periods.

2.3 Tides

Water levels were measured for a duration of one month starting in November 7, 2018 at the locations presented in Figure 2-12 and Table 2-8.

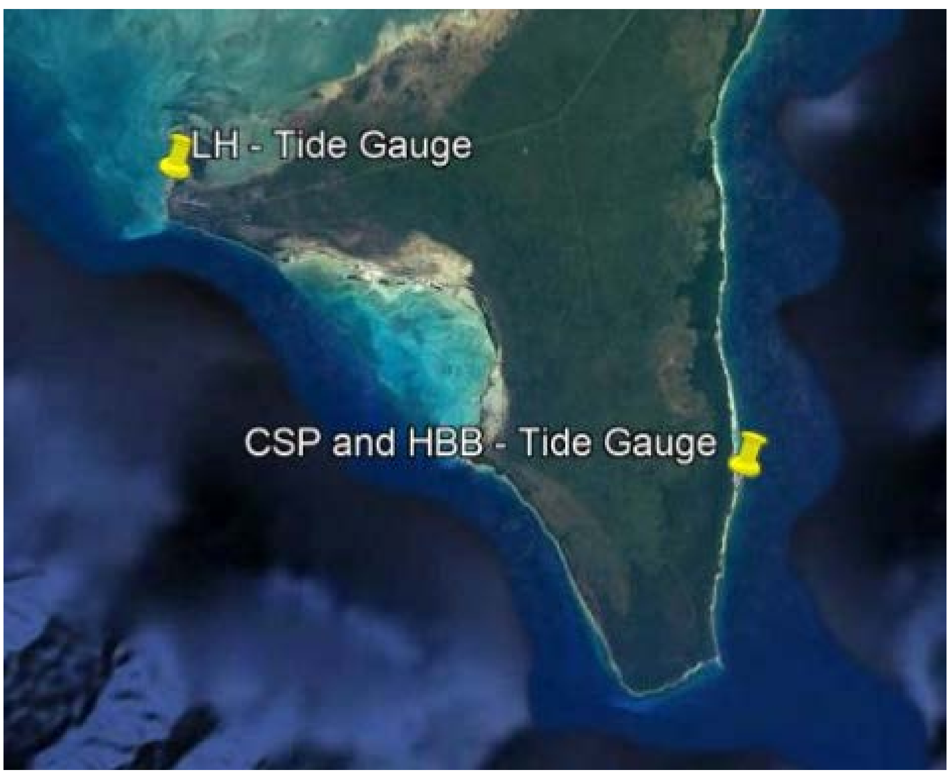


Figure 2-12: Tide Gauges Location (GoogleEarth)

Table 2-8: Tide Gauges Geographical Coordinates

Station	Latitude	Longitude
LH	26° 00' 27.27" N	77° 24' 21.27" W
CSP HBB	25° 55' 3.38" N	77° 10' 46.55" W

Table 2-9 presents the comparison between the tidal datum at the NOAA/COOPS Station 9710441 located at Settlement Point, Grand Bahama Island and the two measured stations.

Table 2-9: Tidal Datum at Station 9710441, and Tide Gauges LH and CSP - HBB

Datum	Description	9710441	LH	CSP - HBB
MHHW	Mean Higher-High Water (m)	0.49	0.49	0.45
MHW	Mean High Water (m)	0.42	0.39	0.35
MSL	Mean Sea Level (m)	0.00	0.00	0.00
MLW	Mean Low Water (m)	-0.42	-0.39	-0.36
MLLW	Mean Lower-Low Water (m)	-0.45	-0.42	-0.38

The great tidal range (MHHW – MLLW) is approximately 0.94 m, 0.91 m, and 0.83 m at the three locations while the mean tidal range (MHW – MLW) is equal to 0.84 m, 0.78 m and 0.71 m respectively.

2.4 Relative Sea Level Rise (SLR)

Sea levels are projected to rise in coming decades as a result of increased global temperatures associated with climate change (IPCC, 2013). When reviewing SLR projections, it is important to distinguish the differences between global and local SLR rates. Local SLR rates discount local effects such as tectonics (i.e., land uplim/subsidence), water temperatures, and wind stress patterns that can act to subdue or amplify the global SLR rates. Local (or relative) SLR refers to the observed changes in sea level relative to the shoreline in a specific region and takes into account these local factors.

A SLR and Resiliency Study was conducted for the Project and is located in Appendix C. This study reviews and summarizes published data on SLR trends, including review of the following:

- National Ocean and Atmospheric Administration (NOAA),
- United States Army Corps of Engineers (USACE),
- National Research Council (NRC), and
- Caribbean Community Climate Chang Centre (CCCC).

The following table outlines the latest SLR projection data by NOAA, which are recommended for the vulnerability and risk assessment in combination with a high tide.

Table 2-10: Sea-Level Rise Projected Water Levels (NOAA)

Scenario	Time Horizon	Sea Level Rise Scenario (NOAA 2017)	Future Sea Level Rise (m)
1	25 Years (2045)	Intermediate	0.30*
2	50 Years (2070)	Intermediate	0.57
3	~100 Years (2100)	Intermediate	1.00

* approx. interpolated value

3.0 HYDRODYNAMIC AND SPECTRAL WAVE NUMERICAL MODELING

Hydrodynamic (HD) and Spectral Wave (SW) numerical modeling was conducted by using the MIKE 21 Flexible Mesh model suite developed by the Danish Hydraulic Institute (DHI) in order to assess:

- The wave propagation from the offshore boundaries to the nearshore project region
- The flushing time and water exchange for the marina at Leeward Harbor and the Conch Sound Point and High Back Bay lagoons
- The design waves and water levels at the project vicinity

3.1 Model Suite

MIKE 21 developed by DHI is an internationally accepted coastal numerical model package. The modeling suite was chosen due to the adaptability of its flexible mesh structure, which allowed for a higher resolution grid in areas of interest, such as the Leeward Harbor marina basin and the Conch Sound Point and High Bank Bay lagoons, without affecting computational time in all areas of the grid.

A MIKE21 flexible mesh was developed and the following modules were used:

The MIKE 21 Spectral Wave module (hereinafter referred to as SW model) was applied to transform waves from offshore to nearshore, as well as to simulate wind-generated waves. The model predicts wave height, period, and directional spectrum by including the effects of wave diffraction, refraction, shoaling, wave breaking, and wetting and drying processes (DHI, 2017a).

The MIKE21 Hydrodynamic module (hereinafter referred to as HD model) is a two-dimensional, depth-averaged model which simulates unsteady free-surface water levels and flows in water bodies where vertical stratification can be ignored (DHI, 2017b). The forcing terms include bottom and wind shear stresses, Coriolis force, barometric pressure gradients, and wave radiation stresses among others. It is designed to model tidal flows, which are dominant in the site area. From its output, parameters such as water levels, discharge and depth-averaged flow velocities can be extracted at any location of interest.

The MIKE21 Transport module (TR) simulates the transport, dispersion and decay of dissolved or suspended substances in water, with hydrodynamic forcings provided by the flow conditions generated by the HD model (DHI 2017c). The substance may be of any kind—conservative or non-conservative, organic or inorganic. The property of substances such as horizontal and vertical diffusivity, viscosity, decay, initial conditions and concentrations are a few of the parameters that are to be described in the model. The spread of materials or substances can be obtained from its output in the form of time-varying concentrations of given components at any location or area of interest. The decay of substances is not considered in the model for the simulations described in this report, as the pollutant is assumed to be conservative. The TR module was used for the flushing and water exchange assessments performed for the marina and lagoons.

3.2 Model Domain

The model domain includes the part of the Atlantic Ocean involving the Grand Bahama, and the Abaco Islands (Figure 3-1). The domain extents are chosen to be far enough from the project location to negate effects of hydrodynamic boundary conditions when solving the fundamental equations. Additionally, the model domain is sufficiently large to account for waves and storm surges generation. The model domain is referenced to the WSG84 UTM Zone 18N coordinate system with units in meters and has approx. 265 km on the N-S direction and 330 km on the S-W direction.

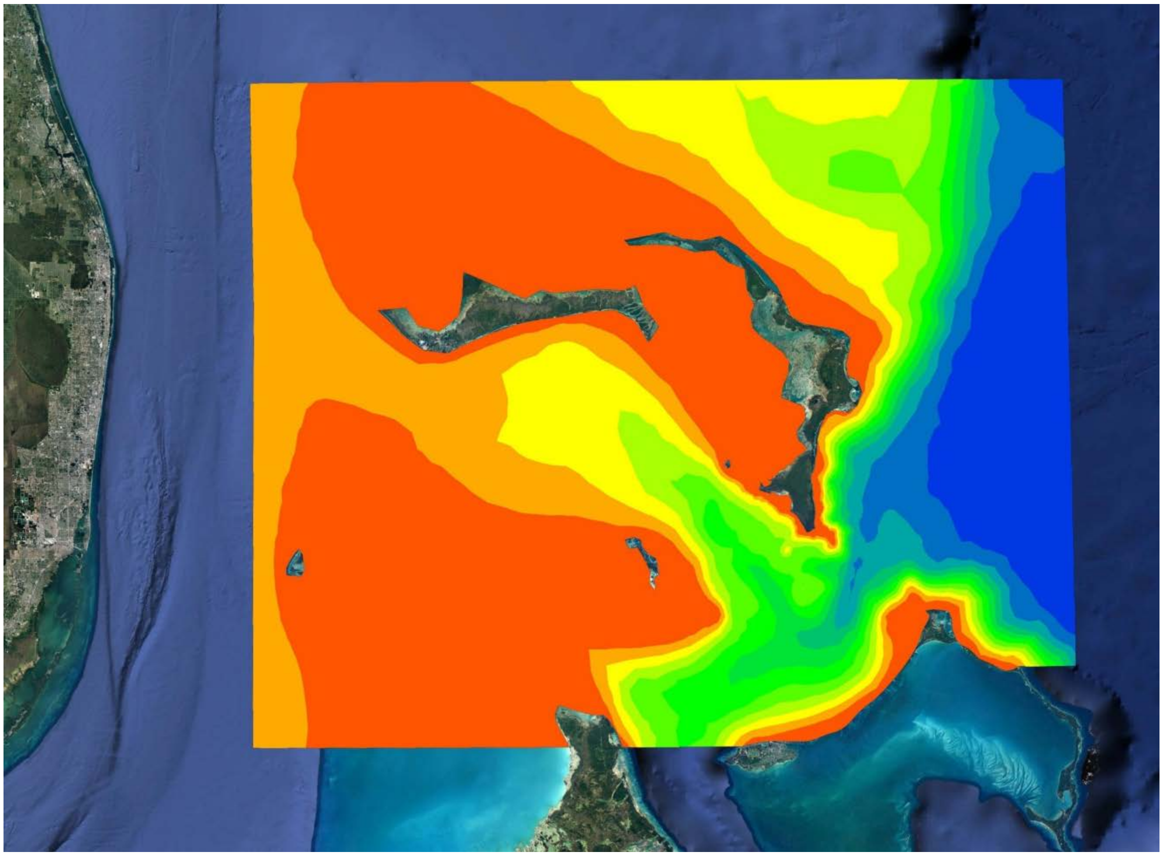


Figure 3-1: Model Domain

The model is composed of a triangulated mesh which has varying resolutions and is enclosed by open boundaries. The mesh resolution varies between 15,200 m and 100 m in the regional and local areas (Figure 3-2 and Figure 3-3), and 20 m to 1 m at the three project sites.

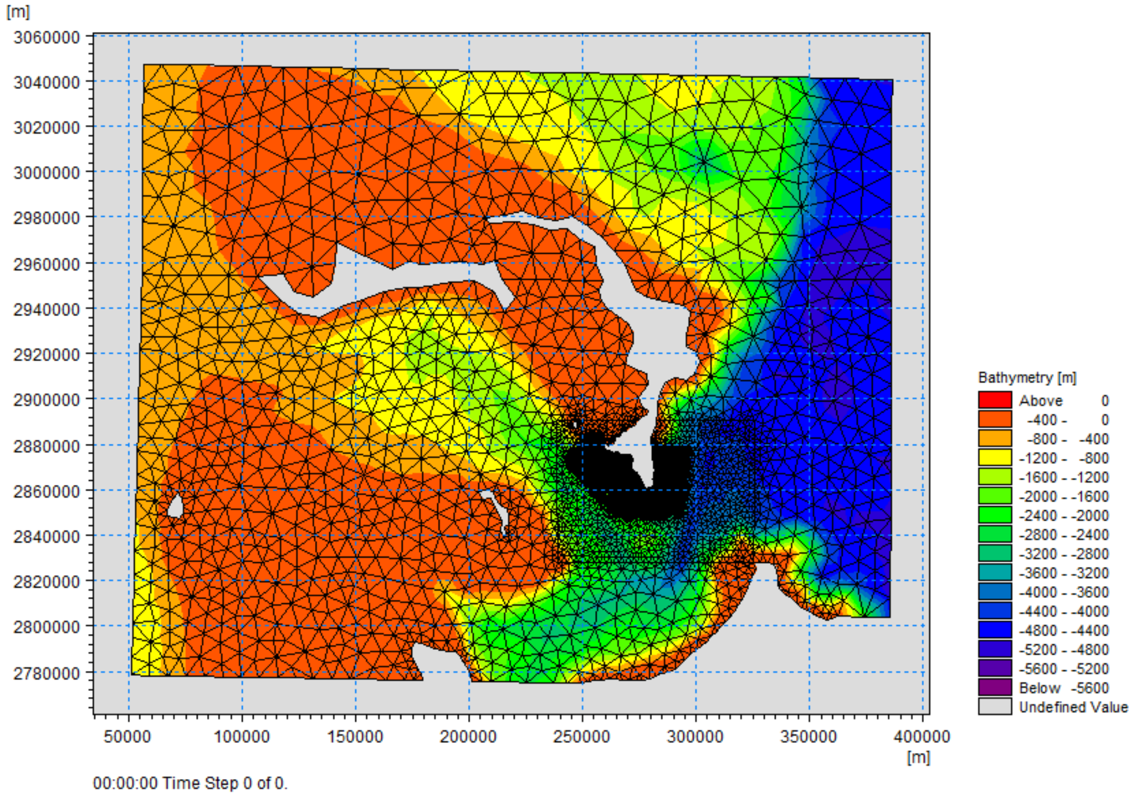


Figure 3-2: Model Mesh – Regional Area Bathymetry (m MSL)

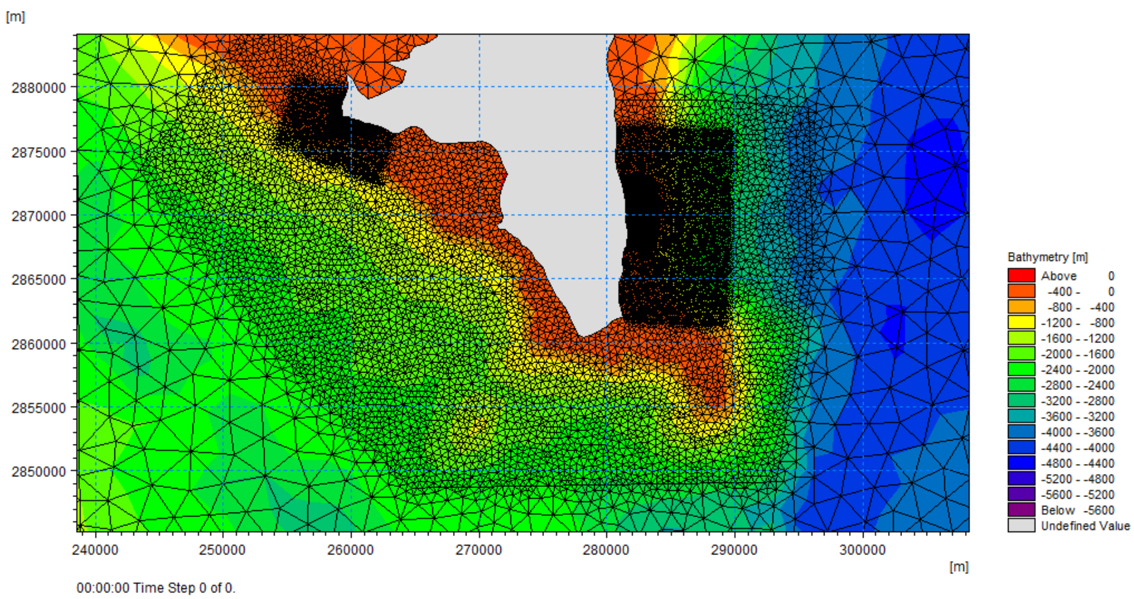


Figure 3-3: Model Mesh – Local Area Bathymetry (m MSL)

The topographic and hydrographic surveys, the Lidar data, and the base files provided by the client were incorporated into the model bathymetry (see coverage of provided data in Figure 3-4). The Jeppesen C-MAP database of digital nautical chart data, via DHI's MIKE

CMAP, supplied the bathymetry in areas not covered by the surveys. Additionally, bathymetric contours were digitalized from Navionics[7] Chart Viewer in the nearshore area of the South Abaco eastern coast.

Figure 3-4: Topography and Bathymetry Data Coverage (LH – CSP – HBB)

The model bathymetry representing the existing conditions at each of the properties is presented in Figure 3-5 to Figure 3-7.

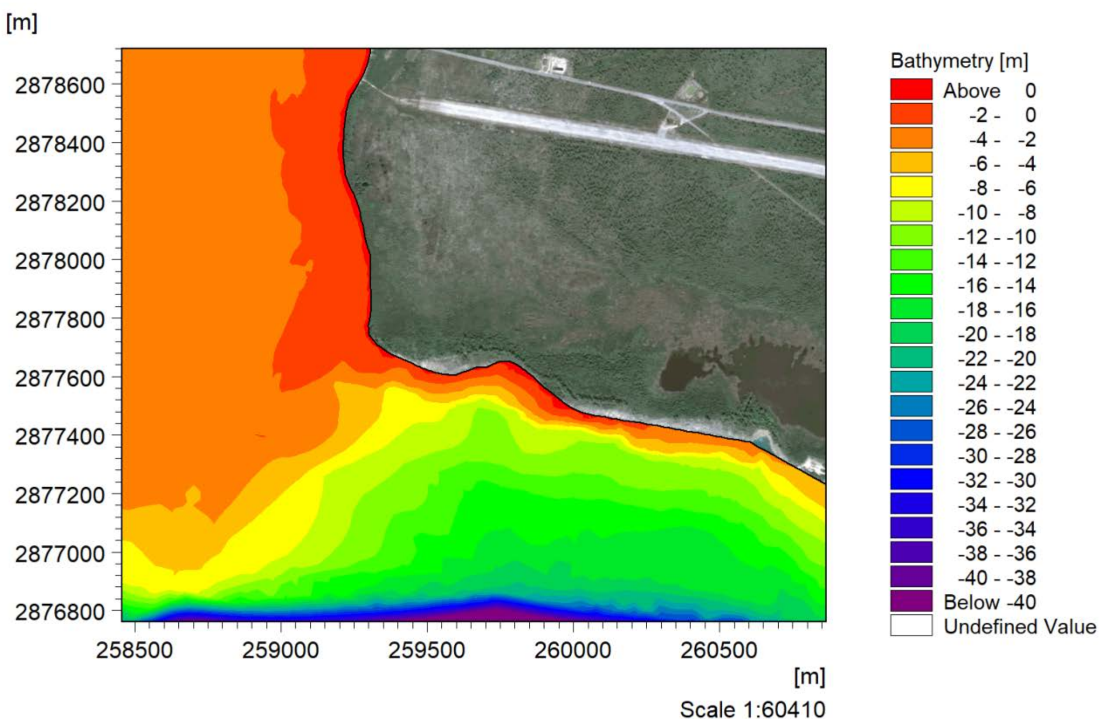


Figure 3-5: Leeward Harbor – Existing Bathymetry (m MSL)

[7] https://www.navionics.com/usa/

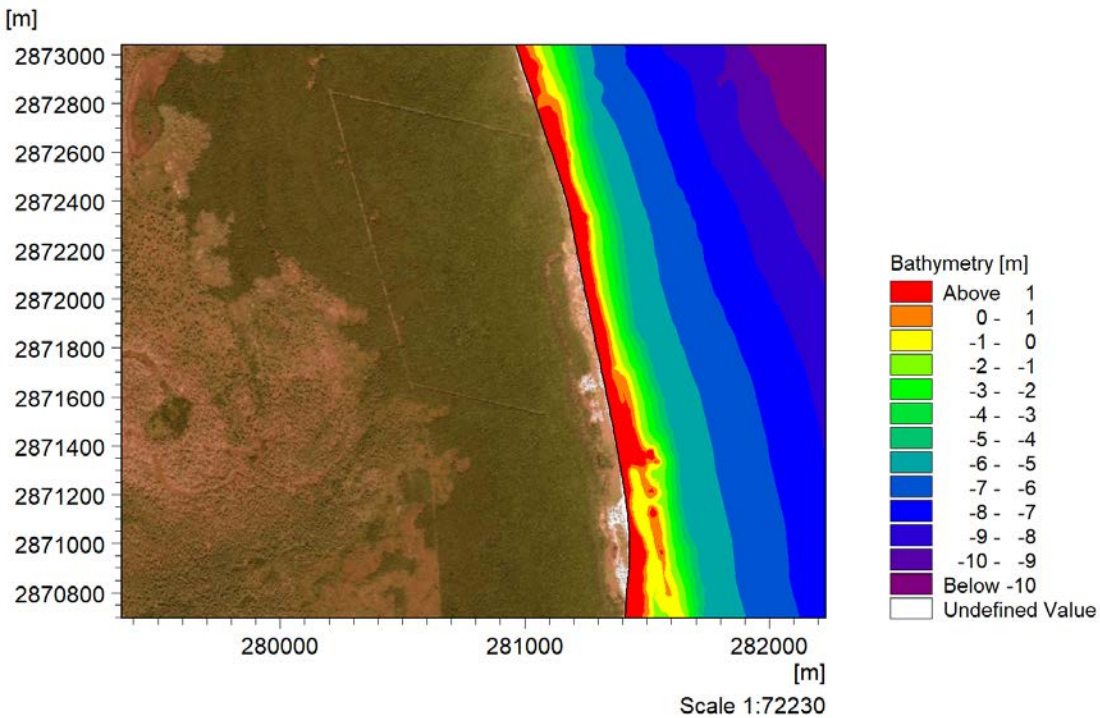


Figure 3-6: Conch Sound Point – Existing Bathymetry (m MSL)

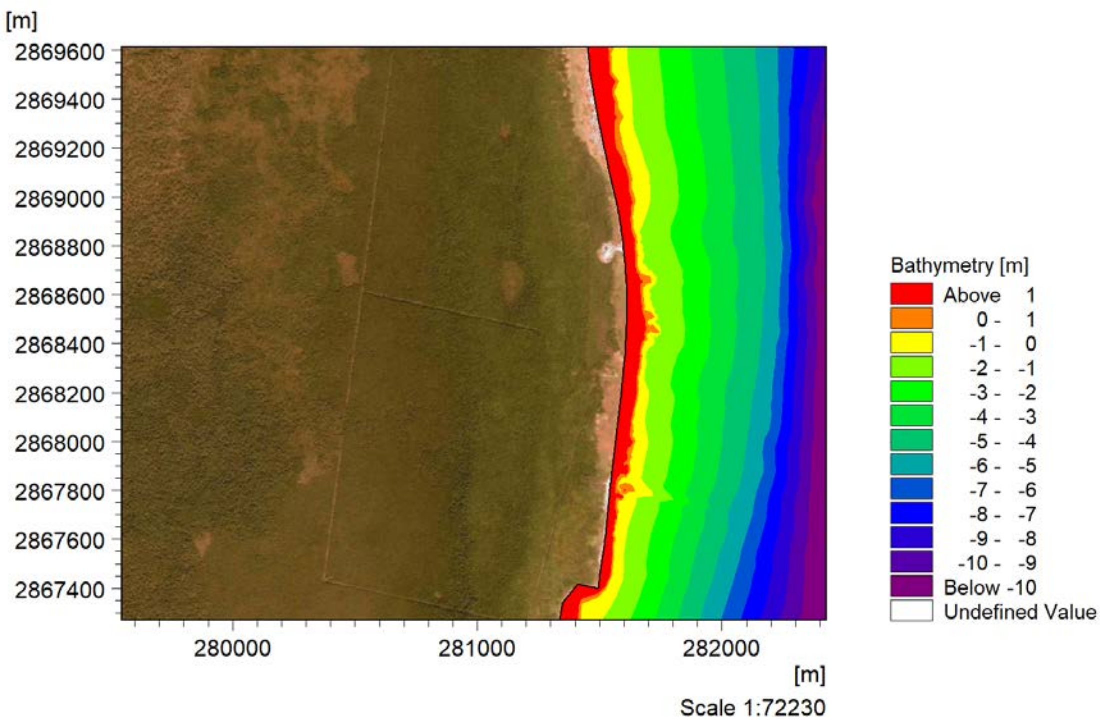


Figure 3-7: High Bank Bay – Existing Bathymetry (m MSL)

3.3 HD Model Calibration

Initially a HD model was calibrated using water level data collected at the locations shown in Table 2-8 and the existing bathymetry presented in the previous subsection. The model was created such that water levels, velocity and discharge are resolved in the areas of interest.

The measured and calculated water levels for the locations presented in Table 2-8 are shown in Figure 3-8 and Figure 3-9. The description of the presented statistical parameters is given in Appendix C.

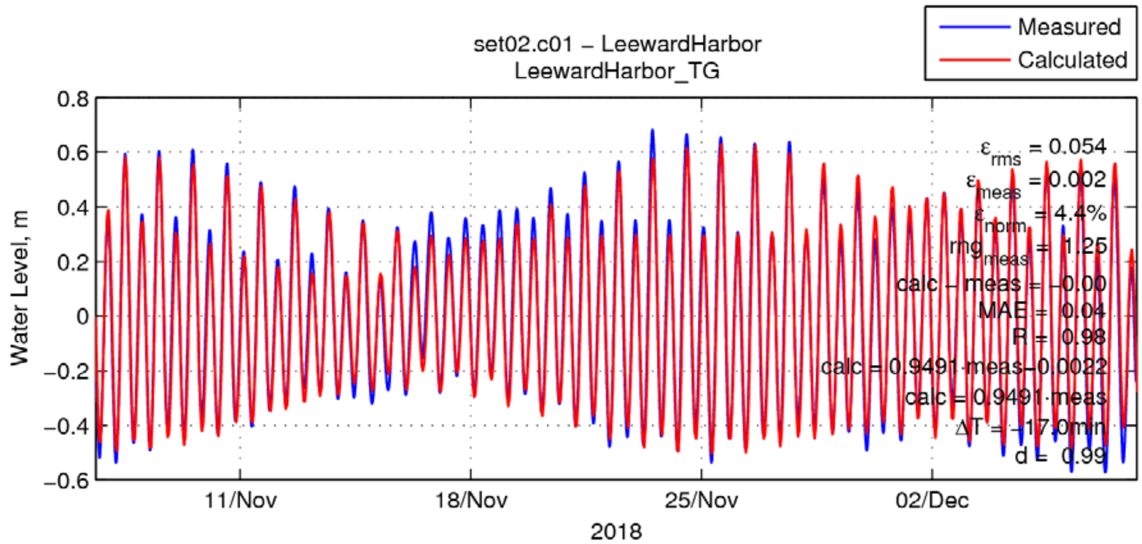


Figure 3-8: HD Model Calibration – Leeward Harbor Tide Gauge

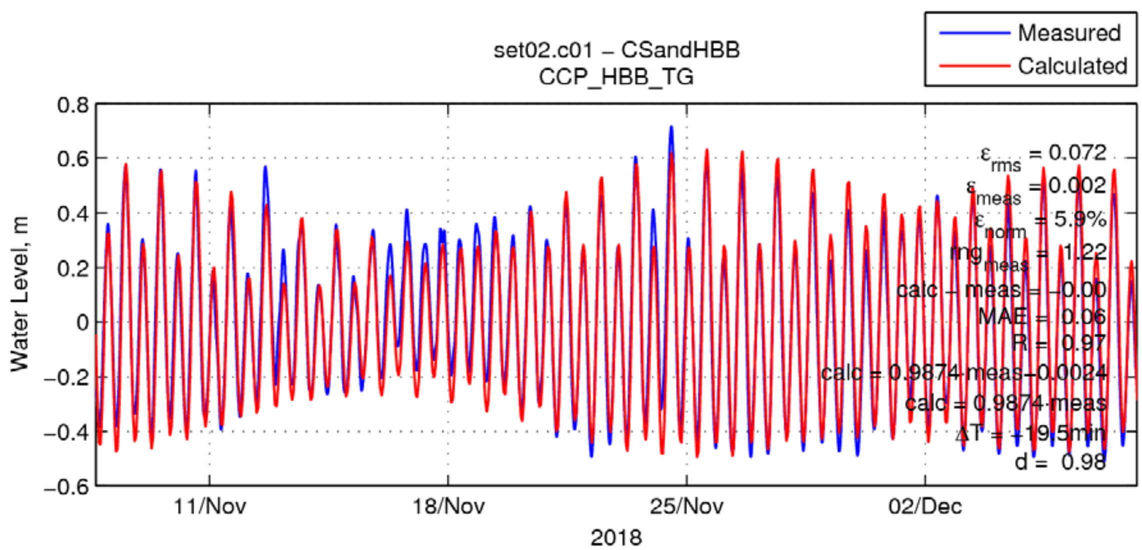


Figure 3-9: HD Model Calibration – CSP and HBB Tide Gauge

The calculated errors are small and the index of agreement “d” is close to one, which indicates a good model prediction capability. The model is considered to adequately reproduce the hydrodynamic conditions and was used for the flushing and water exchange analysis, coupled with the SW model for the extreme waves and storm surge analysis.

The HD calibrated model parameters are presented in Table 3-1.

Table 3-1: Hydrodynamic Model Parameters

Parameter Name	Type	Value
Flood and dry	Standard, on	Default
Density	Barotropic	-
Horizontal eddy viscosity	Smagorinsky formulation data	0.5
Bed resistance	Manning number	40 m^(1/3)/s
Coriolis forcing	Varying in domain	-
Solution method	Low order	

4.0 FLUSHING AND WATER EXCHANGE ANALYSIS

Water quality was evaluated for the Leeward Harbor marina basin and the lagoons at Conch Sound Point and High Bank Bay. For the marina, water quality was evaluated based on two different criteria: the flushing of a fuel tank spill and the overall water exchange. The lagoons were evaluated for overall water exchange only.

The Bahamas Environment, Science and Technology Commission (BEST) requires that the flushing time, defined as the time required for the concentration of a theoretical conservative pollutant to be reduced to 10% of its original concentration, to be equal to or less than 24 hours for marinas. This criterion was verified for a 1,200 gallon fuel tank spill (typical for a 55-foot sport fishing boat) in the marina basin at Leeward Harbor, the only designed water body at which motorized watercrafts will be permitted.

For artificial beaches or swimming lagoons, Mangor et al (2017) states that the flushing can be expressed in terms of a characteristic time "T50", which is the time it takes before 50% of the water in the system has been exchanged with water from the outside the system. According to the same authors, there are no specific requirements for the T50 of beaches or swimming lagoons, but an acceptable value will normally be 5 to 7 days for a natural lagoon and should be preferably shorter for artificial recreational lagoons.

Often the T10 is used instead of the T50 (as it is for the BEST flushing requirement). Therefore, the recommended 5 to 7 days acceptable time for water exchange was evaluated in terms of the T10, averaged over the entire lagoon. Consequently, this approach results in the preferably shorter T50 for artificial lagoons.

The water exchange was evaluated for both the marina and the lagoons by starting the simulation with the entire water body with a non-dimensional concentration of 100 and evaluating the time that it takes for 90% of the water in the system to be exchanged with water from the outside (T10).

In order to analyze both criteria (spill flushing time and overall water exchange), the calibrated HD model was adapted to include the proposed marina and lagoons and coupled with the TR module. The results for each of the three properties are presented in the following sub-sections.

4.1 Leeward Harbor

For the marina at Leeward Harbor, the water quality of the initially proposed layout (Figure 4-1) was evaluated and modifications were proposed to obtain an acceptable water exchange and circulation within the basin.

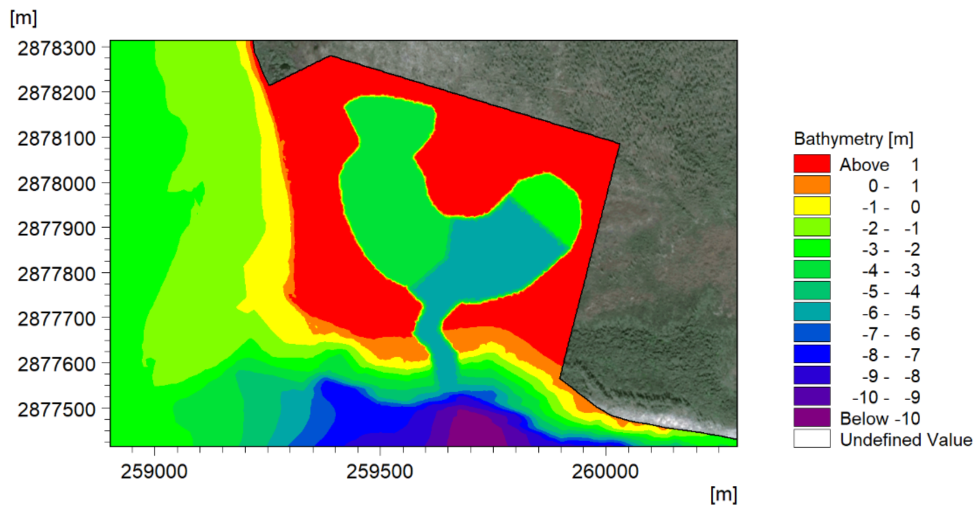


Figure 4-1: Initial Layout for the Marina at Leeward Harbor – Bathymetry (m MSL)

Several combinations of flushing channel location, width and depth were investigated, and the location and width of the entrance channel was also refined. Additionally, different layouts for the marina and respective water depths were assessed. The final marina configuration is presented in Figure 4-2 followed by the flushing analysis discussion. Compared to the initial layout, an approx. 18.3 m (60 ft) wide and 2.2 m MSL deep (1.8 m MLLW, 6 ft MLLW) flushing channel was added at the northwest end of the basin and the entrance channel was moved to the east and widened to approx. 49 m (160 ft) with a 5 m MSL depth (4.6 m MLLW, 15 ft MLLW).

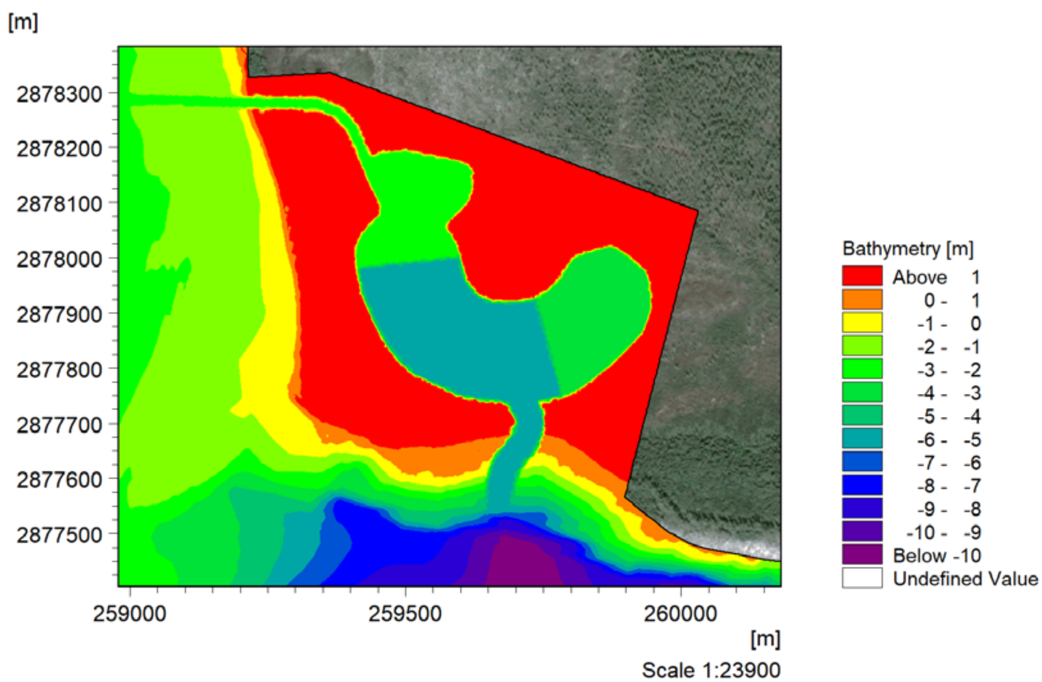


Figure 4-2: Marina at Leeward Harbor Bathymetry (m MSL)

Flushing Analysis

To evaluate the flushing time in the marina, a full fuel tank (1.200 gallons) was considered to be completely spilled in 5 minutes (0.015 m^3/s discharge) at its center, with a non-dimensional concentration of 100.

The spill was simulated on neap tide condition and started at the beginning of a rising tide in order to simulate the less favorable tidal current pattern which is responsible for the dispersion and advection of the pollutant. No wind forcing was considered.

The results are presented in Figure 4-3 to Figure 4-5. After 24 hours of simulation, the depth averaged concentration of the theoretical conservative pollutant is less than 0.5 across the entire marina basin compared to the 100 units of concentration of the simulated spill.

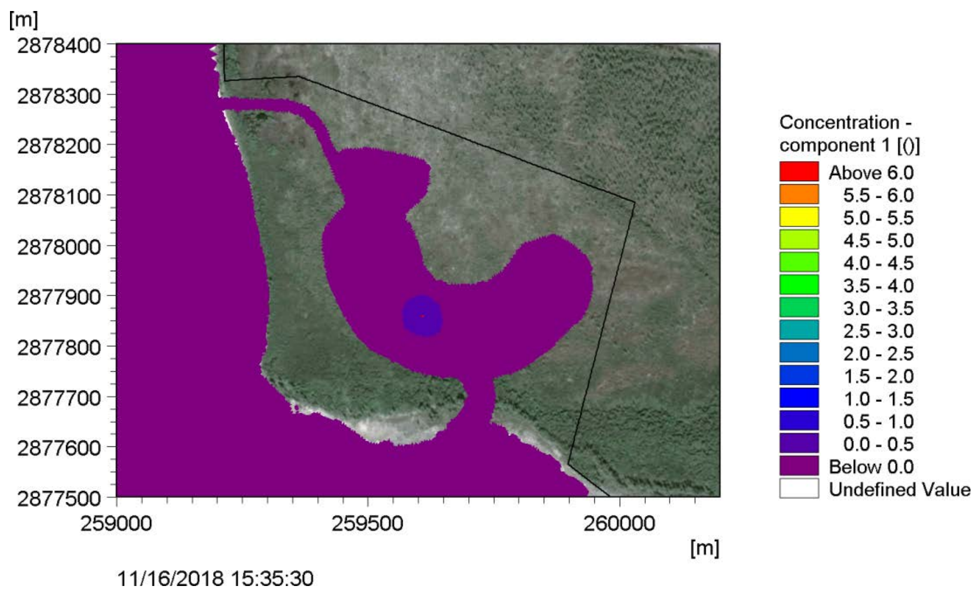


Figure 4-3: Depth Averaged Concentration at the End of the Spill

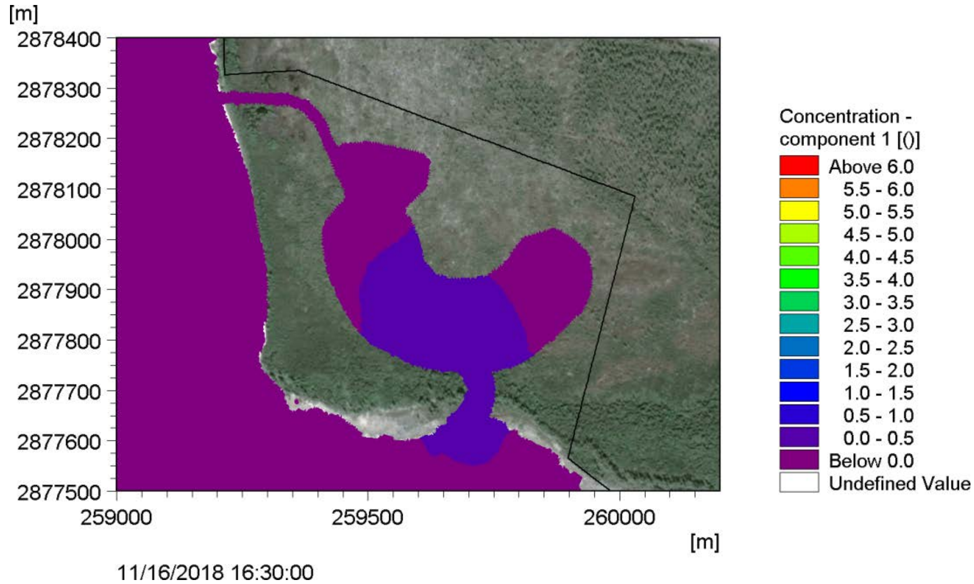


Figure 4-4: Depth Averaged Concentration 1 Hour from the Simulation Start

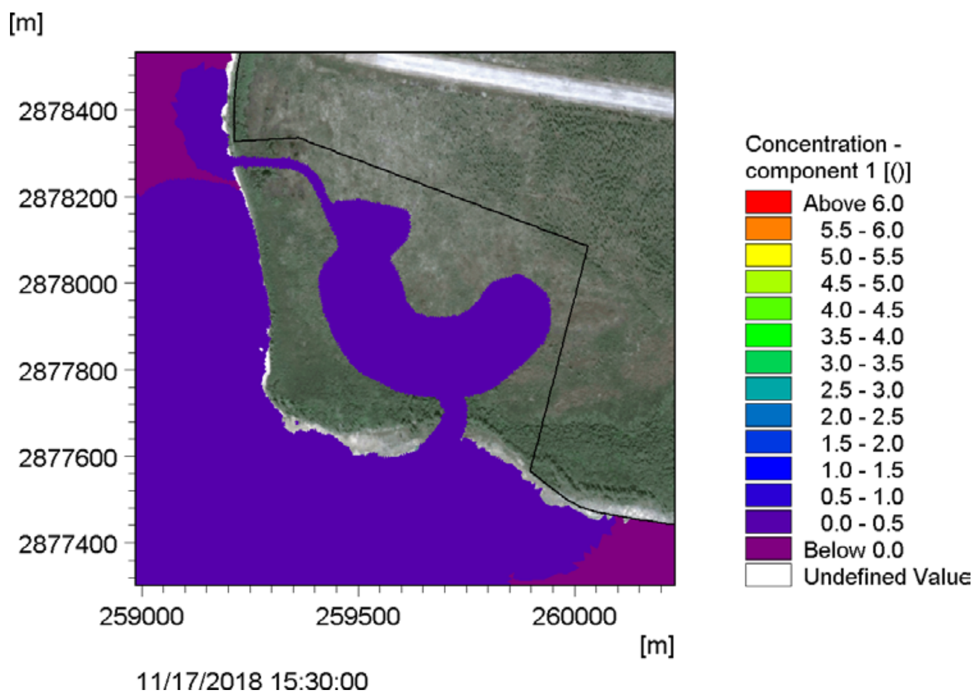


Figure 4-5: Depth Averaged Concentration 24 Hours after the Start of Simulation

Water Exchange Analysis

For the marina water exchange analysis, the HD/TR coupled model was run with tidal boundaries, starting during a neap tidal period, with a constant wind of 2 knots from the East. This wind speed is exceeded more than 99% of the time according to Figure 2-3. The decay of substances was not considered in the model in order to simulate only the advection and dispersion processes, as the pollutant is assumed to be conservative. The model was run for a period of 11 days.

Figure 4-6 present the initial conditions for the fully contaminated system. Figure 4-7 presents the concentrations over the entire lagoons after 10 days of simulation.

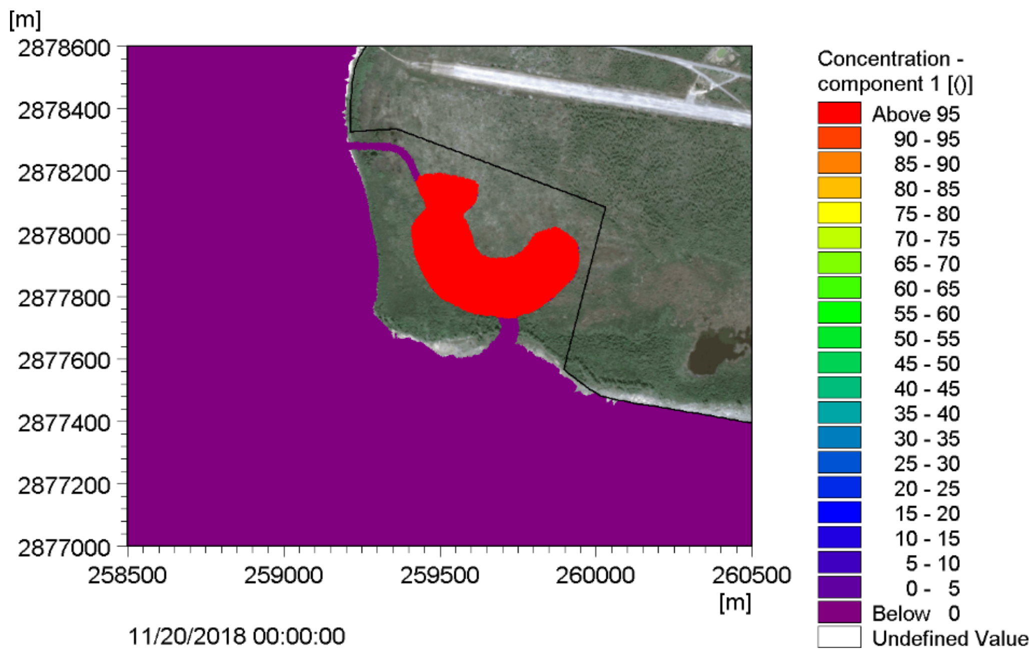


Figure 4-6: Initial Condition for Leeward Harbor

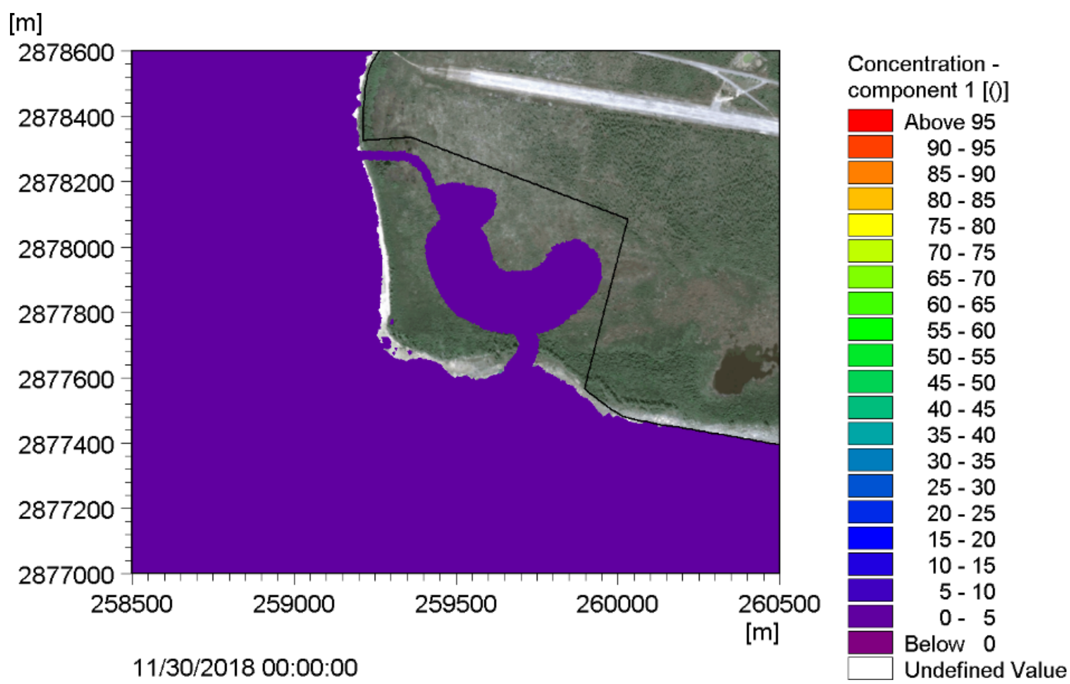


Figure 4-7: LH Concentrations after 10 Days

Figure 4-8 show that the average concentration (blue line) reaches the T10 in 5.5 days. It is important to highlight that not only the average concentration attains the recommended requirements, but also the maximum concentration inside the marina quickly drops after approx. 3 days meaning that no "dead spots" are present in the system.

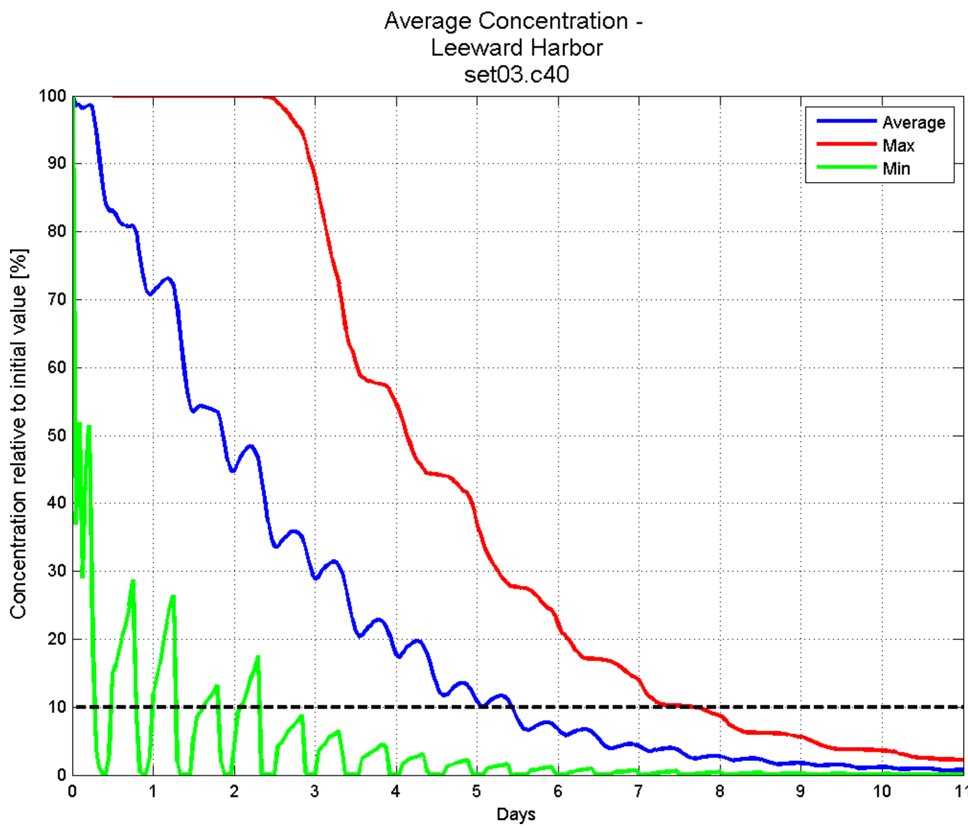


Figure 4-8: Average, Maximum and Minimum Concentrations - LH

4.2 Conch Sound Point and High Bank Bay

The flushing of the initially proposed layout for the lagoons (Figure 4-9 and Figure 4-10), where no motorized watercrafts will be present, was evaluated and modifications were recommended in order to improve circulation and eliminate stagnant areas.

The total area of the lagoons was reduced by eliminating "dead spots" and streamlining the land/water boundaries. Additionally, several locations and widths of channels were evaluated. For Conch Sound Point, the lagoon was concentrated around and north of the main channel and an approx. 18.3 m (60 ft) wide additional flushing channel was required. With respect to High Bank Bay, the south portion of the lagoon was eliminated, and the three initially proposed channels were enough to provide adequate water exchange.

The final configuration for the lagoons, which are -1.2 m MLLW, -1.6 m MSL (4 ft MLLW, 5.4 ft MSL) deep, are presented in Figure 4-5 and Figure 4-12 followed by the flushing analysis discussion.

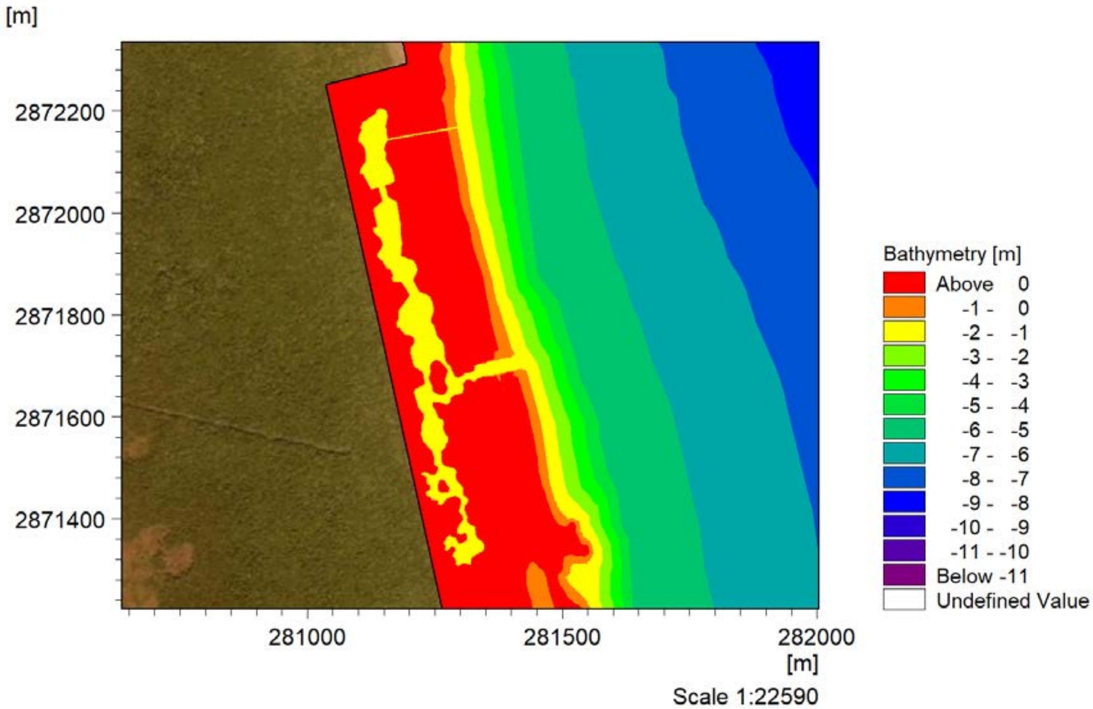


Figure 4-9: Initial Layout for the CSP lagoon – Bathymetry (m MSL)

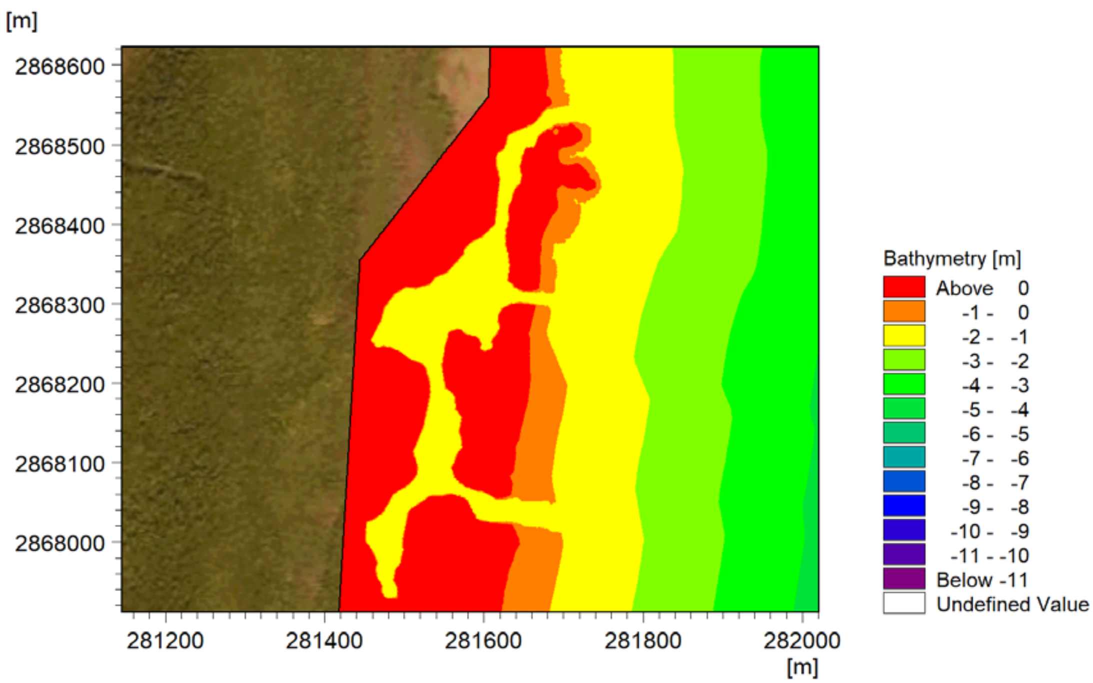


Figure 4-10: Initial Layout for the HBB lagoon – Bathymetry (m MSL)

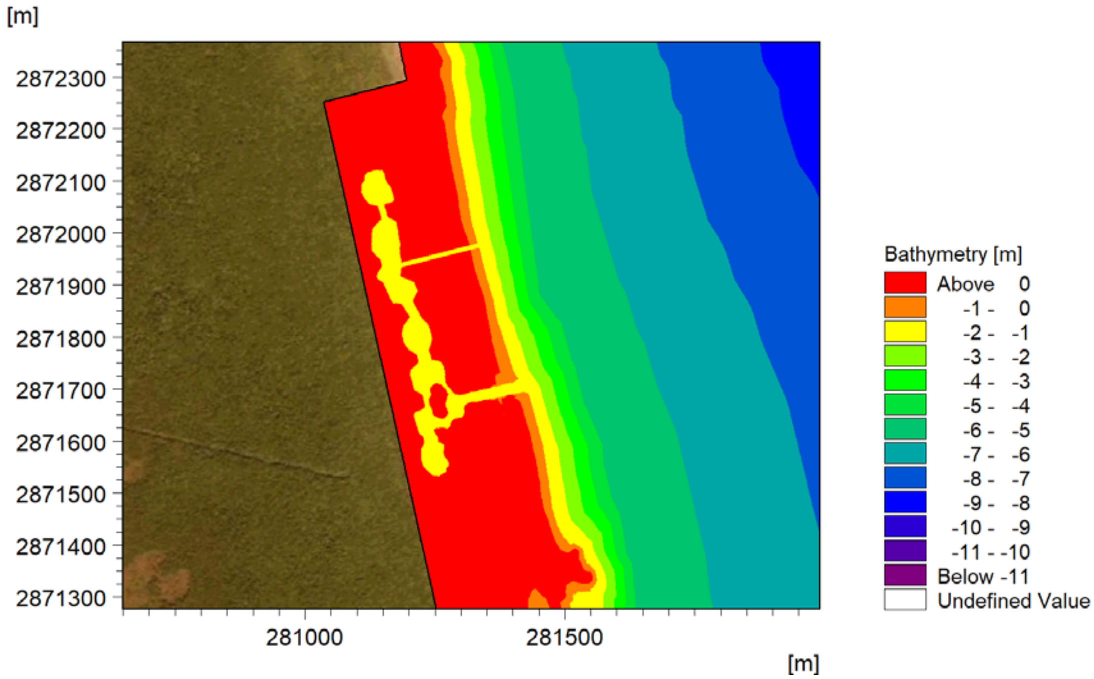


Figure 4-11: Final CSP Lagoon Configuration – Bathymetry (m MSL)

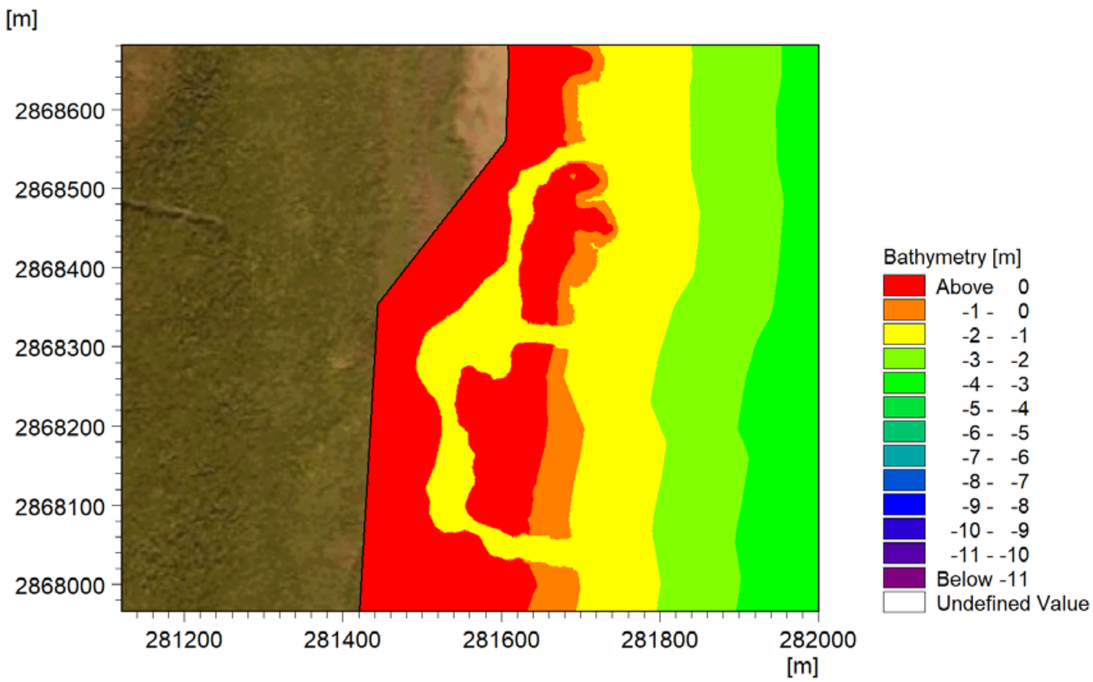


Figure 4-12: Final HBB Lagoon Configuration – Bathymetry (m MSL)

Similar to the marina water exchange analysis, the HD/TR coupled model was run with tidal boundaries for the lagoons at CSP and HBB, starting during a neap tidal period, with a constant wind of 2 knots from the East. This wind speed is exceeded more than 99% of the time according to Figure 2-3. The decay of substances was not considered in the model in order to simulate only the advection and dispersion processes, as the pollutant is assumed to be conservative. The model was run for a period of 11 days.

Figure 4-13 and Figure 4-14 present the initial conditions for both lagoons.

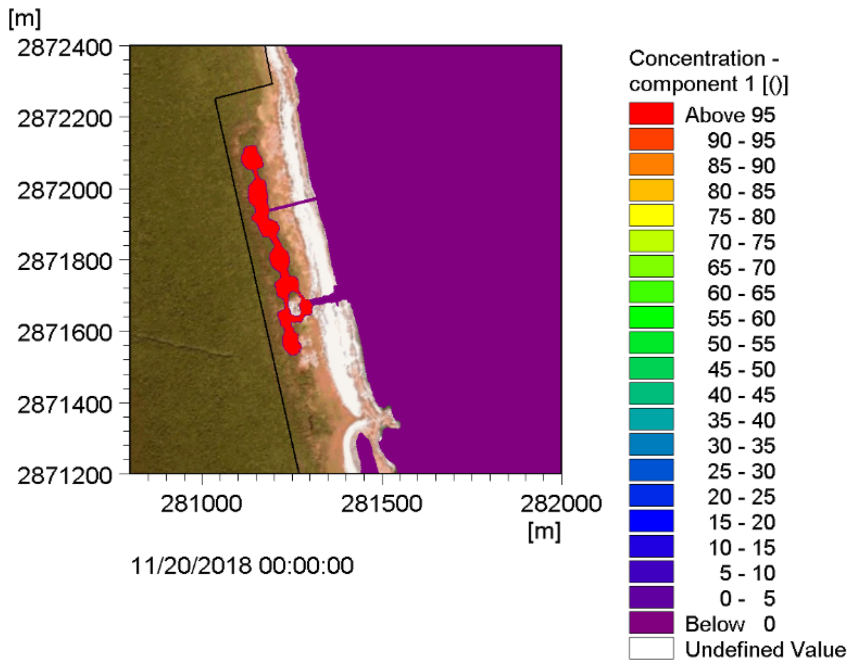


Figure 4-13: Initial conditions CSP

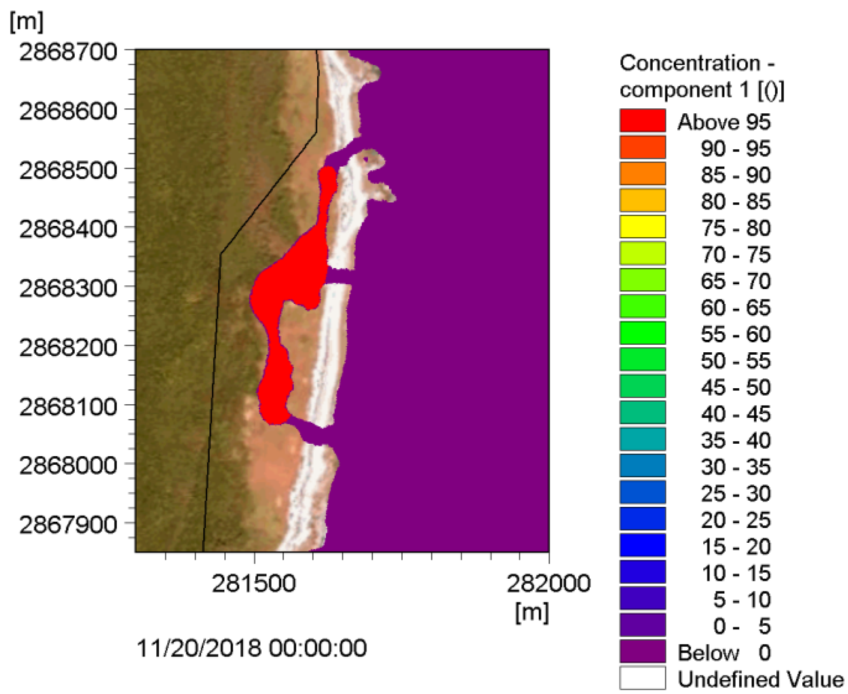


Figure 4-14: Initial conditions HBB

Figure 4-15 and Figure 4-16 present the concentrations over the entire lagoons after 10 days of simulation.

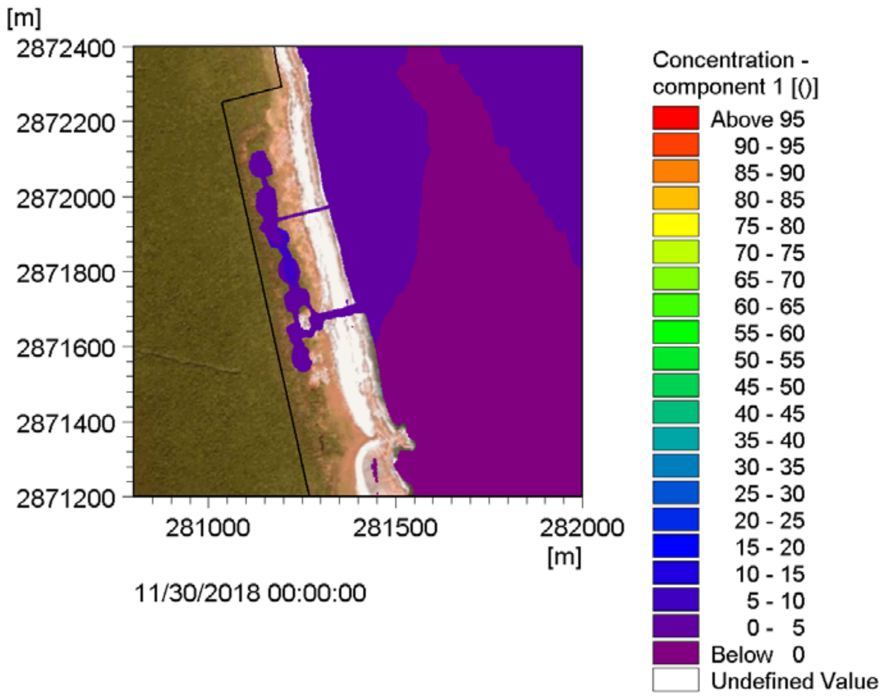


Figure 4-15: CSP concentrations after 10 days

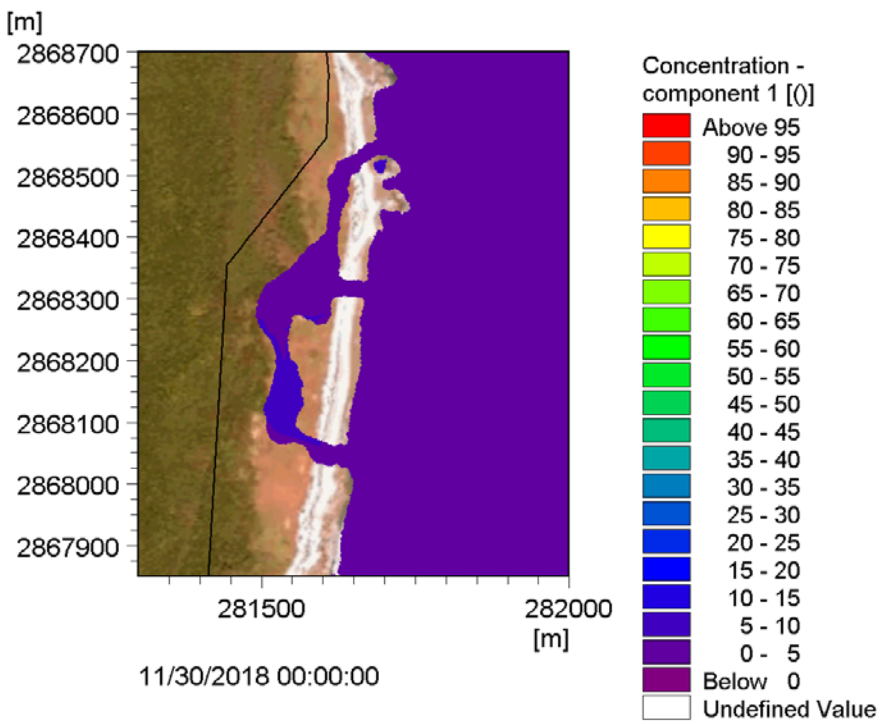


Figure 4-16: HBB concentrations after 10 days

Figure 4-17 and Figure 4-18 show that the maximum concentration (red line) reaches the T50 in approximately 4 days and the average concentration (blue line) reaches the T10 between 5 and 6.5 days. As with the marina results, the maximum concentration values at the lagoons drop below the 10% threshold within the simulated period ensuring that no stagnant "dead spots" are present in the system.

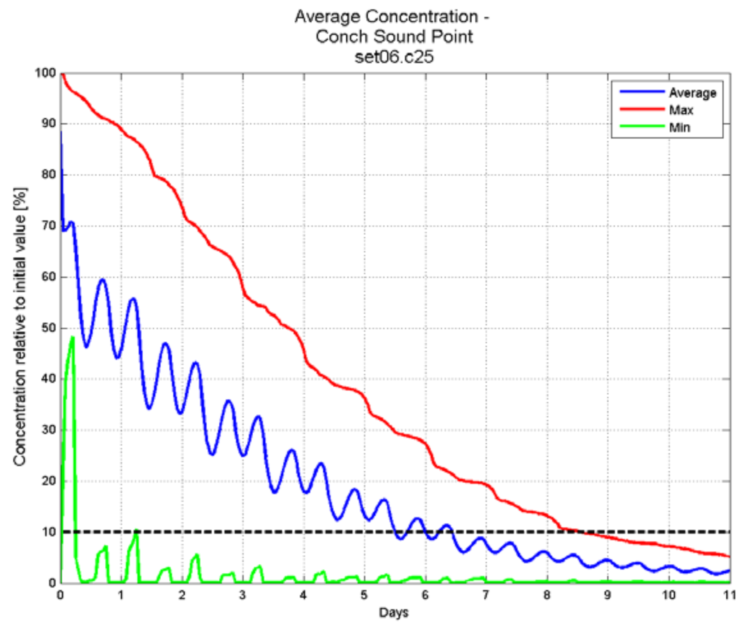


Figure 4-17: Average, maximum and minimum concentrations - CSP

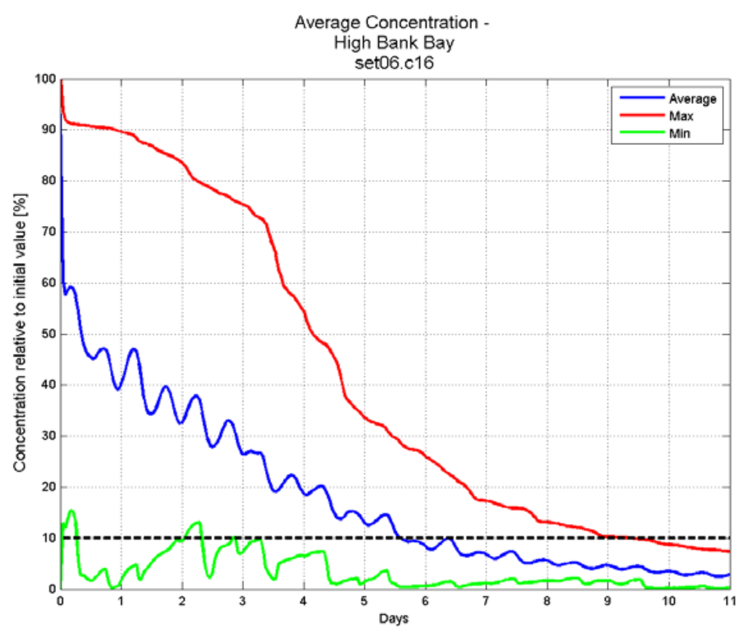


Figure 4-18: Average, maximum and minimum concentrations - HBB

5.0 NEARSHORE WAVE TRANSFORMATION

The SW model was applied to transform waves from offshore to nearshore considering also the wind-generated waves. The model was run for the same period as the offshore waves and winds analyzed data sets (13 years) and was not calibrated due to the lack of measured data.

Figure 5-1 to Figure 5-3 show the three different locations (SW34, SW131 and SW137) for which the nearshore wave results are presented.

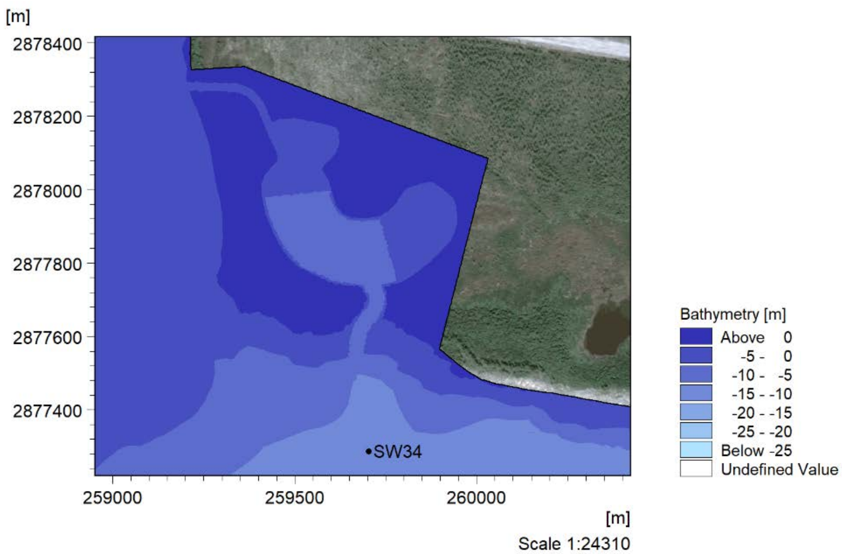


Figure 5-1: Leeward Harbor Bathymetry (m MSL) - Nearshore Waves SW34

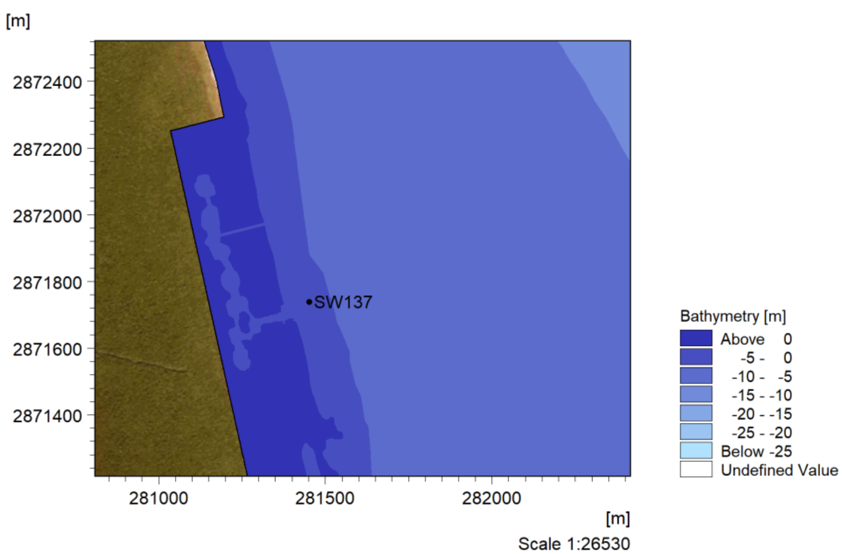


Figure 5-2: Conch Sound Point Bathymetry (m MSL) - Nearshore Waves SW137

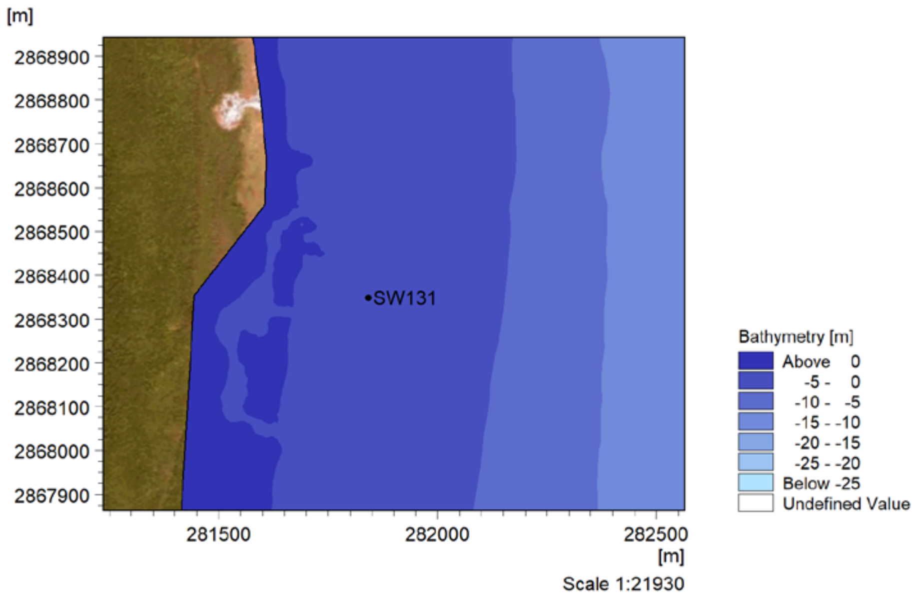


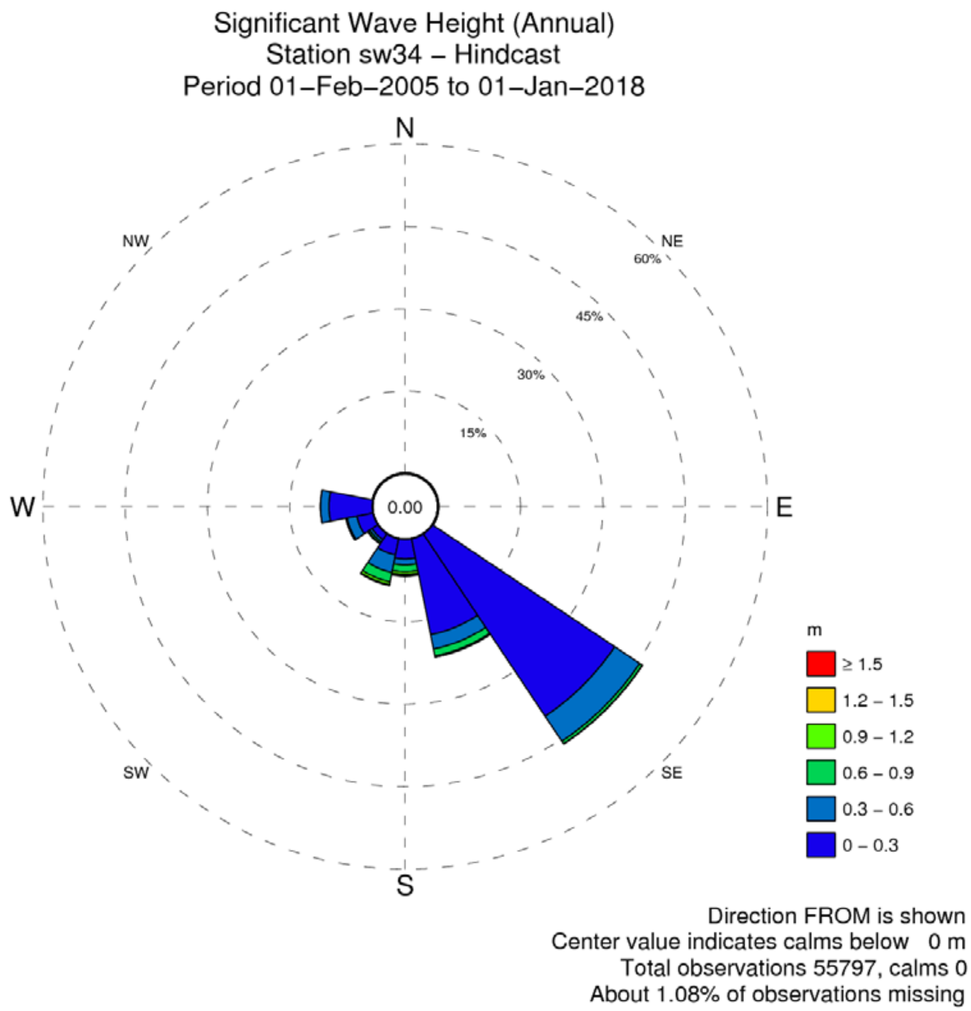
Figure 5-3: High Bank Bay Bathymetry (m MSL) - Nearshore Waves SW131

The SW model parameters are presented in Table 5-1.

Table 5-1: Spectral Wave Model Parameters

Parameter Name	Type	Value
Frequency discretization logarithmic	Number of frequencies	12
	Minimum frequency	0.07 Hz
	Frequency factor	1.15
Directional discretization	360 degrees rose, number of directions	36
Wind forcing	Uncoupled, version 1, Charnock parameter	0.01
Wave breaking	Functional from Ruessink et at. (2003)	1
Bottom friction	Friction factor, f_w	0.03
White Capping	Constant	3.5, 0.6
Solution method	New-Raphson iteration, low order	

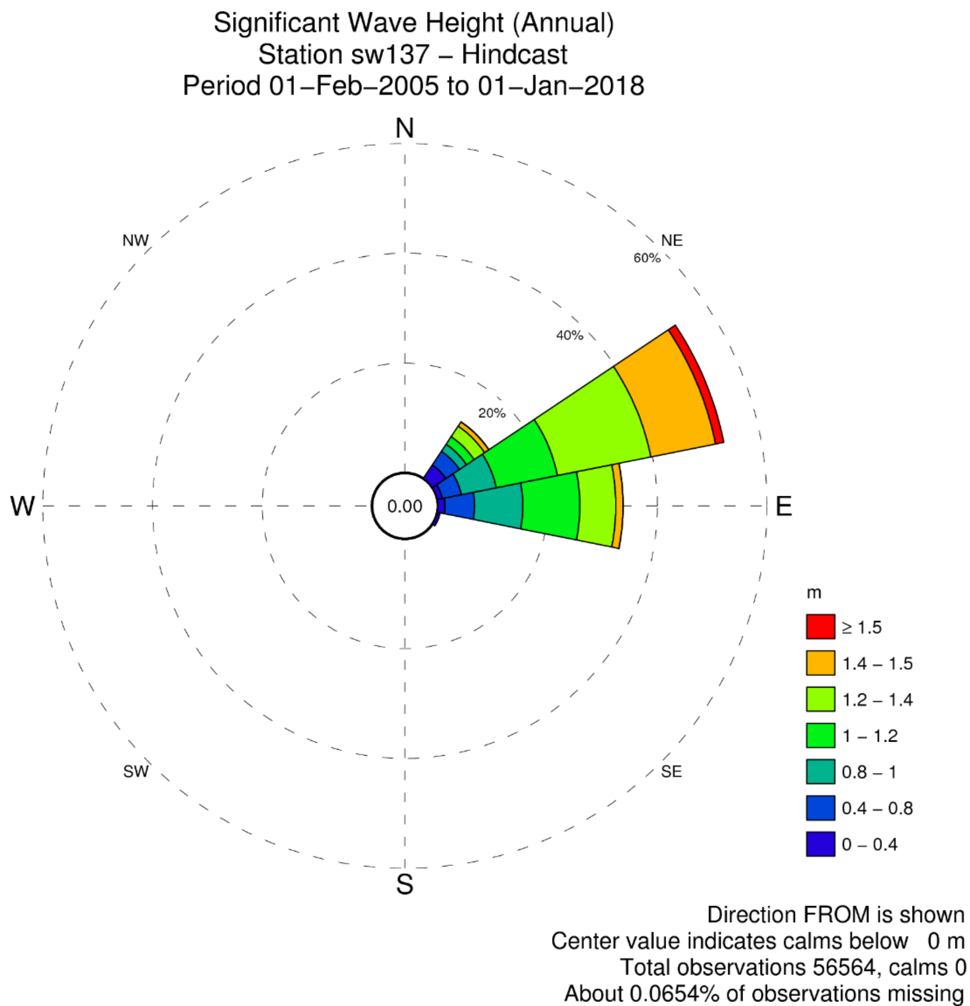
The annual wave roses and the exceedance chart were developed for evaluating the operational conditions. The analyzed annual wave rose at the three nearshore locations are illustrated in Figure 5-4 to Figure 5-6.



Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total							45.99	21.96	6.71	8.66	2.20	5.01	9.43				100.00
≥ 1.5									0.20								0.26
1.2 – 1.5									0.19	0.12							0.35
0.9 – 1.2								0.16	0.46	0.51							1.23
0.6 – 0.9							0.57	1.30	1.22	1.75	0.36	0.23					5.44
0.3 – 0.6							5.46	2.66	1.08	3.23	0.50	1.79	1.55				16.28
0 – 0.3							39.92	17.79	3.56	3.01	1.26	2.98	7.88				76.43

Figure 5-4: Annual Wave Rose – SW34 – LH

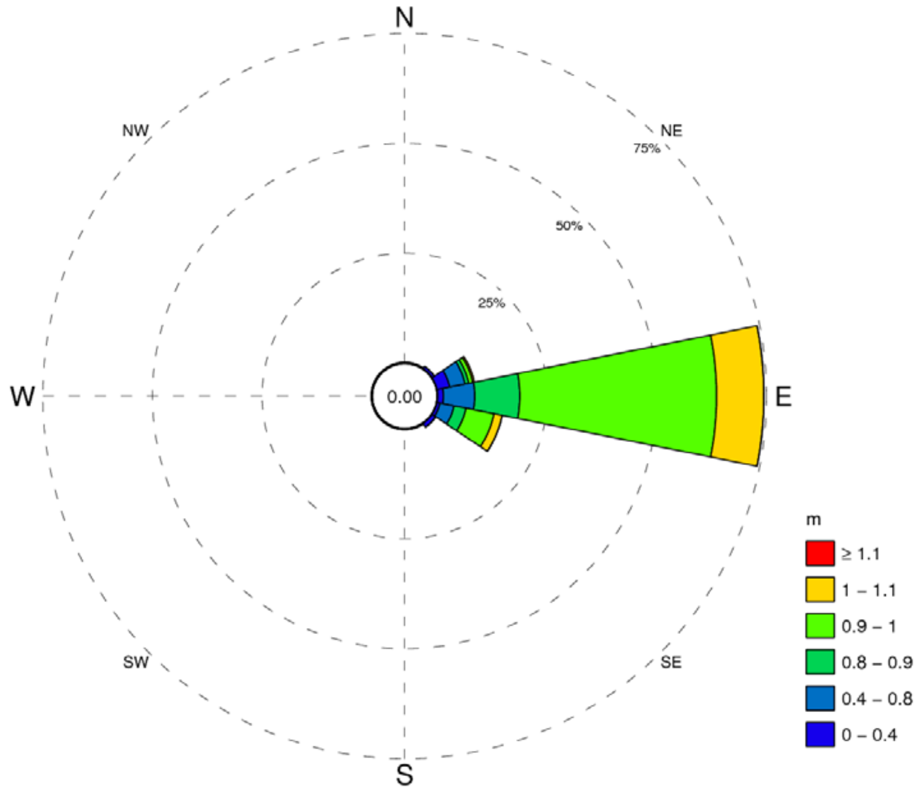


Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total			12.41	53.25	33.77	0.54											100.00
≥ 1.5				1.52													1.57
1.4–1.5			0.93	12.02	1.32												14.27
1.2–1.4			2.29	17.36	6.56												26.21
1–1.2			1.67	11.38	10.38												23.42
0.8–1			1.54	6.47	8.80												16.81
0.4–0.8			2.98	3.54	5.39												11.92
0–0.4			2.98	0.95	1.31	0.53											5.80

Figure 5-5: Annual Wave Rose – SW137 – CSP

Significant Wave Height (Annual)
Station sw131 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018



Percentage of Occurrence

Significant Wave Height, m	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Total			0.63	8.69	74.41	15.15	1.05										100.00
1.1																	
1 – 1.1				0.39	10.78	1.89											13.06
0.9 – 1				0.93	44.86	6.52											52.30
0.8 – 0.9				0.85	10.26	2.77											13.88
0.4 – 0.8				3.57	7.14	3.26											14.02
0 – 0.4			0.62	2.95	1.34	0.71	1.00										6.70

Figure 5-6: Annual Wave Rose – SW131 – HBB

Based on the statistics, generally the prevailing waves are from SE, ENE and E for Leeward Harbor, Conch Sound Point and High Bank Bay respectively. The analyzed monthly and seasonal wave roses are showed in Appendix D.

The exceedance charts are illustrated in Figure 5-7 to Figure 5-9.

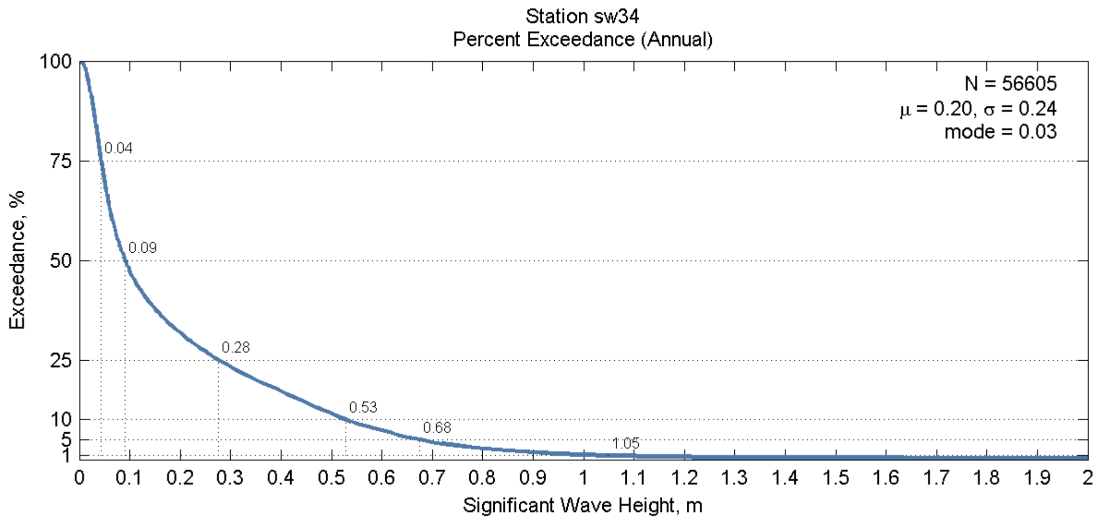


Figure 5-7: Percent Exceedance Wave Heights – SW34 – LH

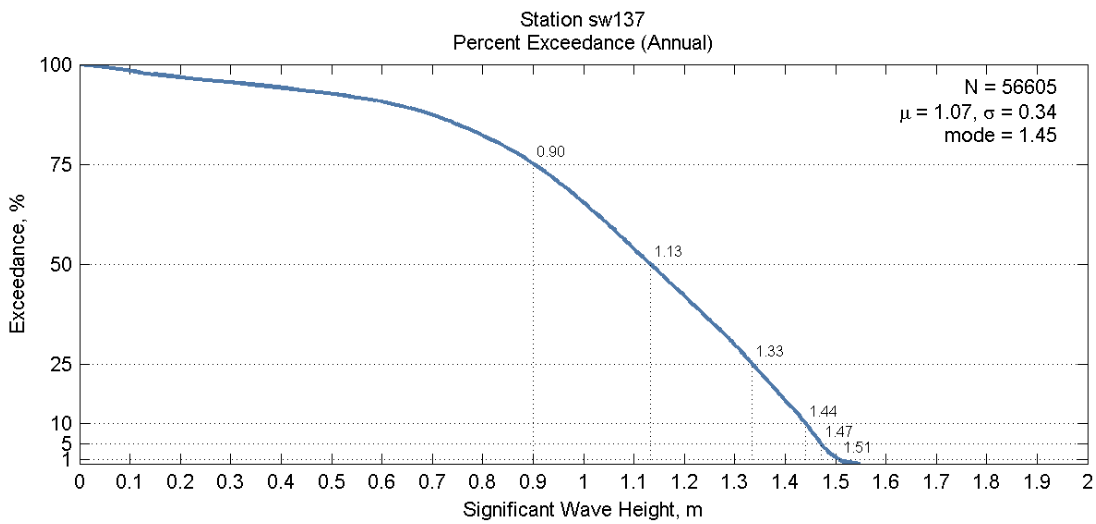


Figure 5-8: Percent Exceedance Wave Heights – SW137 – CSP

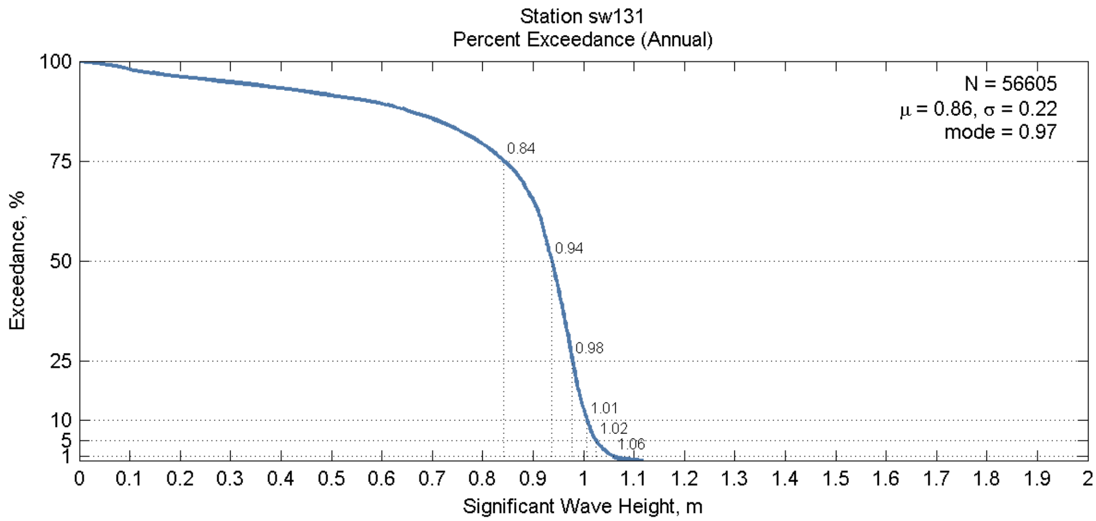


Figure 5-9: Percent Exceedance Wave Heights – SW131 – HBB

Table 2-6 summarizes the offshore operational wave conditions.

Table 5-2: Operational Nearshore Wave Conditions

Annual Percentage of Exceedance	Significant Wave Height		
	SW34 - LH	SW137 - CSP	SW131 - HBB
75%	0.04 m	0.90 m	0.84 m
50%	0.09 m	1.13 m	0.94 m
25%	0.28 m	1.33 m	0.98 m
10%	0.53 m	1.44 m	1.01 m
5%	0.68 m	1.47 m	1.02 m
1%	1.05 m	1.51 m	1.06 m

The significant wave heights and associated peak wave periods were analyzed, and the annual joint histograms are presented in Figure 5-10 to Figure 5-12. The majority of the waves in LH are small long period waves. In CSP, the majority of the waves range from 1 to 1.5 m with periods between 7 and 11 seconds and in HBB from 0.8 to 1.1 m with similar periods.

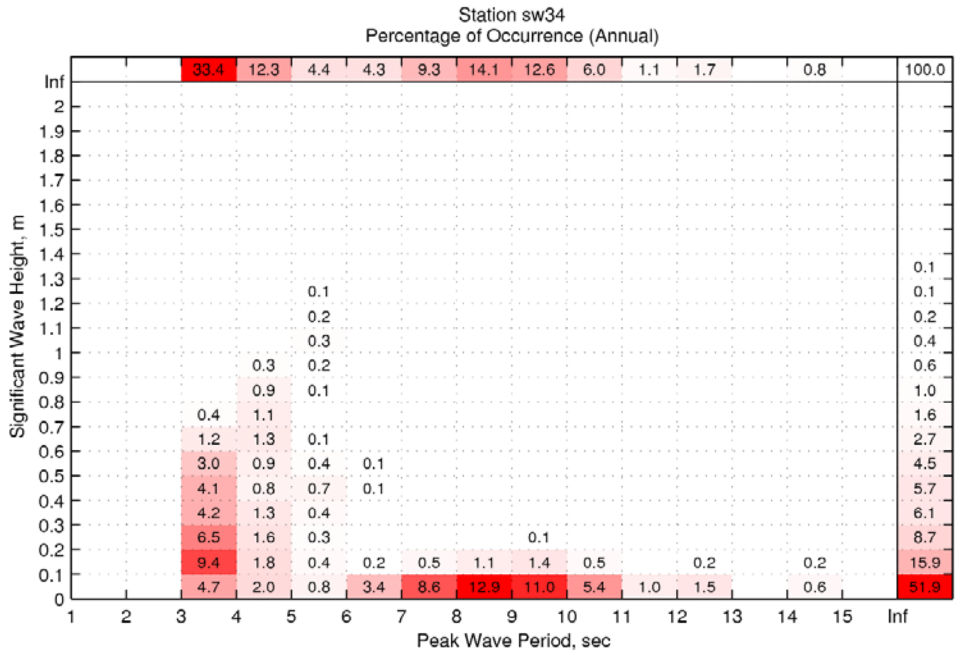


Figure 5-10: Joint Histogram – Significant Wave Height and Period – SW34 – LH

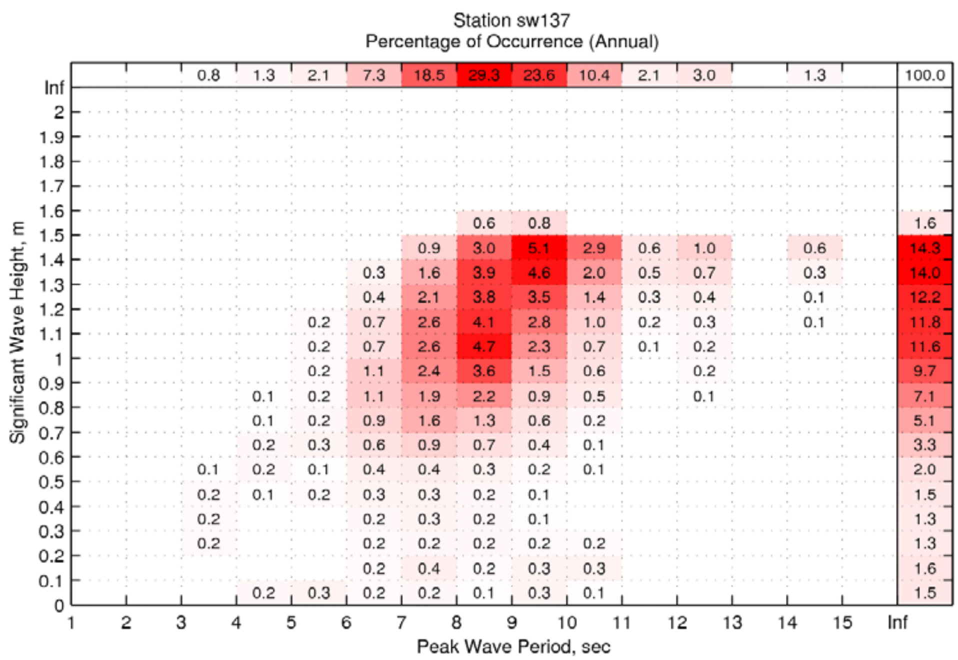


Figure 5-11: Joint Histogram – Significant Wave Height and Period – SW137 – CSP

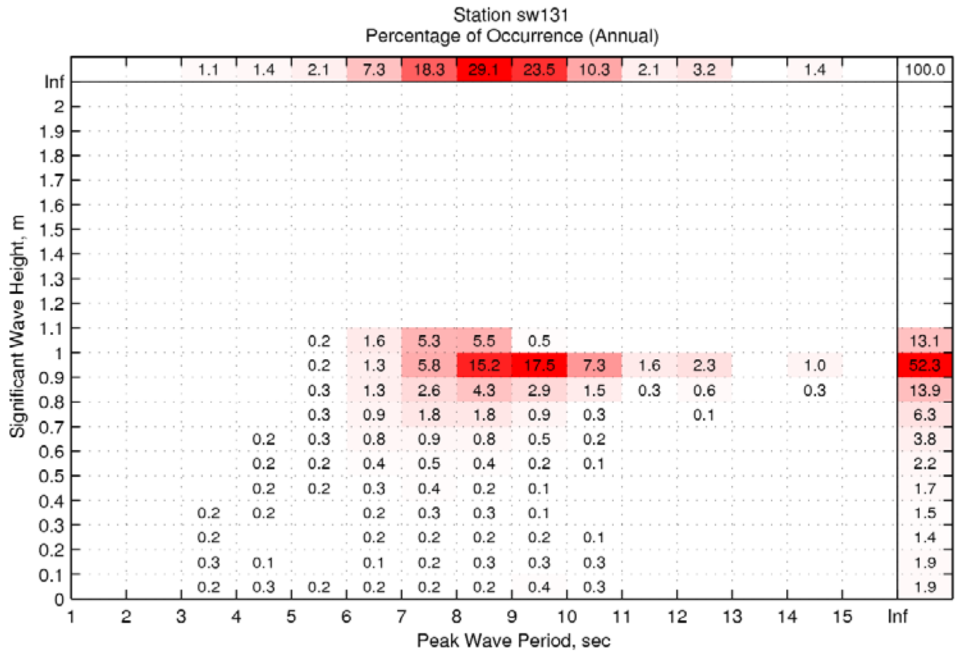


Figure 5-12: Joint Histogram – Significant Wave Height and Period – SW131 – HBB

6.0 STORM SURGE, EXTREME WAVES AND FLOOD ELEVATIONS

The design water levels were determined through numerical modeling of storm surge conditions. The coupled HD/SW model, which has both wave propagation and hydrodynamic capabilities, was used to determine the storm surge and extreme wave heights. The flood elevations were calculated based on the model outputs. The results of this analysis will support the landside planners on defining the infrastructure location and grading.

6.1 Storm Surge Definition

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. The maximum potential storm surge for a particular location depends on a number of different factors. In the northern hemisphere, the surge will be largest in the right-forward part of the storm, while the left-forward part may experience significantly depressed water levels. The worst surge is typically generated from storms located within 80 km of landfall. Based on historical hurricane tracks at the project site, a wider zone of influence of 120 km (65 nautical miles) was selected. Breaking waves also cause water to pile up on the shoreline in a phenomenon known as wave setup. In addition, the crests of waves can be several feet above the still-water elevation.

Storm surge is a very complex phenomenon because it is sensitive to the slightest changes in storm intensity, forward speed, size (radius of maximum winds), angle of approach to the coast, central pressure, and the shape and characteristics of coastal features such as bays and estuaries. In this analysis, specific storm tracks were not considered, and a simplified approach was applied where a mean high tide and the pressure setup were added to MSL while extreme winds from the 16 wind-rose directions forced the coupled model to evaluate the water level changes due to waves and winds.

The level of storm surge in a particular region is also determined by the slope of the continental shelf. A shallow slope off the coast will allow a greater surge to inundate coastal communities. Locations with a steep continental shelf will generally not see as much surge inundation, although large breaking waves can still present major problems.

Storm surge should not be confused with storm tide (herein referred as the storm still water level), which is defined as the water level rise due to the combination of storm surge and the astronomical tide. This rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide. Figure 6-1 illustrates an example of storm surge which may occur on the open coast.

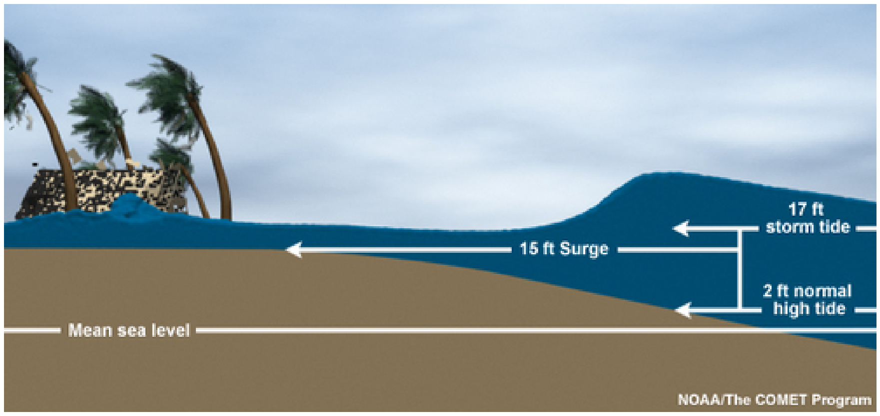


Figure 6-1: Example of Storm Surge Diagram (NOAA)

In order to assess the storm surge and respective extreme waves, a coupled HD/SW model was used as described in the following sub-section.

6.2 Model Setup

The initial HD (flushing analysis) and SW (nearshore wave transformation) models considered either a normal tide variation around MSL (former) or a constant water level at MSL (latter). During storm conditions, the water level rises due to pressure setup, wind setup, and wave setup, and since timing of a hurricane is unpredictable, a normal high tide should also be considered.

Wave setup is the water level tilting effects caused by spatial changes in the wave radiation stresses (i.e. wave breaking) in the coastal surf-zone. Wind setup is the water level tilting effects caused by strong winds blowing over the water surface. The wave setup and wind setup are outputs of the model while the pressure setup and the tide are inputs. The extreme winds that forces the extreme waves and storm surge is also a model input.

Given that both 25- and 50-year return periods extreme winds correspond to a category 4 hurricane, only the 50 and 100-year return periods were evaluated for the storm surge and extreme waves analysis, which correspond to a category 4 and a category 5 storm respectively.

6.3 Extreme Winds

The extreme wind conditions were discussed in section 2.1.2. Table 6-1 reproduces the results for the 50- and 100-year return periods, from which the 30-min average values were used to force the storm surge and extreme waves model.

Table 6-1: Extreme Wind Speeds

Return Period, years	Wind Speed (1-min), kt			Hurricane Category[††]	Wind Speed (30-min), kt	Wind Speed (1-hour), kt
	Best-fit	95% non-exc.	5% non-exc.[†]	Saffir-Simpson	Best-Fit[†]	Best-Fit[†]
50	128.68	138.65	118.71	4	104.73	103.45
100	137.41	148.83	126.00	5	111.84	110.47

[†] Converted with ISO 19901-1:2005(E) formulation
[††] Based on the maximum sustained wind (1-min) best-fit (see also, Table 2-2)

As seen in Figure 2-4 hurricanes can pass through the project area from potentially any side and following any track. As a hurricane passes by, the counterclockwise cyclone may generate higher speed winds from all directions.

In order to simulate the storm surge and extreme waves caused by extreme winds, and account for all fetches from different directions to which the properties are exposed, a large area of approximately 265 km on the N-S direction and 330 km on the S-W direction was considered in the model domain, as presented in section 3.2. The design winds were applied from 16 cardinal directions in a coupled HD/SW model (to determine the largest combined wind and wave setup), resulting in a total of 16 runs for each evaluated return period as summarized in Table 6-3 further in this report.

6.4 Pressure Setup

Pressure setup is the water level rise caused by sudden drop in atmospheric pressure within the eye of the hurricane. The difference between the ambient atmospheric pressure and the hurricane minimum central pressure induces that increase in water surface elevation. According to the World Meteorological Organization Guide to Storm Surge Forecast (WMO, 2011), for every reduction in pressure of 1 hectopascal (hPa) at the center of the weather system, the sea level rises temporarily by approximately 0.01 m.

Based on the global average atmospheric pressure of 1013 hPa, and on the extreme central pressures determined in section 2.1.3, the design pressure setups were calculated and are presented in Table 6-2.

Table 6-2: Design Pressure Setup

Return Period, years	Central Pressure (hPa)	Design Pressure Setup (m)
50	929.88	0.84
100	918.48	0.95

6.5 Tide

The timing of a hurricane is unpredictable and therefore the mean high water (MHW) elevation (+0.4 m, MSL – see Table 2-9) was used as the tidal level for the storm surge study.

6.6 Simulated Conditions

The winds are the main driver of the extreme waves and storm surge analysis. As explained previously in this report, only the 50- and 100-year return periods were evaluated. Sixteen runs, for each return period, are required to simulate the winds coming from all cardinal directions. It is known that the maximum pressure setup and the maximum wind setup do not occur simultaneously. However, for the purpose of this analysis, the initial water level was calculated as the sum of the MHW and pressure setups resulting in the values presented in Table 6-3, which leads to conservative design water levels. The coupled HD/SW model was run to calculate the combined wind and wave setup. In total 32 runs were performed, to account for the combination of all variables presented.

Table 6-3: Extreme Waves and Storm Surge - Simulated Conditions.

Return Period, years	Wind Speed (kt)	Initial Water Level (m)	16 Wind directions
50	104.73	1.24	N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW
100	111.84	1.35	

The selected run duration was 18 hours based on the hurricane tracks observed on NOAA's website. However, a steady condition for significant wave heights and water levels for the most extreme scenarios (usually with winds perpendicular to the coast) was reached after approximately 3 hours.

6.7 Model Results

The water level (storm surge) and extreme waves were extracted at several locations within the model domain. Figure 6-2 to Figure 6-4 show some of the points at the vicinity of Leeward Harbor, Conch Sound Point and High Bank Bay.

For each of the points, 32 results were available (16 wind directions, for 50- and 100-year return periods). The results were analyzed and the maximum storm surge at each of the points was computed as well as the storm still water level for every case and return period.

The results for the extreme waves were also analyzed at all points and the highest value, resulting from the 16 simulated wind directions, was defined for each return period. The initial water level (MHW + pressure setup), the storm surge (wind setup + wave setup) and the extreme wave heights were considered for the flood elevation calculation.

Typically flood elevations reference the highest wave crest elevation, which includes the storm surge level and the height of wave crests. In general engineering practice in the United States, buildings in coastal zone should be designed to accommodate storms of 100-year return period; however, for this project the 50- and 100-year flood elevations were determined.

The flood elevation depends generally on the maximum wave crest elevation. The wave crest height depends on wave height and can be approximated as 70% of the wave height in shallow water. Therefore, the flood elevation was determined as the storm still water level plus 70% of the extreme wave height.

The forcing (wind speed and direction) that generates the greatest storm surge is not always the same that results in the maximum wave heights. Therefore, the water level and wave heights obtained at each point were used to establish the flood elevations for each separate case and then, the maximum flood elevation at each point was selected. The combination of events (pressure setup, wind setup, wave setup and wave crest height) used to develop the flood elevations are conservative and should be used only as guidance. The selection of first floor elevations for building structures should be based on the 100-year flood elevation as a boundary condition and refined using a coastal inundation analysis, final site grading, and local building codes (foundation design).

Appendix E presents the tables with the storm still water levels, extreme wave heights and flood elevation for all simulated cases. Table 6-4 to Table 6-9 present the summary of results for the 50-year and 100-year storm still water levels, wave heights and flood elevations at the three properties.

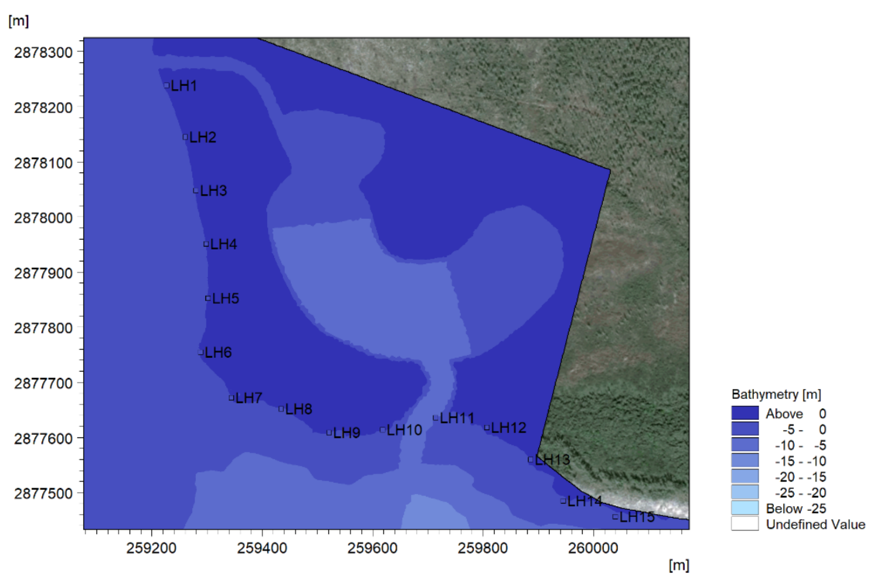


Figure 6-2: Leeward Harbor HD and SW Output Points

Table 6-4: 50-year Extreme Results – Leeward Harbor

50-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
LH1	1.24	0.82	1.21	2.86	9.39
LH2	1.24	0.84	1.12	2.86	9.37
LH3	1.24	0.83	1.12	2.79	9.17
LH4	1.24	0.83	1.13	2.76	9.04
LH5	1.24	0.83	1.04	2.66	8.72
LH6	1.24	0.78	0.94	2.68	8.78
LH7	1.24	0.93	1.45	3.18	10.43
LH8	1.24	0.93	2.07	3.63	11.89
LH9	1.24	1.03	1.95	3.63	11.92
LH10	1.24	1.18	1.83	3.70	12.14
LH11	1.24	1.29	3.00	4.62	15.15
LH12	1.24	1.21	1.74	3.67	12.03
LH13	1.24	0.95	1.79	3.44	11.30
LH14	1.24	1.06	2.36	3.95	12.97
LH15	1.24	0.98	3.23	4.48	14.69

Table 6-5: 100-year Extreme Results – Leeward Harbor

100-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
LH1	1.35	0.91	1.39	3.14	10.30
LH2	1.35	0.93	1.28	3.11	10.22
LH3	1.35	0.94	1.33	3.07	10.06
LH4	1.35	0.95	1.36	3.03	9.94
LH5	1.35	0.85	1.22	2.93	9.61
LH6	1.35	0.89	1.16	2.96	9.73
LH7	1.35	0.82	1.57	3.39	11.11
LH8	1.35	0.82	2.20	3.89	12.76
LH9	1.35	0.87	2.11	3.90	12.79
LH10	1.35	0.96	2.01	4.00	13.12
LH11	1.35	1.07	3.21	4.93	16.18
LH12	1.35	1.06	1.88	3.92	12.88
LH13	1.35	1.03	1.90	3.63	11.92
LH14	1.35	0.91	2.61	4.29	14.06
LH15	1.35	1.13	3.41	4.77	15.66

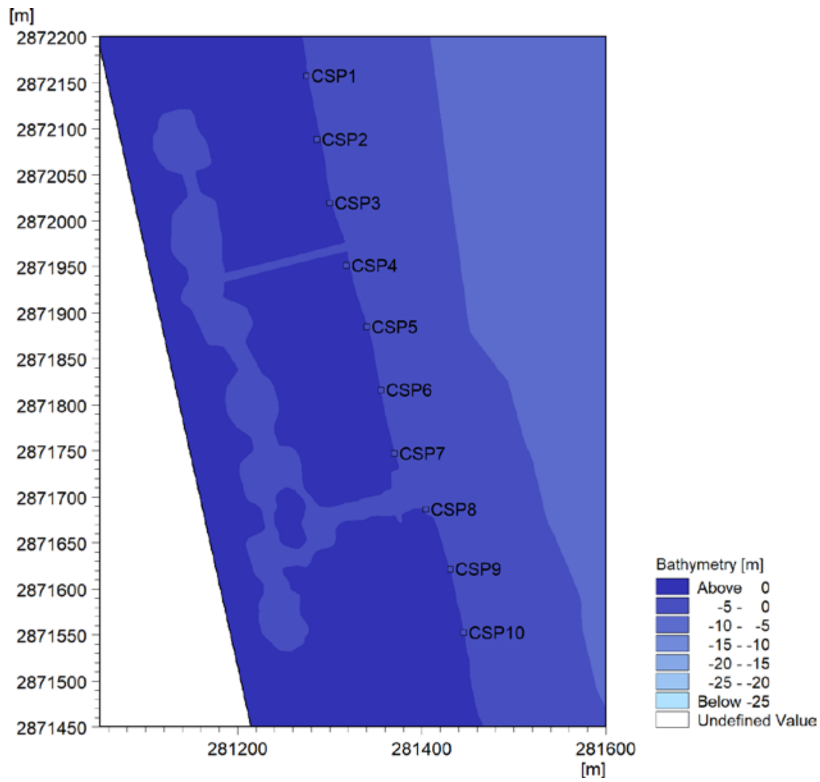


Figure 6-3: Conch Sound Point HD and SW Output Points

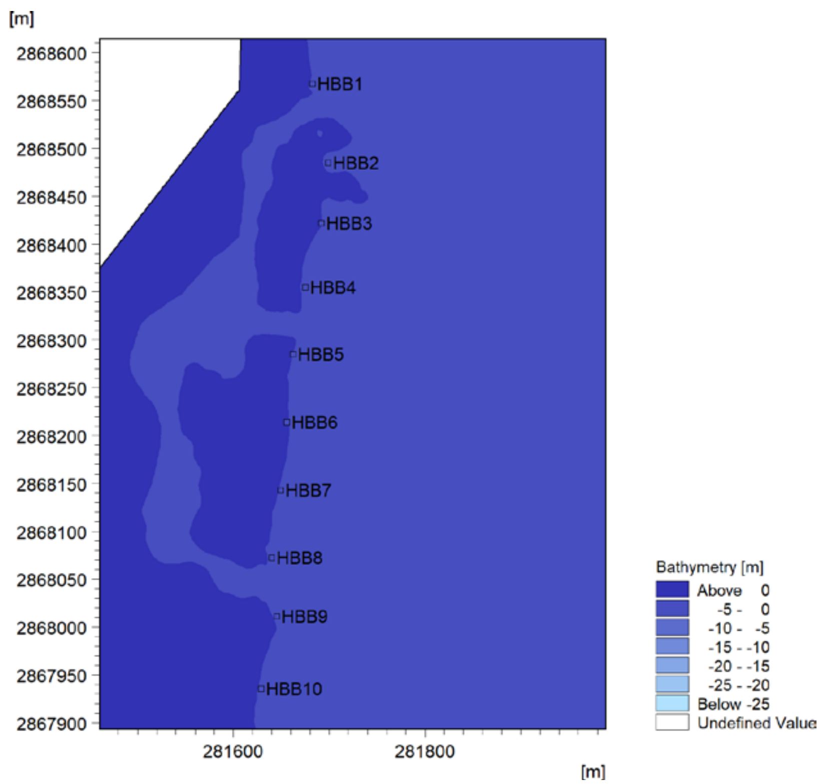


Figure 6-4: High Bank Bay HD and SW Output Points

Table 6-6: 50-year Extreme Results – Conch Sound Point

50-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
CSP1	1.24	0.96	1.63	3.34	10.96
CSP2	1.24	0.98	1.44	3.22	10.58
CSP3	1.24	0.97	1.68	3.38	11.10
CSP4	1.24	0.96	1.59	3.31	10.87
CSP5	1.24	0.94	1.74	3.40	11.16
CSP6	1.24	0.96	1.72	3.37	11.04
CSP7	1.24	0.99	1.53	3.30	10.83
CSP8	1.24	0.95	1.75	3.40	11.15
CSP9	1.24	0.95	1.76	3.42	11.23
CSP10	1.24	0.94	1.68	3.33	10.94

Table 6-7: 100-year Extreme Results – Conch Sound Point

100-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
CSP1	1.35	0.92	1.73	3.57	11.72
CSP2	1.35	0.92	1.59	3.49	11.44
CSP3	1.35	0.95	1.78	3.62	11.86
CSP4	1.35	0.95	1.75	3.58	11.75
CSP5	1.35	0.95	1.90	3.67	12.03
CSP6	1.35	0.90	1.77	3.60	11.81
CSP7	1.35	0.91	1.63	3.53	11.59
CSP8	1.35	0.91	1.91	3.62	11.89
CSP9	1.35	0.91	1.87	3.66	12.00
CSP10	1.35	0.91	1.77	3.52	11.55

Table 6-8: 50-year Extreme Results – High Bank Bay

50-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
HBB1	1.24	0.97	1.34	3.12	10.22
HBB2	1.24	0.98	1.13	3.01	9.87
HBB3	1.24	0.96	1.37	3.12	10.24
HBB4	1.24	0.96	1.48	3.24	10.64
HBB5	1.24	0.96	1.50	3.21	10.54
HBB6	1.24	0.97	1.34	3.14	10.32
HBB7	1.24	0.97	1.28	3.10	10.18
HBB8	1.24	0.96	1.44	3.20	10.49
HBB9	1.24	0.94	1.35	3.12	10.24
HBB10	1.24	0.97	1.23	3.07	10.07

Table 6-9: 100-year Extreme Results – High Bank Bay

100-year	Storm still water level		Max (Significant Wave Height)	Max (Flood Elevation)	
	MHW + Pressure setup	Max (Wind setup + wave setup)			
	(m, MSL)	(m)	(m)	(m, MSL)	(ft, MSL)
HBB1	1.35	1.00	1.43	3.34	10.97
HBB2	1.35	1.01	1.21	3.23	10.61
HBB3	1.35	1.01	1.46	3.35	11.00
HBB4	1.35	1.01	1.58	3.47	11.39
HBB5	1.35	1.01	1.58	3.44	11.29
HBB6	1.35	1.01	1.43	3.37	11.06
HBB7	1.35	1.02	1.37	3.33	10.93
HBB8	1.35	1.01	1.53	3.43	11.26
HBB9	1.35	1.01	1.46	3.36	11.02
HBB10	1.35	0.96	1.32	3.30	10.81

7.0 WAVE AGITATION STUDY

A Mike21 Boussinesq Wave (BW) model was developed for the marina at Leeward Harbor to assess local wave conditions within the basin. This numerical model is used to simulate wave transformation from open water to the project site and considers wave transformation phenomena including shoaling, reflection, refraction and diffraction (MIKE, 2017d).

The results from this model show theoretical wave conditions within the basin and allow for an analysis of entrance channel and structures alternatives in terms of wave attenuation.

The model domain consists of an 820 m by 1050 m rectangular grid with a uniform resolution of 1.0 m. The model simulates the propagation of each wave from the model boundary, so each simulation was set for 30 minutes to allow for the wave climate to fully develop and propagate through the model domain including the marina basin. The spatial resolution and the time step were defined according to the MIKE 21 BW Model Setup Planner limits to simulate the selected wave periods varying from 4 to 12 seconds.

The shoreline and bathymetry data used to develop the BW model were obtained from the previously setup HD and SW model. The BW model bathymetry and domain are presented in Figure 7-1. Initially the basin was simulated without any coastal structure to prevent the waves from propagating inside the marina, except for the curved shape of the entrance channel (Base Case).

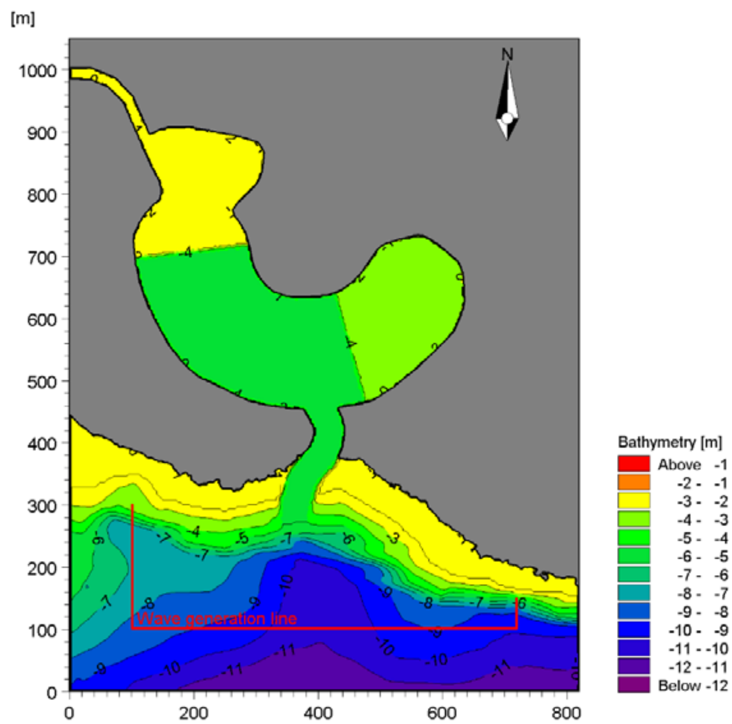


Figure 7-1: BW Model Domain and Bathymetry (m, MSL)

Additionally, the bathymetry was modified by imposing a minimum depth of 2.0 m in order to exclude wave breaking in the model which improves model speed and stability without diminishing the relative wave comparison results. As the depth at the marina basin area is greater than 2.0 m., this modification does not affect model results at the area of interest.

Porosity values were applied to model partial reflection of waves at different types of land/water boundaries. The MIKE 21 Toolbox Calculation of Reflection Coefficients was used to calculate the porosity values depending on the water depth, the selected reflection coefficient, and the wave conditions.

According to the DHI manual, natural beaches have a typical reflection coefficient of 0.05 to 0.2 and rough rubble slopes from 0.3 to 0.6 depending on the grade and material. However, for some combinations of wave conditions, water depths and recommended reflection coefficients, the toolbox was not able to find the corresponding porosity values. Therefore, larger values than the recommended reflection coefficient were used for the beach and rubble areas leading to a greater reflection and hence more conservative results.

The porosity values were calculated based on the codes presented in Figure 7-2. The beach (code 6) was considered to reflect 40% of the waves while vertical walls (code 7 to 9) 99%, and the revetted areas (code 11 and higher) 90%.

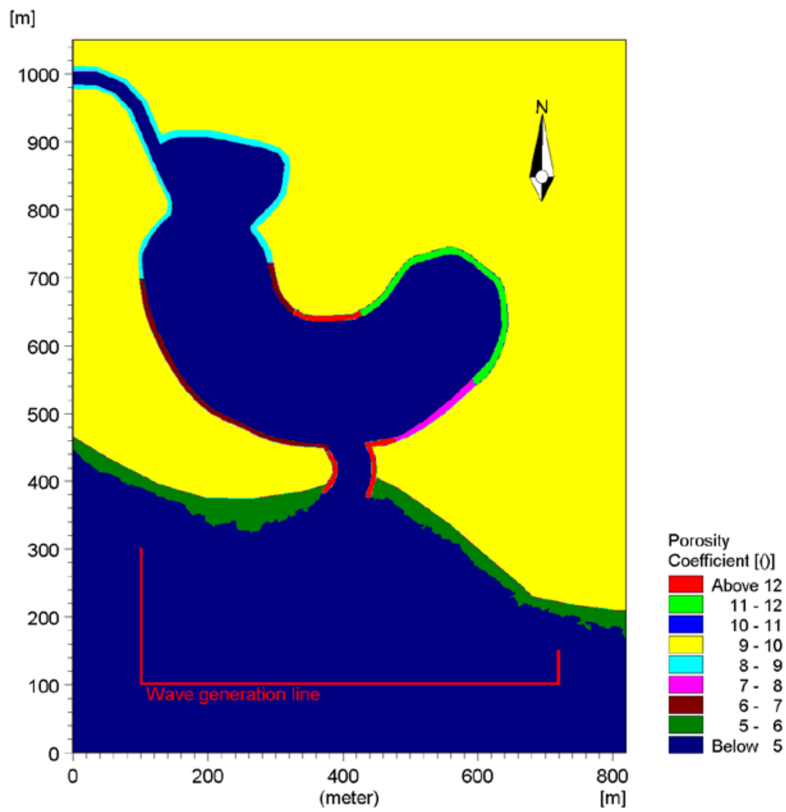


Figure 7-2: BW Model – Porosity Codes

Based on the waves results extracted at the BW model boundary (location SW34 from the nearshore wave transformation model - see section 5.0), 30 cases consisting of a combination of 5 wave periods and 6 wave directions (SE through WSW were simulated (see Table 7-1).

Table 7-1: Simulated BW Cases

Cases	Wave Period (s)	Mean Wave Direction (degN)
1/6/11/16/21/26	4	135 (SE) 157.5 (SSE) 180 (S) 202.5 (SSW) 225 (SW) 247.5 (WSW)
2/7/12/17/22/27	6	
3/8/13/18/23/28	8	
4/9/14/19/24/29	10	
5/10/15/20/25/30	12	

For the Base Case scenario, the highest mean wave attenuation factor was of 35% for 4 s waves coming from SSE, meaning that the wave height inside the marina is on average 35% of the wave in open waters. The wave attenuation factor map is presented in Figure 7-3 for this specific scenario and in Appendix F for all simulated cases. The mean wave attenuation factors (averaged over the marina basin) for the Base Case simulated cases are presented in Table 7-2.

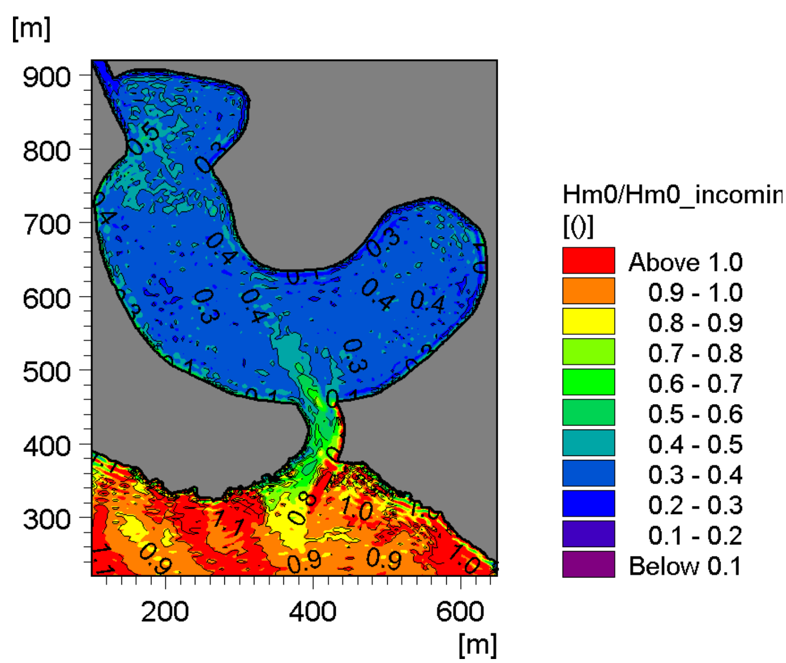


Figure 7-3: Wave Attenuation Factor – Base Case, 4 seconds, SSE

Table 7-2: BW model Base Case Results – Mean Wave Attenuation Factor

	Tp (s)	Dir (degN)	Base Case
c01	4	SE - 135	33%
c06	4	SSE - 157.5	35%
c11	4	S - 180	29%
c16	4	SSW - 202.5	34%
c21	4	SW - 225	33%
c26	4	WSW - 247.5	23%
c02	6	SE - 135	28%
c07	6	SSE - 157.5	30%
c12	6	S - 180	23%
c17	6	SSW - 202.5	23%
c22	6	SW - 225	24%
c27	6	WSW - 247.5	16%
c03	8	SE - 135	26%
c08	8	SSE - 157.5	27%
c13	8	S - 180	23%
c18	8	SSW - 202.5	19%
c23	8	SW - 225	20%
c28	8	WSW - 247.5	13%
c04	10	SE - 135	22%
c09	10	SSE - 157.5	23%
c14	10	S - 180	21%
c19	10	SSW - 202.5	18%
c24	10	SW - 225	19%
c29	10	WSW - 247.5	12%
c05	12	SE - 135	21%
c10	12	SSE - 157.5	24%
c15	12	S - 180	21%
c20	12	SSW - 202.5	19%
c25	12	SW - 225	18%
c30	12	WSW - 247.5	11%

For the operational conditions, Figure 5-7 presented the annual percentage of exceedance of wave heights at location SW34 (BW model boundary), which shows that 99% of the time the waves are smaller than 1.05 m. Figure 5-10 shows that waves higher than 1 m have between 5 and 6 s of peak period. Therefore, it can be expected that only 1% of the time during the year the waves inside the basin will be higher than 30% (highest mean wave attenuation factor for 6-second waves) times 1.05 m which corresponds to a 0.32 m (less than 1 foot) significant wave height. Considering that the adopted reflection coefficients for the revetted areas are greater than what is expected in reality, the significant wave heights are estimated to be smaller than 1 foot during most of the prevailing conditions.

However, when considering extreme conditions, the significant wave height at the SW34 location can get as high as 9.0 m for the 100-year return period wind speed (from SSW). Figure 7-4 shows a snapshot of a SW model run for the referred scenario and Table 7-3 present the wave conditions for all simulated wind cases.

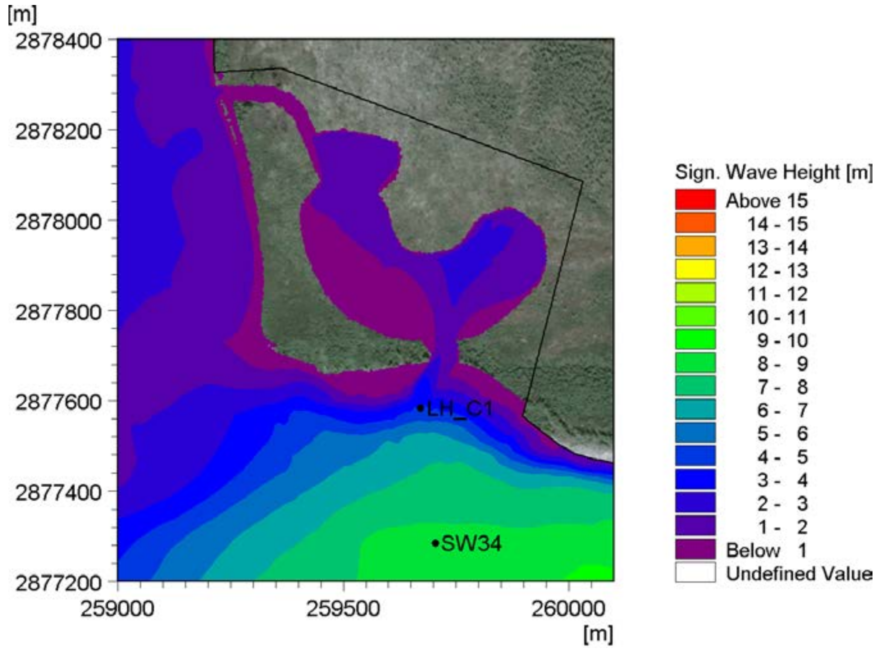


Figure 7-4: SW Model Result, 100-year Winds from SSW

Table 7-3: Extreme Wave Results – SW34 and LH_C1

Extreme wave analysis - 100 year return wind speed - Leeward Harbor						
Wind Directions	SW34			LH C1		
	Hs	Tp	MWD	Hs	Tp	MWD
N	1.85	3.91	294.52	0.58	7.03	214.83
NNE	1.10	4.71	178.20	0.46	6.37	198.48
NE	2.43	4.73	102.48	1.15	5.71	139.48
ENE	3.38	5.37	116.88	2.41	5.73	142.85
E	5.00	9.87	136.31	3.65	9.49	149.64
ESE	6.97	11.24	148.90	4.05	11.77	154.04
SE	8.56	11.58	156.70	4.32	12.56	156.78
SSE	8.90	11.42	165.35	4.50	12.48	161.25
S	9.05	11.44	171.51	4.49	12.62	164.16
SSW	9.04	11.07	190.97	4.68	10.83	169.28
SW	8.24	11.69	190.93	4.17	10.36	165.46
WSW	6.78	11.68	197.31	3.78	10.62	169.91
W	4.78	10.90	210.40	3.20	11.49	204.89
WNW	4.16	11.25	232.20	2.57	12.67	203.08
NW	3.28	4.92	249.24	1.93	13.53	200.03
NNW	2.45	4.15	283.02	1.03	12.69	205.98
max	**9.05**			**4.68**		

The peak wave period of this extreme condition wave is approximately 12 s and the waves are coming from a southerly direction. At the location LH_C1 right in front of the entrance channel (Figure 7-4), the significant wave height for that same extreme condition is 4.68 m. Therefore, when applying the mean wave attenuation factor of 21% (c15), an average significant wave height of approximately 1.0 m is expected inside the marina. However, at several locations within the basin, an attenuation factor of up to 30% is predicted, and up to 40% closer to the entrance channel, which corresponds to significant wave heights of 1.4 m to 1.9 m that can result in damage to the dock system.

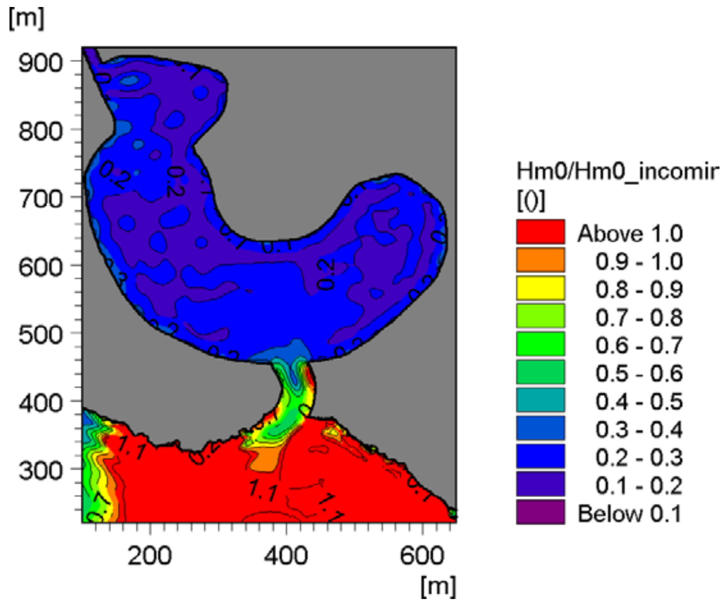


Figure 7-5: Wave Attenuation Factor – Base Case, 12 seconds, S

In order to decrease the wave conditions inside the marina during extreme events, a 60 m (200 feet) jetty is proposed along the southeast edge of the channel. Figure 7-6 and Figure 7-7 present the same results for the jetty as shown previously for the Base Case. Additional cases are presented in Appendix F.

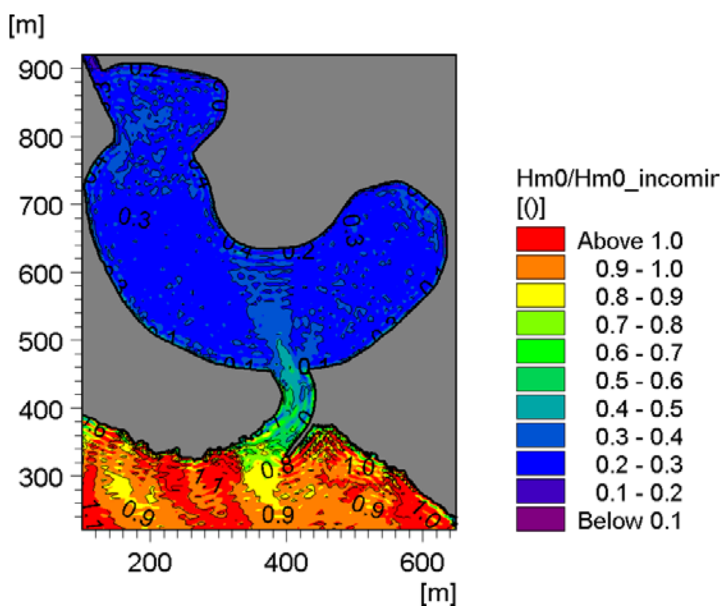


Figure 7-6: Wave Attenuation Factor – Jetty, 4 seconds, SSE

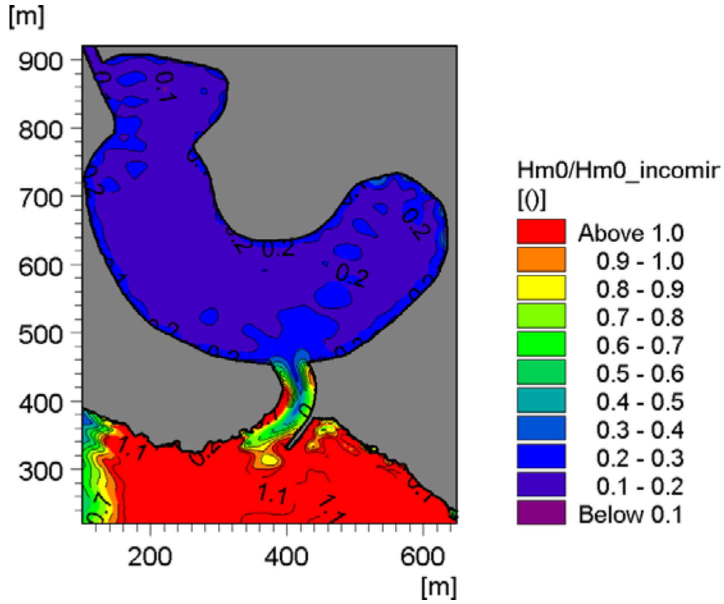


Figure 7-7: Wave Attenuation Factor – Jetty, 12 seconds, S

Table 7-4 shows the results for both scenarios (Base Case and Jetty) and the difference between them. The highest mean wave attenuation factor value for the 12 seconds extreme waves is of 18% resulting in an average significant wave height of 0.84 m inside the marina. As seen in Figure 7-7, most of the marina is in the range of 10 to 20% of the open water wave heights, with the exception of some places in the range on 20 to 30% where the maximum significant wave height is expected to be no more than 1.4 m. Regarding the operational conditions, the mean wave attenuation factor is significantly reduced for the 4, 6 and 8 second waves coming from SE and SSE which are the predominant directions (see Figure 5-4).

It is expected that changes to the channel alignment and extension to the landside of the project can also result in improvements in the wave attenuation factors. A combination of jetty and land changes will be evaluated during the design phases of the project.

Table 7-4: BW model Base Case and Jetty Results – Mean Wave Attenuation Factor

	Tp (s)	Dir (degN)	Base Case	Jetty	Jetty - Base
c01	4	SE - 135	33%	22%	-11.2%
c06	4	SSE - 157.5	35%	27%	-8.5%
c11	4	S - 180	29%	31%	1.6%
c16	4	SSW - 202.5	34%	34%	0.3%
c21	4	SW - 225	33%	32%	-0.8%
c26	4	WSW - 247.5	23%	22%	-0.9%
c02	6	SE - 135	28%	19%	-9.3%
c07	6	SSE - 157.5	30%	23%	-7.2%
c12	6	S - 180	23%	24%	0.7%
c17	6	SSW - 202.5	23%	25%	2.3%
c22	6	SW - 225	24%	25%	0.5%
c27	6	WSW - 247.5	16%	16%	0.5%
c03	8	SE - 135	26%	19%	-6.7%
c08	8	SSE - 157.5	27%	22%	-5.1%
c13	8	S - 180	23%	22%	-0.4%
c18	8	SSW - 202.5	19%	22%	2.8%
c23	8	SW - 225	20%	24%	4.2%
c28	8	WSW - 247.5	13%	16%	2.3%
c04	10	SE - 135	22%	18%	-4.8%
c09	10	SSE - 157.5	23%	19%	-4.3%
c14	10	S - 180	21%	20%	-1.3%
c19	10	SSW - 202.5	18%	19%	1.0%
c24	10	SW - 225	19%	22%	2.9%
c29	10	WSW - 247.5	12%	14%	1.6%
c05	12	SE - 135	21%	16%	-4.9%
c10	12	SSE - 157.5	24%	17%	-6.2%
c15	12	S - 180	21%	18%	-3.6%
c20	12	SSW - 202.5	19%	17%	-1.3%
c25	12	SW - 225	18%	18%	0.2%
c30	12	WSW - 247.5	11%	11%	0.5%

8.0 CONCLUSIONS

The following methodology was used to perform the Coastal Engineering Study for the three proposed sites for the Kakona Development.

- Metocean data was collected to evaluate the coastal processes including winds, waves, tides and relative sea level rise.

- Operational offshore winds and wave conditions were determined based on 13-years of data obtained from the production hindcast WW3 model, while the nearshore operational waves were determined by running a SW model forced by WW3 winds and offshore waves boundary conditions.

- Storm data was collected using NOAA's Historical Hurricane Tracks Tool which identified 91 storms and hurricanes passing within a 120 km (65 nautical miles) radius from South Abaco.

- The extreme winds and central pressures were determined through an extreme probability analysis of HURDAT2 data, and the extreme waves and storm surges were estimated by running a coupled HD and SW model forced by those extreme winds. The effects of pressure setup, wind setup, wave setup were considered for the 50- and 100-year return periods. The flood elevations were calculated based on the coupled model outputs.

- A BW model was run to investigate the wave agitation in the entrance channel and inside the marina basin during both operational and extreme conditions.

- The HD/TR coupled model was used to simulate a flushing analysis for the marina at Leeward Harbor and a water exchange analysis for the three proposed water bodies: the marina at Leeward Harbor and the lagoons at Conch Sound Point and High Bank Bay.

The results of the metocean analysis, site specific design conditions, flushing, and harbor agitation studies are presented in this chapter. A discussion on sea level rise and resiliency is presented in Appendix G.

8.1 General Metocean Conditions

The following meteorological and oceanographic (metocean) conditions were collected to evaluate the site-specific conditions and establish design parameters for the planned waterfront developments.

- The great tidal range in South Abaco is approximately 0.9 m (2.95 ft) while the mean tidal range is in the order of 0.7 m (2.3 ft). The MHW is approximately 0.4 m (1.31) above MSL and the MLLW 0.4 m (1.31 ft) below MSL.

- NOAA's 2017 Intermediate Sea Level Rise Scenario projects a future SLR of 0.57 m (1.87 ft) in 50 years (2070). The effects of Sea Level Rise were not considered in the calculations for the wave height or water levels.

- The prevailing offshore winds east of the Abaco Islands are from east-northeast to the south-southeast directions. Stronger winds are from the east-northeast direction. The 1% annual exceedance wind is approximately 25 kt.

- The 1-minute duration design extreme wind speed in the vicinity of the Project varies from approximately 119 kt to 137 kt for the 25- to 100-year return periods, while the corresponding 30-minute duration design extreme wind speed varies from approximately 97 kt to 112 kt. The respective extreme central pressure varies from 943 to 918 hPa.

- The majority of prevailing offshore waves range from 1 m to 2 m (3.28 ft to 6.56 ft) with a period between 7 and 9 seconds. The 1% annual exceedance offshore significant wave height is 3.9 m (12.8 ft).

- The design extreme offshore wave heights east of the Abaco Islands vary from 11.6 m to 15.2 m (38.0 ft to 49.9 ft) while peak wave periods vary from 14.6 s to 16.8 s for 25- to 100-year return periods.

8.2 Site Specific Metocean and Design Conditions

8.2.1 Leeward Harbor Marina Basin

The marina basin at Leeward Harbor was evaluated for nearshore prevailing winds, extreme water levels and waves, and water quality.

- The nearshore transformed prevailing waves are generally from the SE with significant wave heights near the marina entrance of less than 0.30 m (0.98 ft). The annual 1% exceedance significant wave height is 1.05 m (3.44 ft).

- The 100-year storm still water levels are between 2.02 m (6.64 ft) and 2.53 m (8.31 ft) above MSL. The 100-yr storm maximum significant wave height is 3.21 m (10.53 ft) near the marina entrance channel and 1.39 m (4.55 ft) near the flushing channel. The combination wind and wave conditions used to develop the flood elevations are conservative and should only be used as guidance. The selection of first floor elevations for building structures should be based on the 100-year flood elevation as a boundary condition and refined using a coastal inundation analysis, final site grading, and local building codes (foundation design).

- Flushing and water exchange analyses were performed to evaluate marina spill response conditions and overall marina water quality, respectively.

- The flushing analysis was simulated using a 1,200-gallon fuel tank spill inside the basin. The results of the flushing analysis indicate the harbor meets the guidelines provided by the BEST commission (concentration reduction to 10% of the original spill in 24 hours).

- The water exchange analysis for the marina was simulated with a non-dimensional concentration of 100 over the entire basin. The results of the overall water exchange analysis showed that 90% of the water in the basin exchanged within 5 to 6 days which is consistent with industry guidelines for marinas.

- The BW model results for the Base Case show that 1% of the year the significant wave height inside the basin exceeds 0.32 m (approx. 1 ft). The addition of a jetty on the east side of the entrance channel significantly reduces this wave height for the 4, 6 and 8 second waves coming from SE and SSE which are the predominant directions.

- The agitation study indicated that an entrance structure (i.e. jetty) was required to reduce heights inside the basin during extreme conditions. The results show that the highest mean wave attenuation factor value for the 12 second extreme waves is of 18% resulting in an average significant wave height of 0.84 m (2.76 ft) inside the marina and a maximum significant wave height of 1.4 m (4.59 ft). This maximum value is observed near the entrance channel while the rest of the basin experiences values closer to the average.

The final configuration of the marina basin at Leeward Harbor includes a 49 m (160 ft) wide marina entrance channel with a 60 m (200 ft) jetty along the east side of the entrance channel for wave protection. A flushing channel is provided at the northwest corner of the site to improve water quality in the basin. The final alignment and configuration of the jetty will be evaluated during the final phase of the project to further reduce wave agitation in the basin.

8.2.2 Conch Sound Point and High Bank Bay Lagoons

The lagoons at Conch South Point and High Bank Bay were evaluated for nearshore waves, extreme water levels and overall water quality.

- The nearshore transformed prevailing waves are generally from ENE and E near the lagoon entrances with significant wave heights up to 1.5 m (4.92 ft) for CSP and 1.10 m (3.6 ft) for HBB.

- The 100-year storm still water levels vary from 2.32 m (7.62 ft) and 2.39 m (7.84 ft) above MSL. The corresponding maximum significant wave heights are 1.91 m (6.27 ft) at CSP and 1.58 m (5.19 ft) at HBB. The resulting 100-year flood elevations are between 3.23 m (10.61 ft) and 3.67 m (12.03 ft) above MSL.

- The water exchange analysis for the lagoons was simulated with a non-dimensional concentration of 100 over the entire water body. The results of the water exchange analysis show that 50% of the water in the lagoons is exchanged in 4 days, and 90% of the water of the lagoon is exchanged in approximately 6 days. This meets the recommended criteria for artificial beaches or swimming lagoons (50% of water exchanged in less than 5-7 days).

The final configuration of the Conch Sound Point lagoon includes an open channel to the south and a culvert to the north. The lagoon at High Bank Bay has three open channels to provide sufficient water circulation through the lagoon.

9.0 REFERENCES

Goda, Y. (2000). “Random Seas and Design of maritime Structures.” World Scientific, River Edge, NJ.

U.S. Army Corps of Engineers (2006). “Coastal Engineering Manual.”

Danish Hydraulic Institute (DHI), (2017a). “Mike 21 Spectral Waves FM – Spectral Wave Module”.

Danish Hydraulic Institute (DHI), (2017b). “Mike 21 Flow Model FM – Hydrodynamic Module”.

Danish Hydraulic Institute (DHI), (2017c). “Mike 21 Flow Model FM – Transport Module”.

Danish Hydraulic Institute (DHI), (2017d). “Mike 21 BW - Boussinesq Waves Module”.

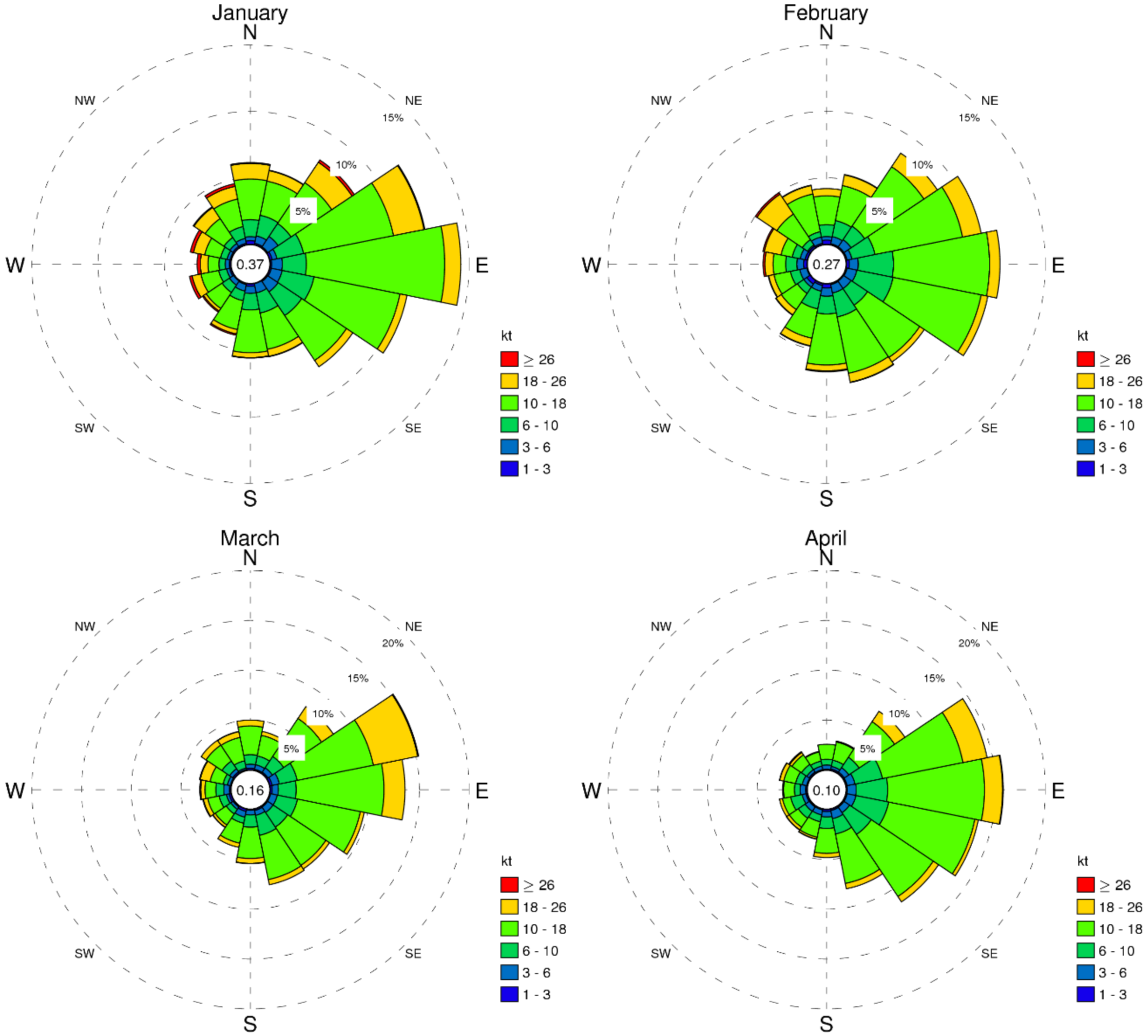
Mangor, K., Drønen, N. K., Kaergaard, K.H. and Kristensen, N.E. (2017). Shoreline management guidelines. DHI https://www.dhigroup.com/marine-water/ebook-shoreline-management-guidelines.

World Meteorological Organization (2011) Guide to storm surge forecasting. Geneva, Switzerland, World Meteorological Organization, 120pp. (WMO-No 1076). http://hdl.handle.net/11329/393

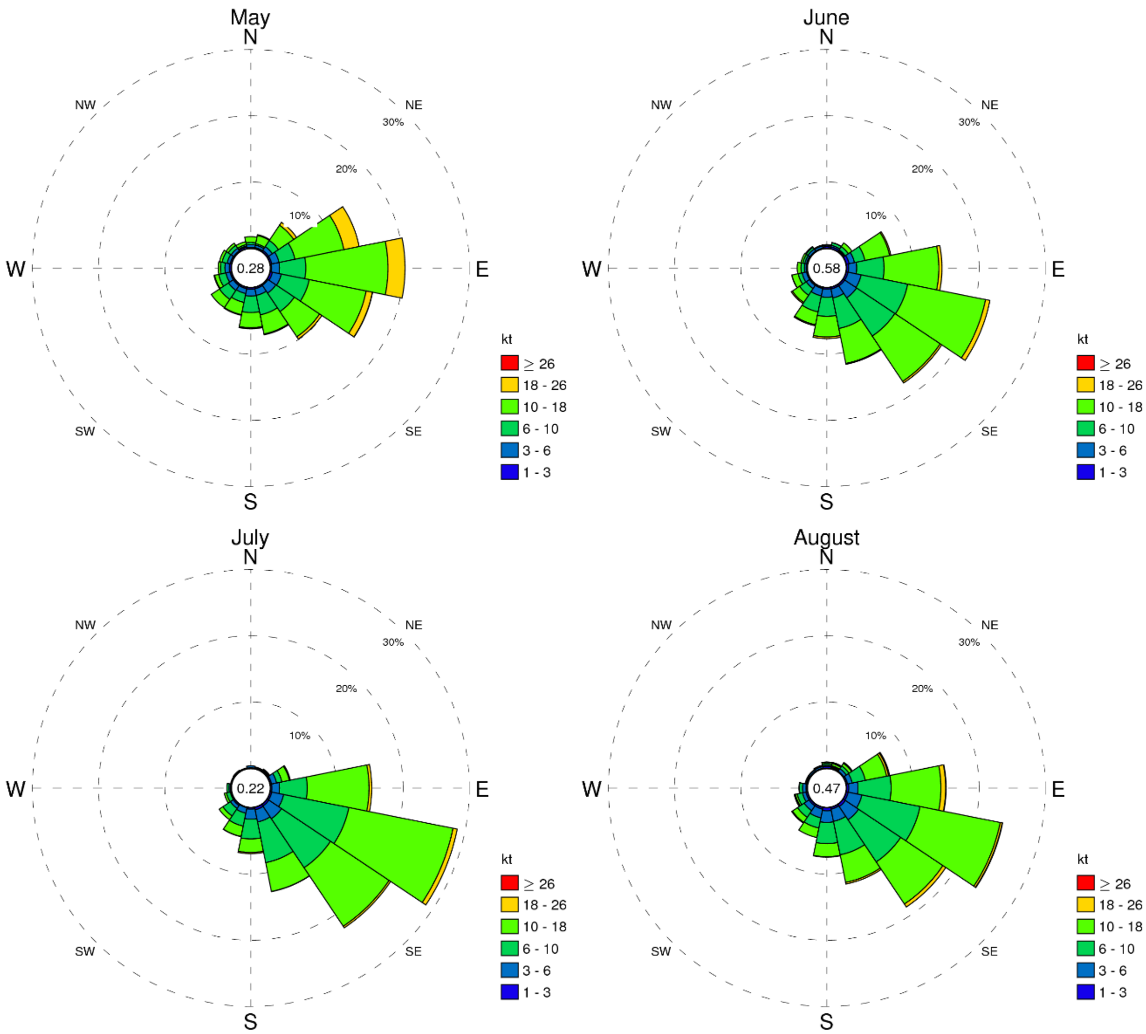
APPENDIX A

MONTHLY AND SEASONAL WIND ROSES

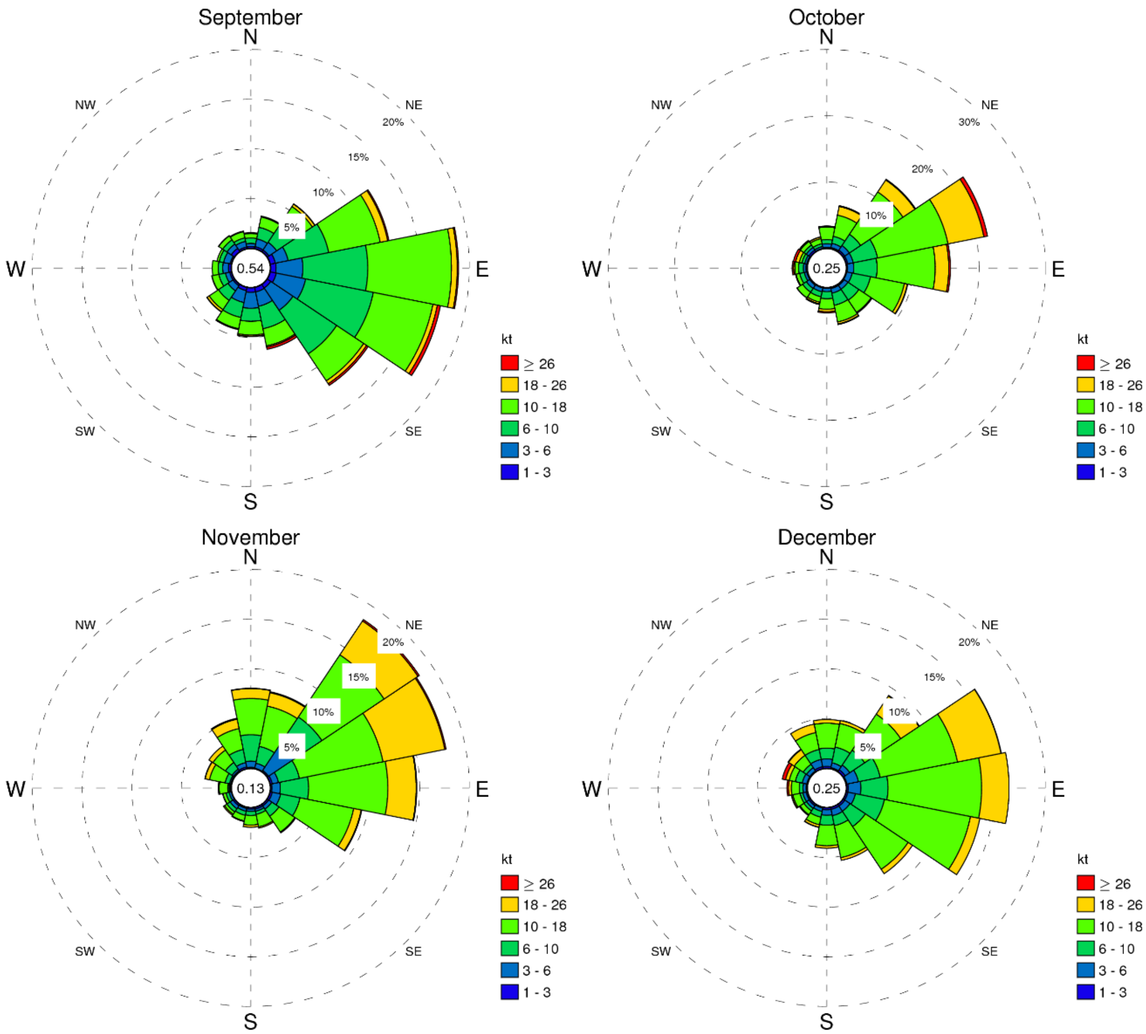
Wind Speed
Station Offshore_Abaco_South - NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01-Feb-2005 to 01-Jan-2018

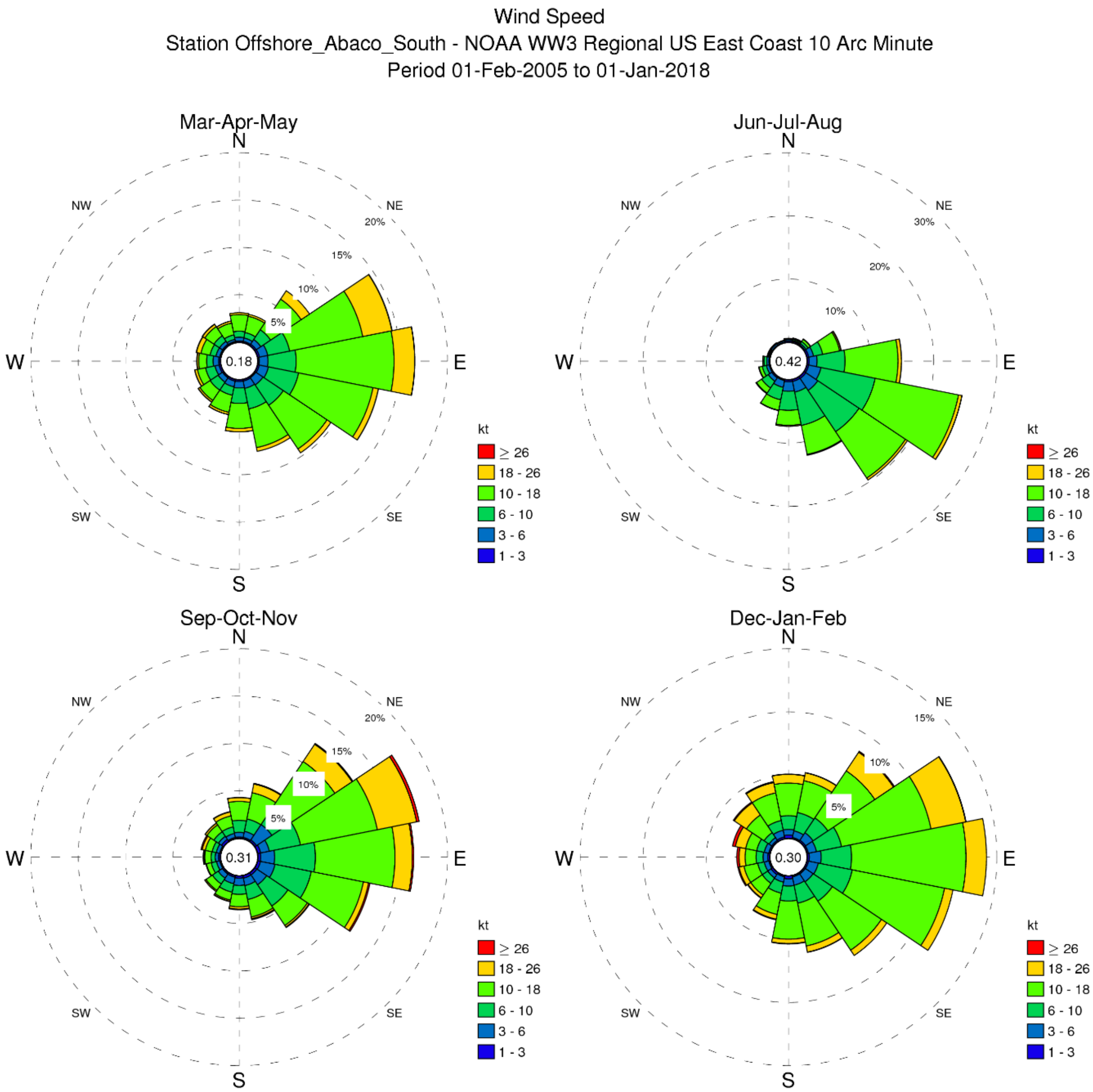


Wind Speed
Station Offshore_Abaco_South - NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01-Feb-2005 to 01-Jan-2018



Wind Speed
Station Offshore_Abaco_South - NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01-Feb-2005 to 01-Jan-2018

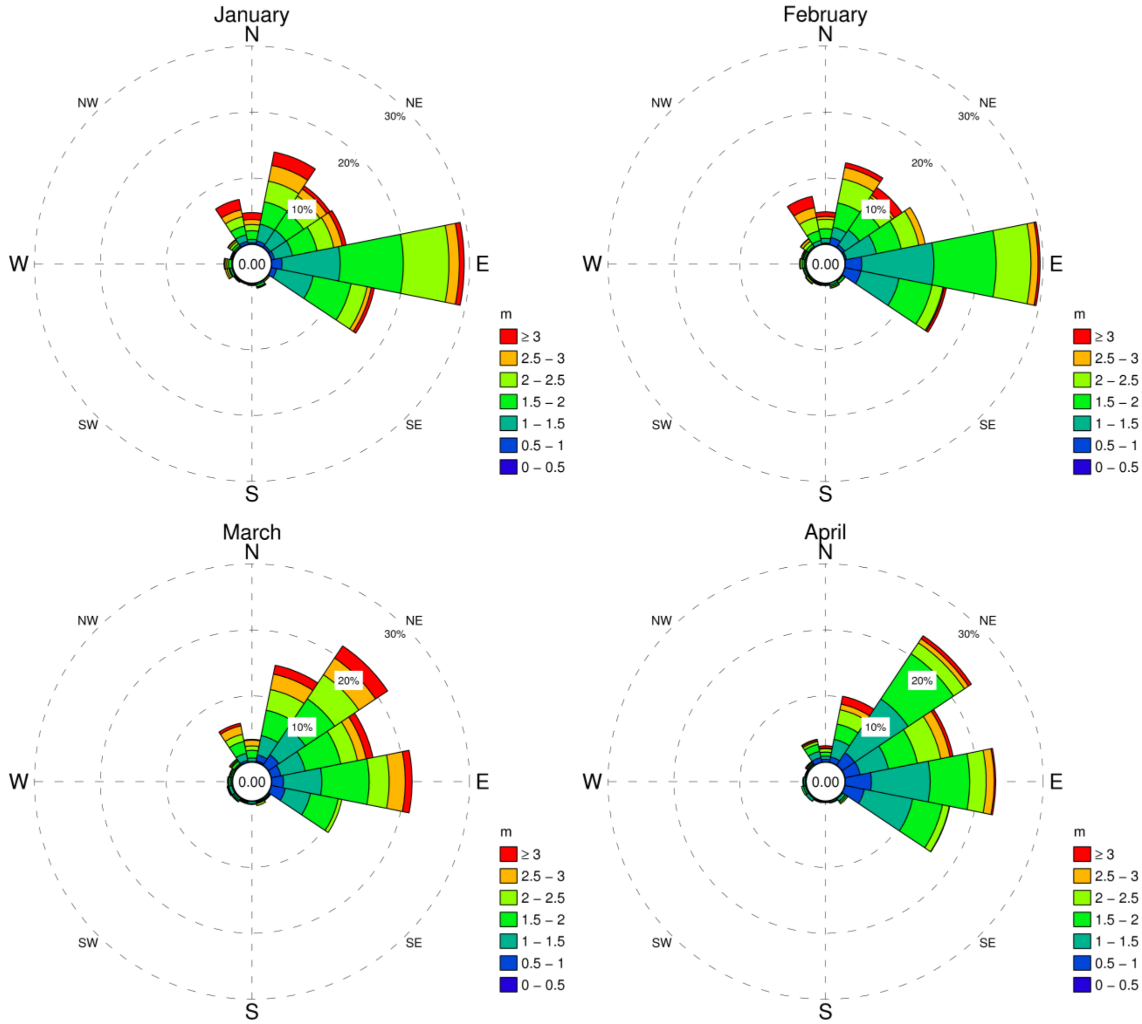


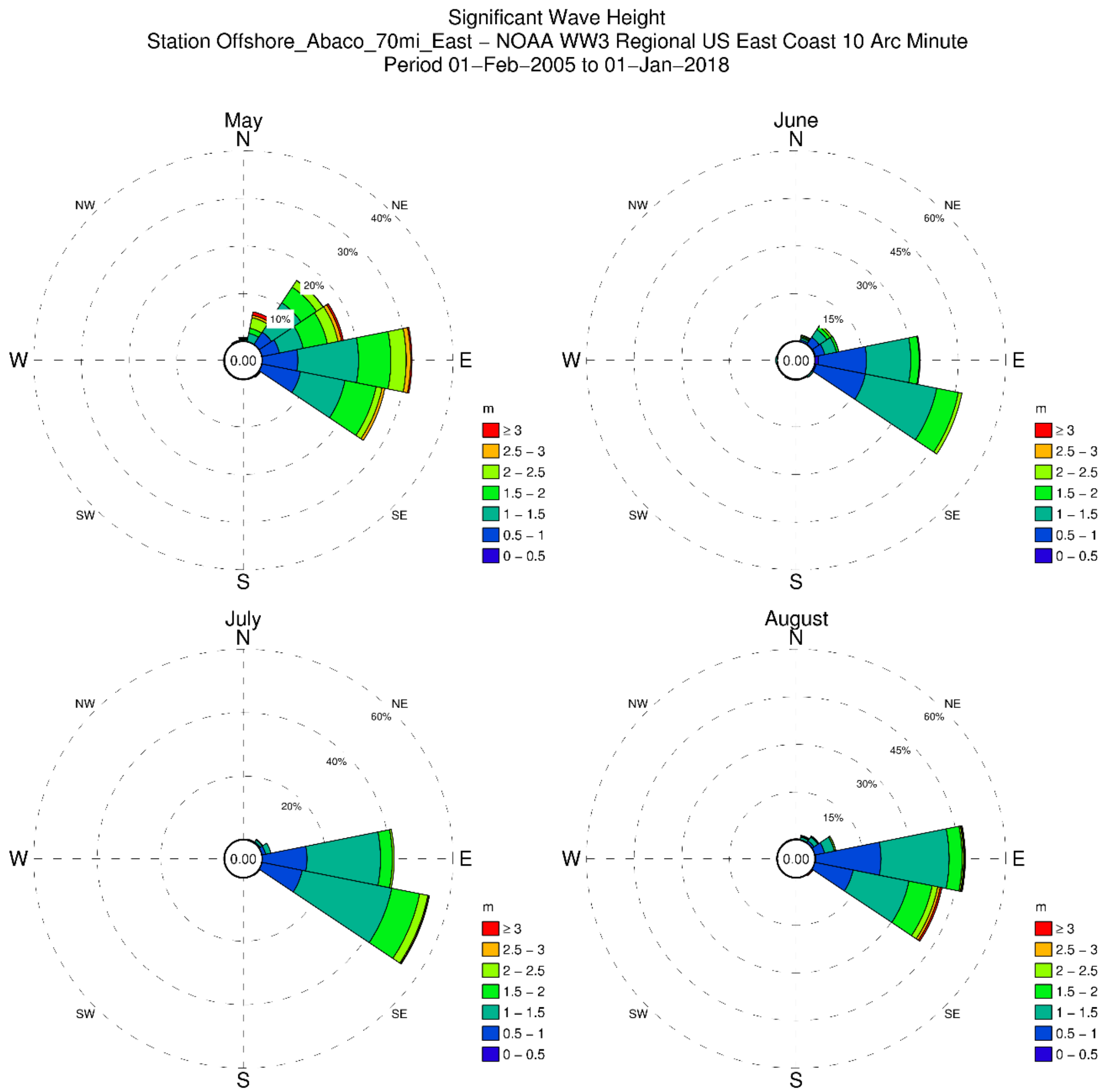

Wind Speed
Station Offshore_Abaco_South - NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01-Feb-2005 to 01-Jan-2018
Mar-Apr-May
Jun-Jul-Aug
Sep-Oct-Nov
Dec-Jan-Feb
N
NE
E
SE
S
SW
W
NW
0.18
0.42
0.31
0.30
kt
≥ 26
18 - 26
10 - 18
6 - 10
3 - 6
1 - 3

APPENDIX B

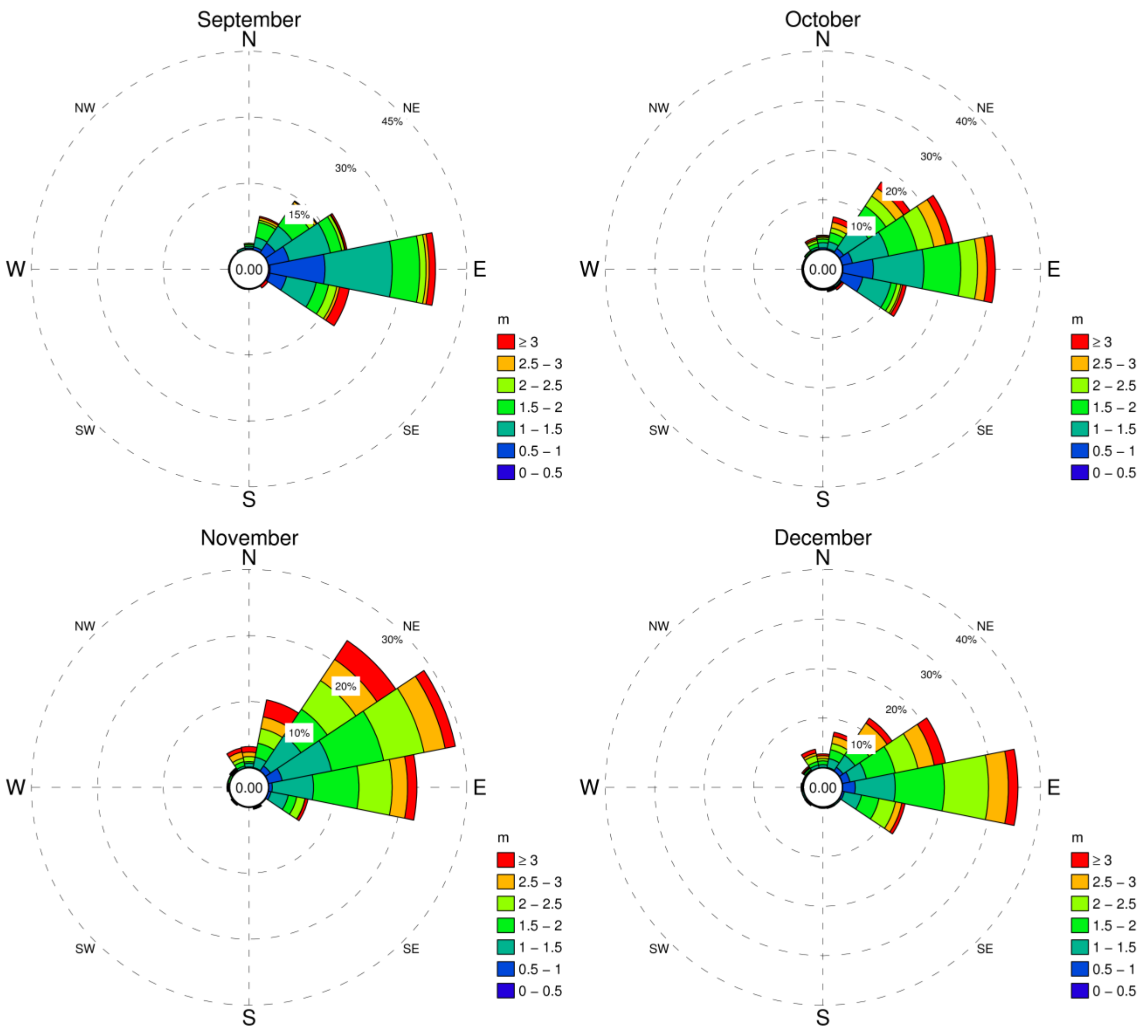
MONTHLY AND SEASONAL OFFSHORE WAVE ROSES

Significant Wave Height
Station Offshore_Abaco_70mi_East – NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01–Feb–2005 to 01–Jan–2018

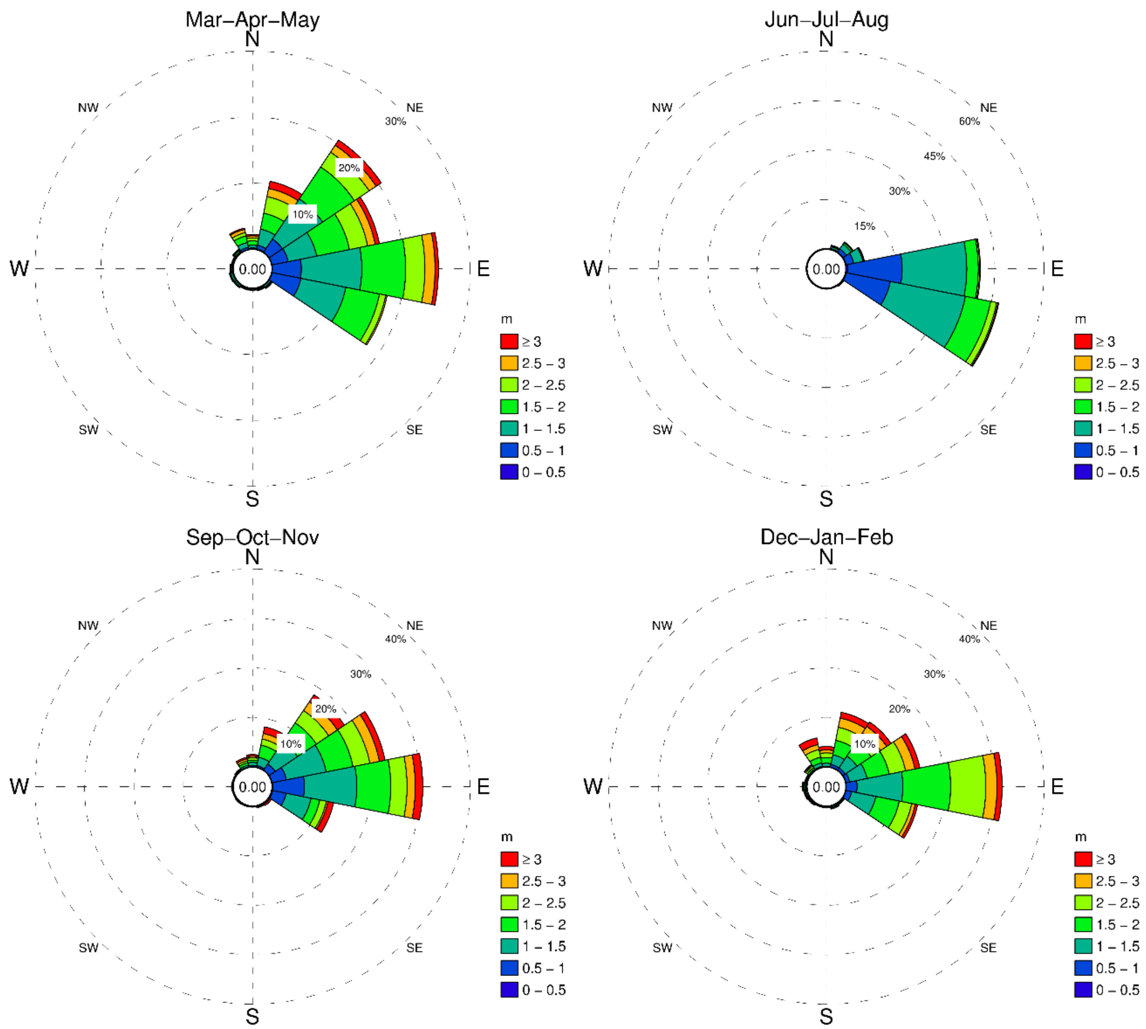



Significant Wave Height
Station Offshore_Abaco_70mi_East – NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01–Feb–2005 to 01–Jan–2018
May
N
NW
NE
W
E
SW
SE
S
0.00
10%
20%
30%
40%
June
15%
30%
45%
60%
July
20%
40%
60%
August
15%
30%
45%
60%
m
≥ 3
2.5 – 3
2 – 2.5
1.5 – 2
1 – 1.5
0.5 – 1
0 – 0.5

Significant Wave Height
Station Offshore_Abaco_70mi_East – NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01–Feb–2005 to 01–Jan–2018



Significant Wave Height
Station Offshore_Abaco_70mi_East – NOAA WW3 Regional US East Coast 10 Arc Minute
Period 01–Feb–2005 to 01–Jan–2018



APPENDIX C

MODEL CALIBRATION STATISTICS

Several statistical parameters were used to assess model calibration and validation results. These include the mean error (*ME*), root mean square (*RMS*) error, normalized *RMS* error, mean absolute error (*MAE*), correlation coefficient (*R*), and index of agreement (*d*). These parameters are briefly described here.

If x and y be the measured and calculated data respectively, then the following statistics can be calculated:

Mean error (*ME*):

$$ME = \bar{y} - \bar{x} \tag{1}$$

where "bar" denotes the sample mean.

Root mean square error (*RMS*):

$$\varepsilon_{RMS} = \sqrt{\overline{(x-y)^2}} \tag{2}$$

To reduce the effect of measurement error and possible outliers, a one-hour low-pass filter was applied to the measured data to compute trend x_f. Then the normalized error is calculated as

$$\varepsilon_{norm} = \frac{\varepsilon_{RMS}}{x_{f,\max} - x_{f,\min}} \cdot 100\% \tag{3}$$

where $x_{f,\max}$ and $x_{f,\min}$ are the maximum and minimum values of the trend x_f. The residual in the denominator defines the range of measured data.

The root mean square error of measured data was estimated as:

$$\varepsilon_{meas} = \sqrt{\overline{(x-x_f)^2}} \tag{4}$$

Mean absolute error (*MAE*):

$$MAE = \overline{|x-y|} \tag{5}$$

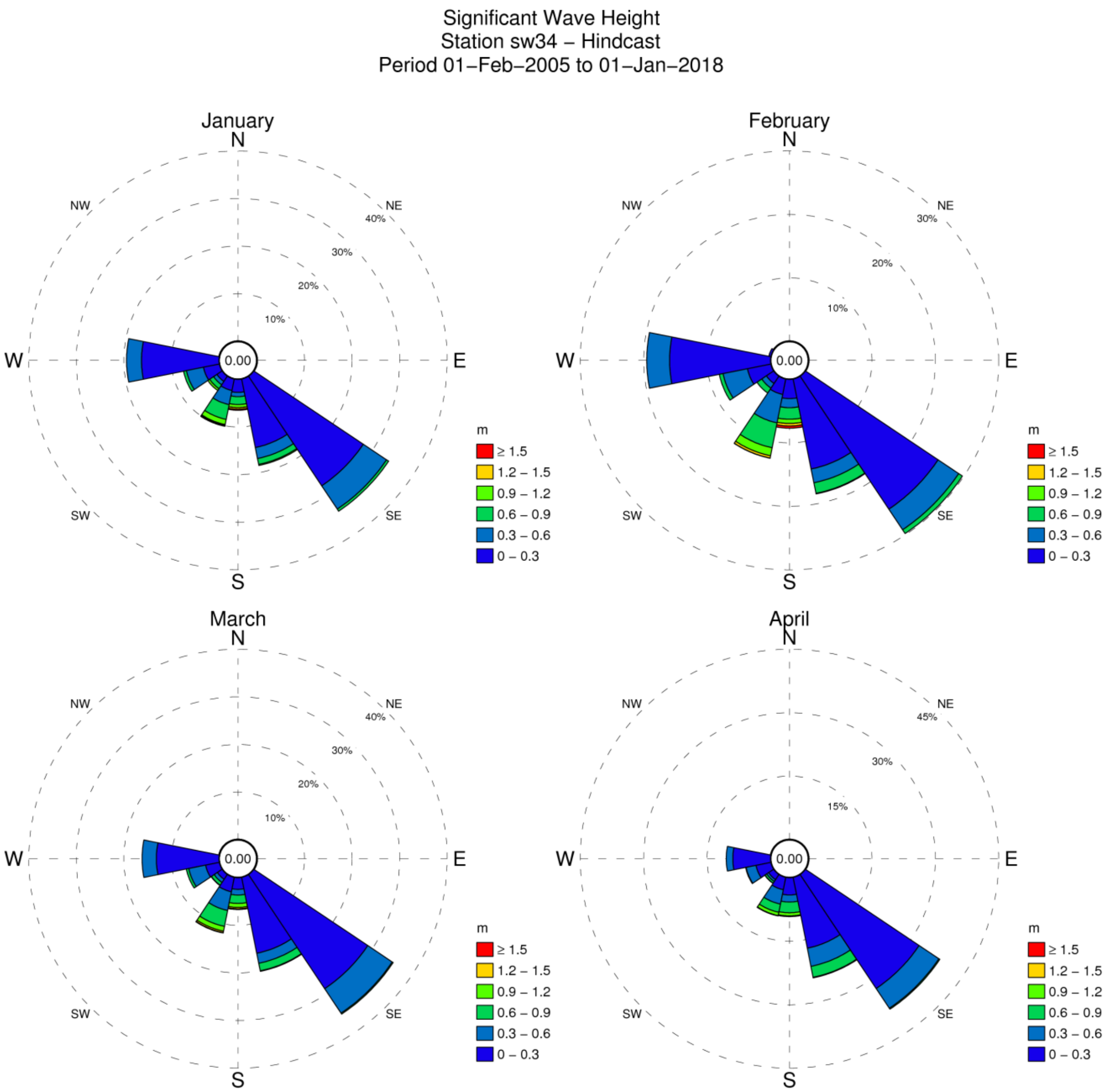
The correlation coefficient *R* was calculated using standard method and represents a non-squared value.

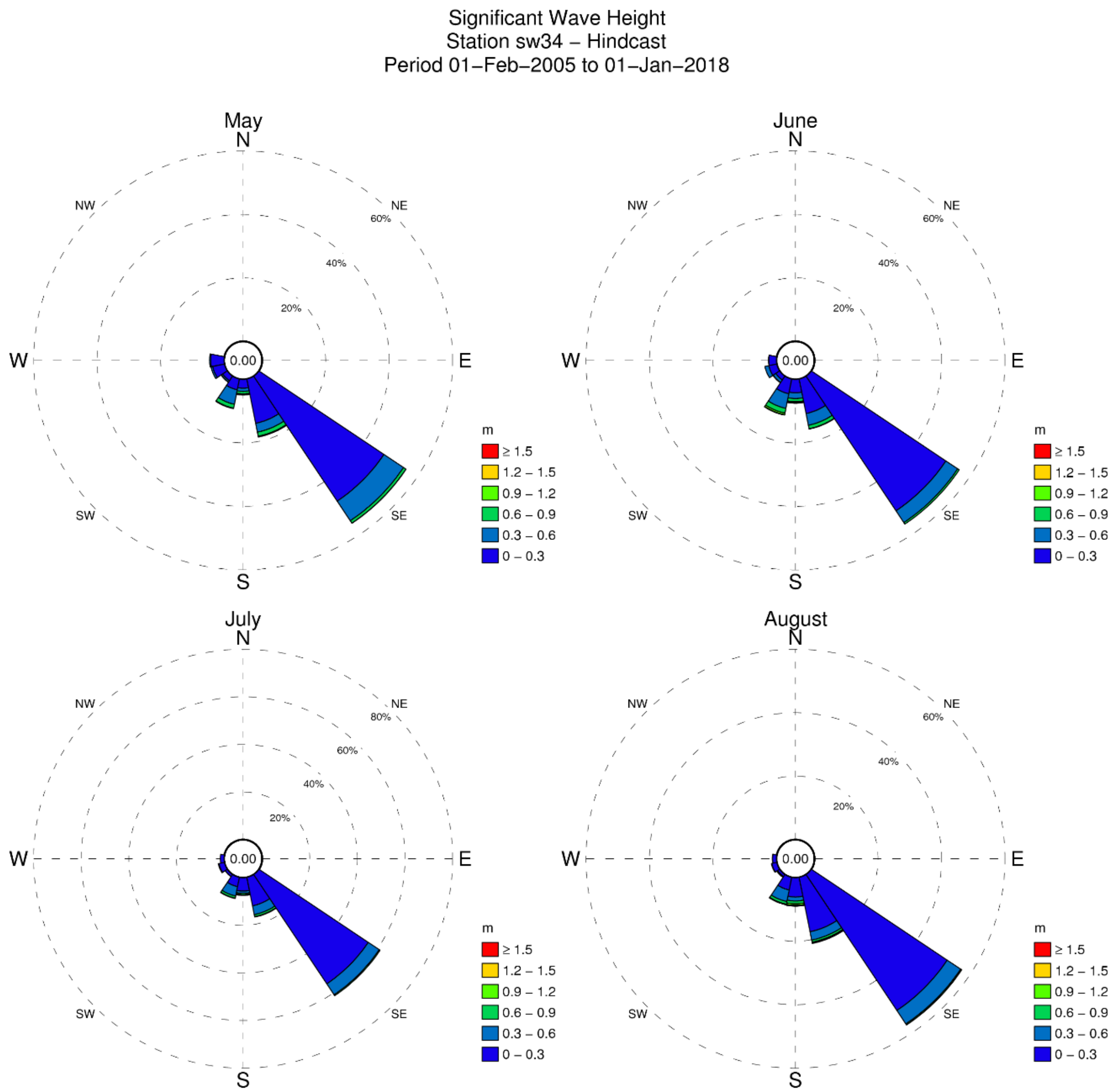
The model prediction capability was estimated with the index of agreement between measured and calculated data (after Willmott, 1982 and Willmott et al., 1985):

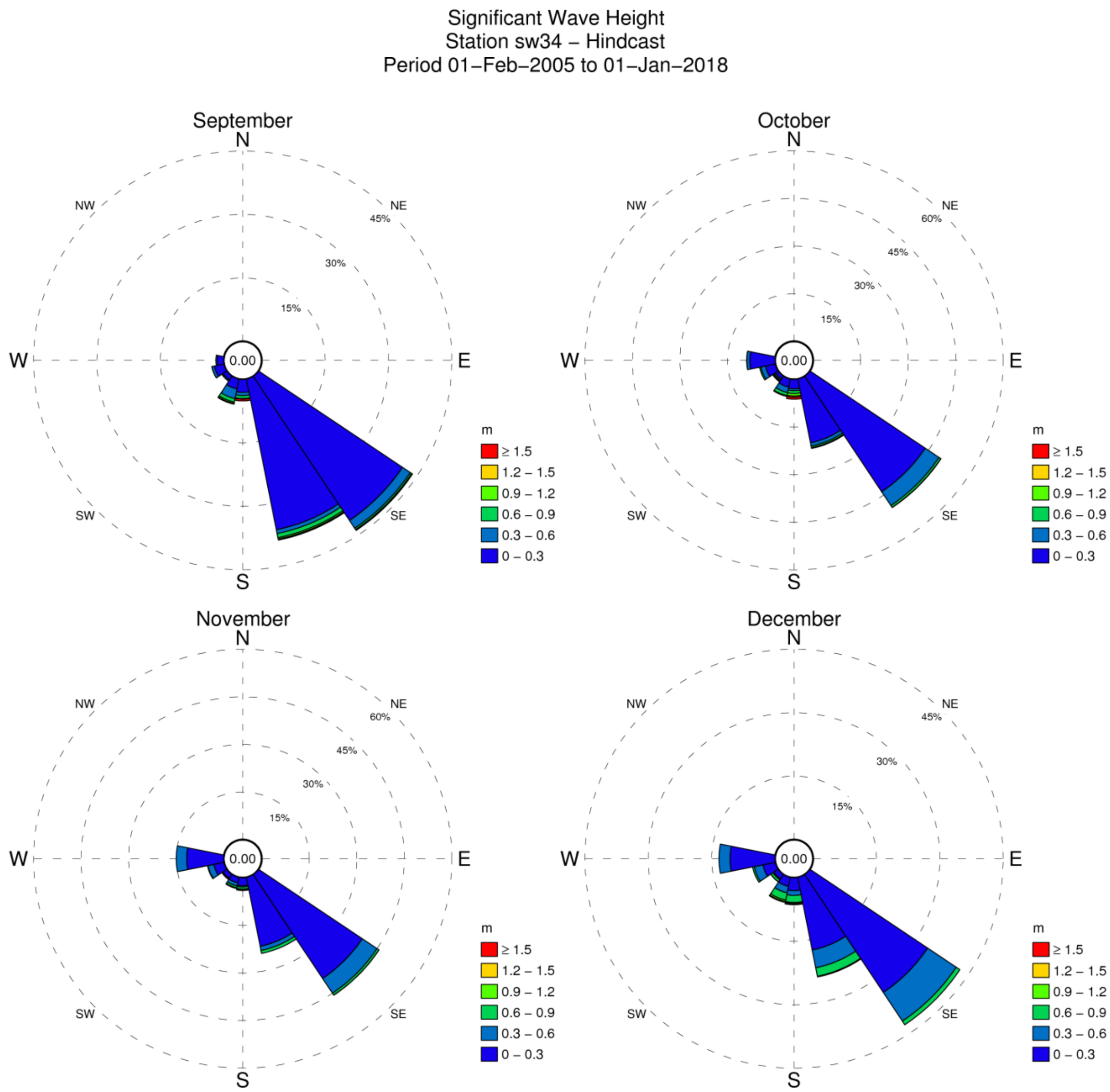
$$d = 1 - \frac{\overline{(x-y)^2}}{\overline{\left(|x-\bar{x}| + |y-\bar{x}|\right)^2}}, \; 0 \le d \le 1 \tag{6}$$

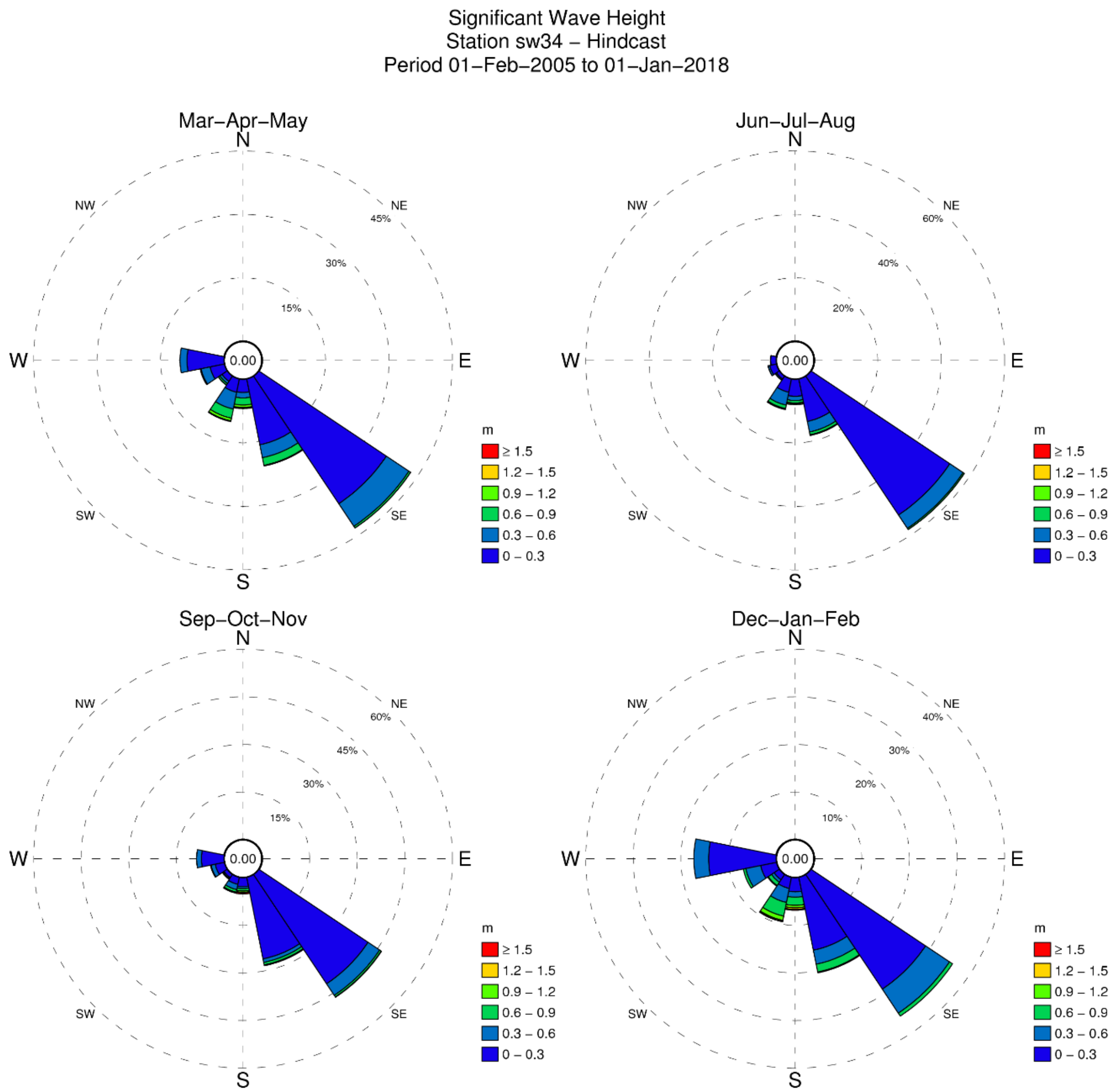
APPENDIX D

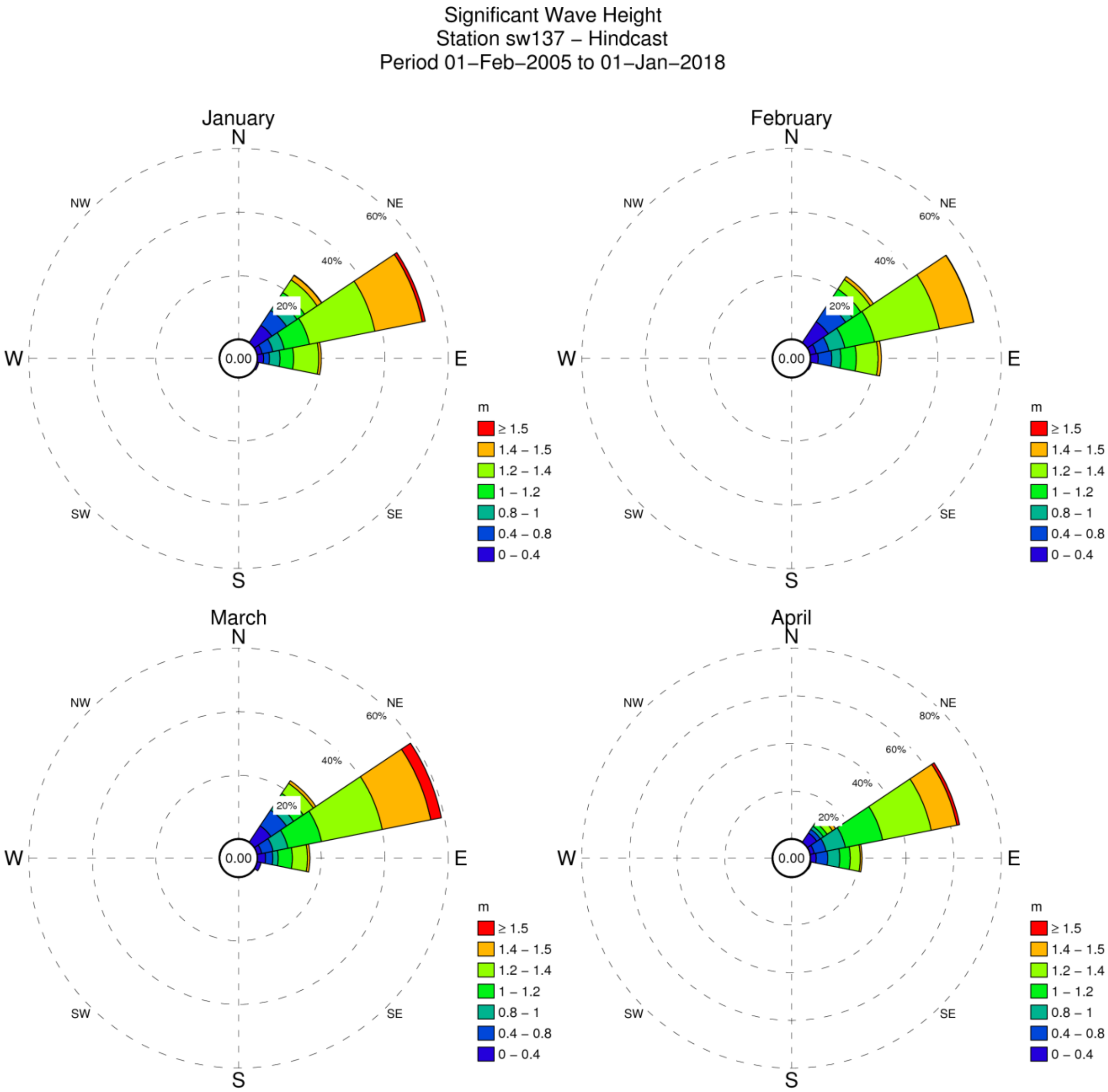
MONTHLY AND SEASONAL NEARSHORE WAVE ROSES


Significant Wave Height
Station sw34 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
January
February
March
April
N
NE
E
SE
S
SW
W
NW
0.00
m
≥ 1.5
1.2 – 1.5
0.9 – 1.2
0.6 – 0.9
0.3 – 0.6
0 – 0.3

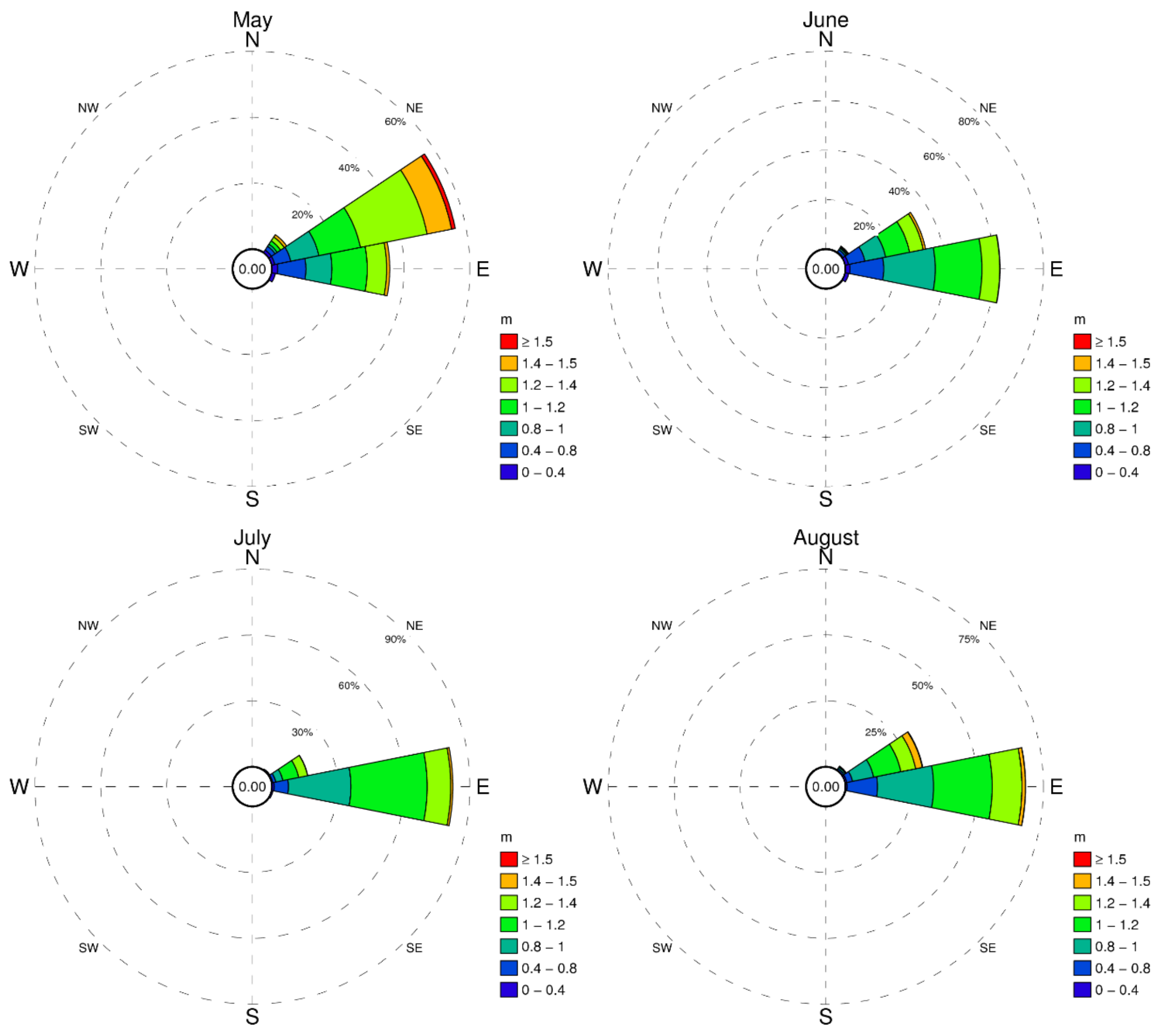

Significant Wave Height
Station sw34 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
May
June
July
August
N
NE
E
SE
S
SW
W
NW
0.00
20%
40%
60%
80%
m
≥ 1.5
1.2 – 1.5
0.9 – 1.2
0.6 – 0.9
0.3 – 0.6
0 – 0.3

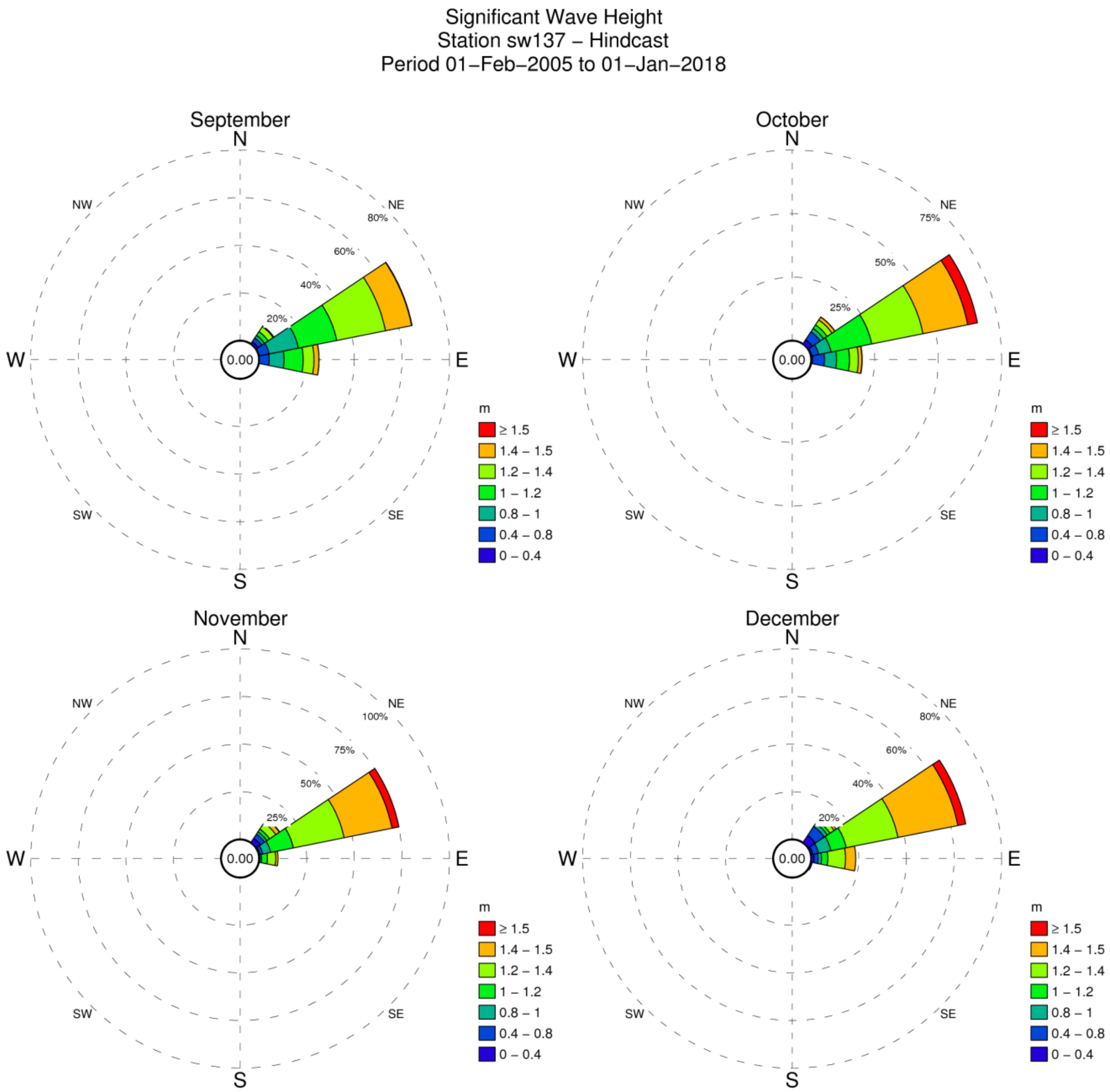

Significant Wave Height
Station sw34 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
September
October
November
December
N
NE
E
SE
S
SW
W
NW
0.00
15%
30%
45%
60%
m
≥ 1.5
1.2 – 1.5
0.9 – 1.2
0.6 – 0.9
0.3 – 0.6
0 – 0.3

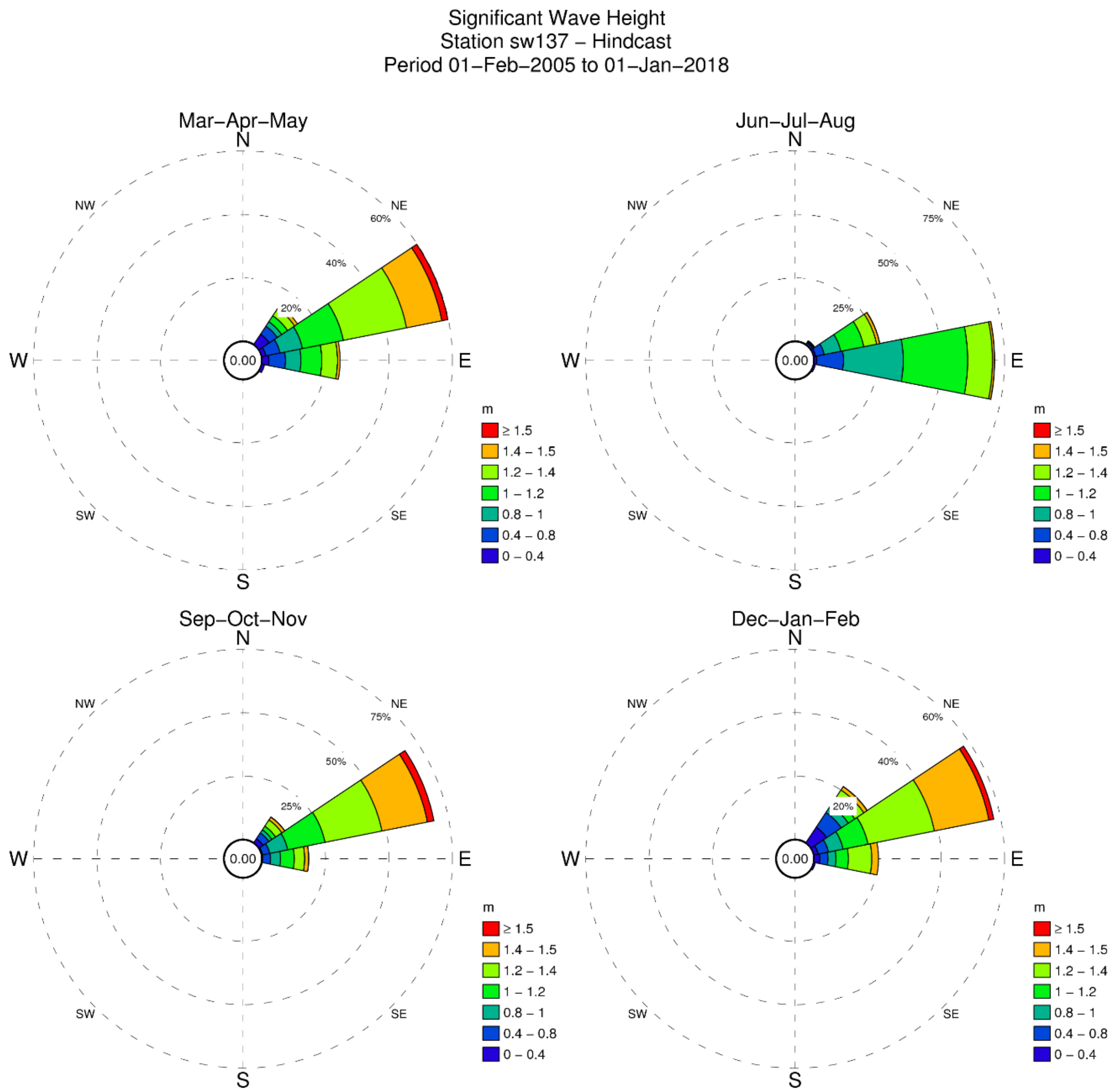

Significant Wave Height
Station sw34 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
Mar–Apr–May
Jun–Jul–Aug
Sep–Oct–Nov
Dec–Jan–Feb
N
NE
E
SE
S
SW
W
NW
0.00
15%
30%
45%
20%
40%
60%
10%
m
≥ 1.5
1.2 – 1.5
0.9 – 1.2
0.6 – 0.9
0.3 – 0.6
0 – 0.3

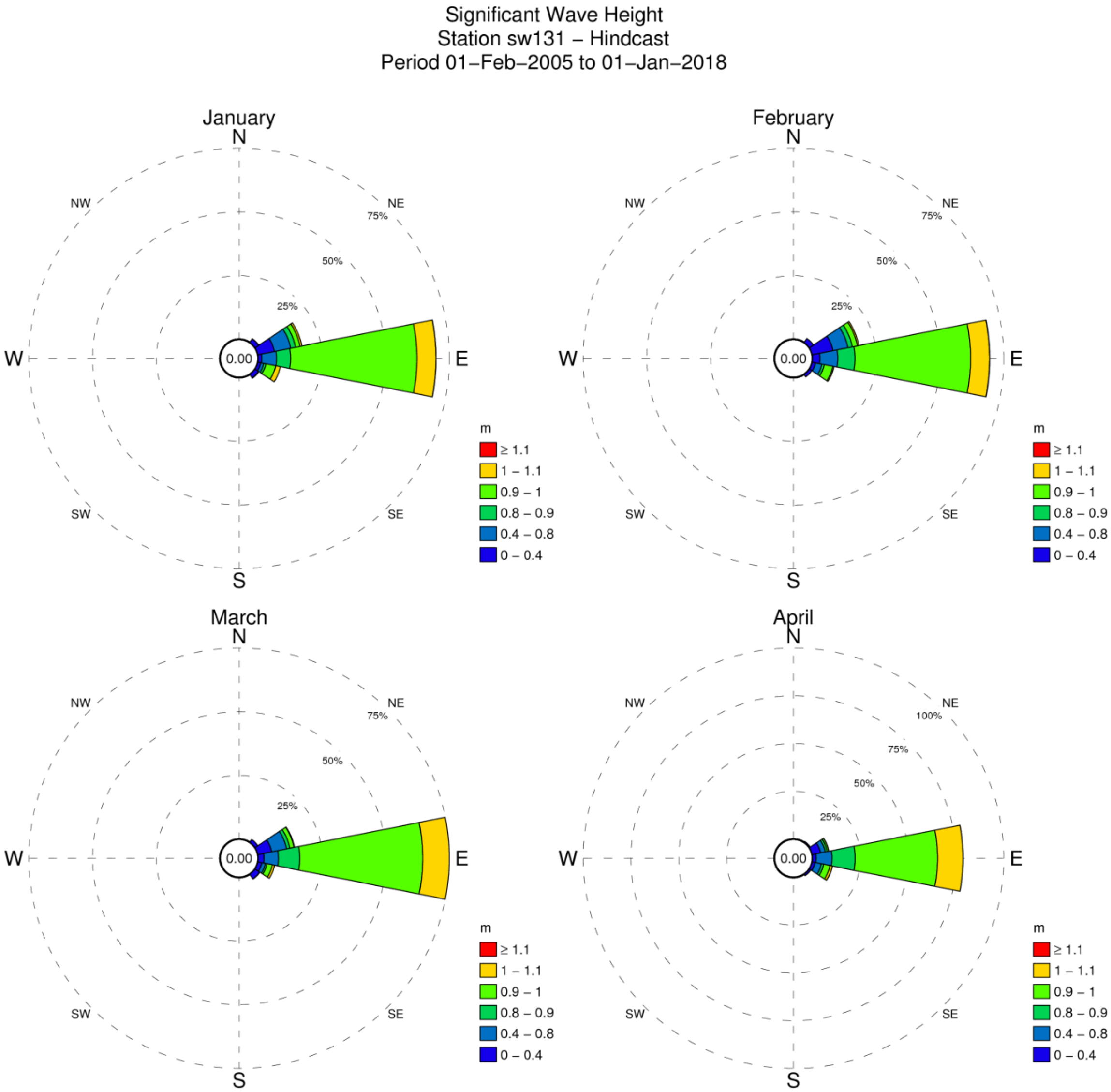

Significant Wave Height
Station sw137 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
January
February
March
April
N
NE
E
SE
S
SW
W
NW
0.00
20%
40%
60%
80%
m
≥ 1.5
1.4 – 1.5
1.2 – 1.4
1 – 1.2
0.8 – 1
0.4 – 0.8
0 – 0.4

Significant Wave Height
Station sw137 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018

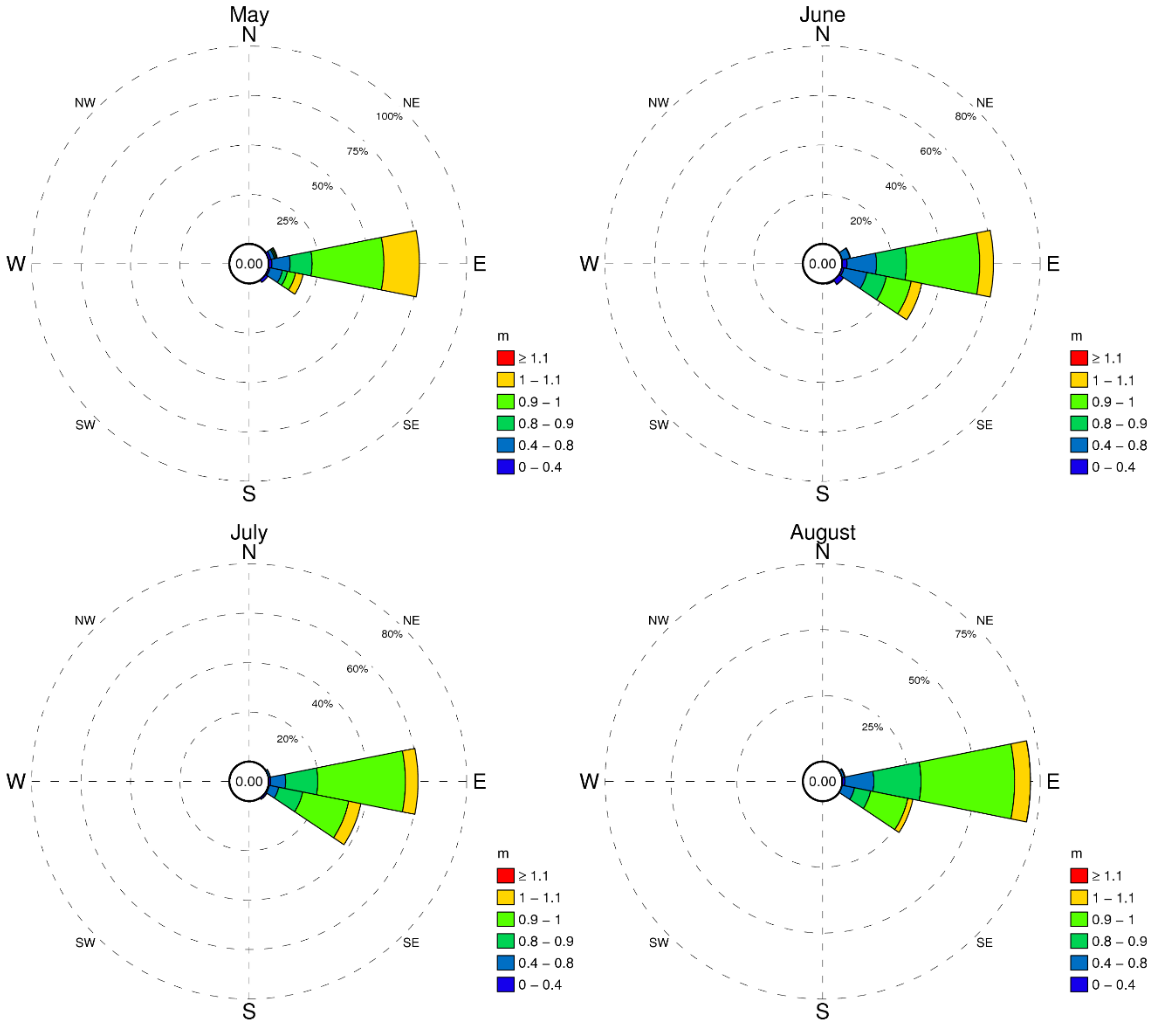


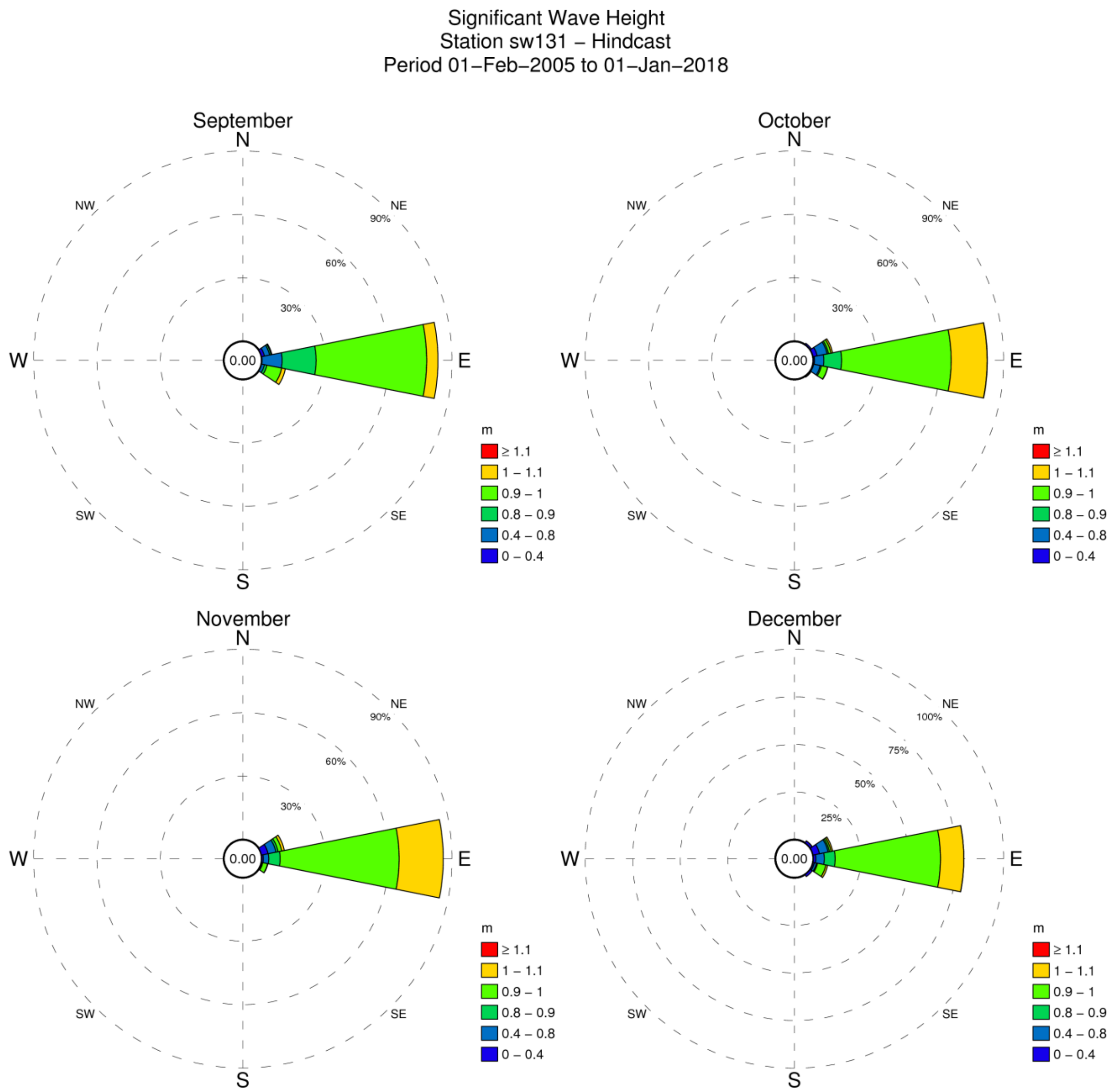

Significant Wave Height
Station sw137 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
September
October
November
December
N
NE
E
SE
S
SW
W
NW
0.00
20%
40%
60%
80%
25%
50%
75%
100%
m
≥ 1.5
1.4 – 1.5
1.2 – 1.4
1 – 1.2
0.8 – 1
0.4 – 0.8
0 – 0.4


Significant Wave Height
Station sw137 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
Mar–Apr–May
Jun–Jul–Aug
Sep–Oct–Nov
Dec–Jan–Feb
N
NE
E
SE
S
SW
W
NW
0.00
20%
40%
60%
25%
50%
75%
m
≥ 1.5
1.4 – 1.5
1.2 – 1.4
1 – 1.2
0.8 – 1
0.4 – 0.8
0 – 0.4

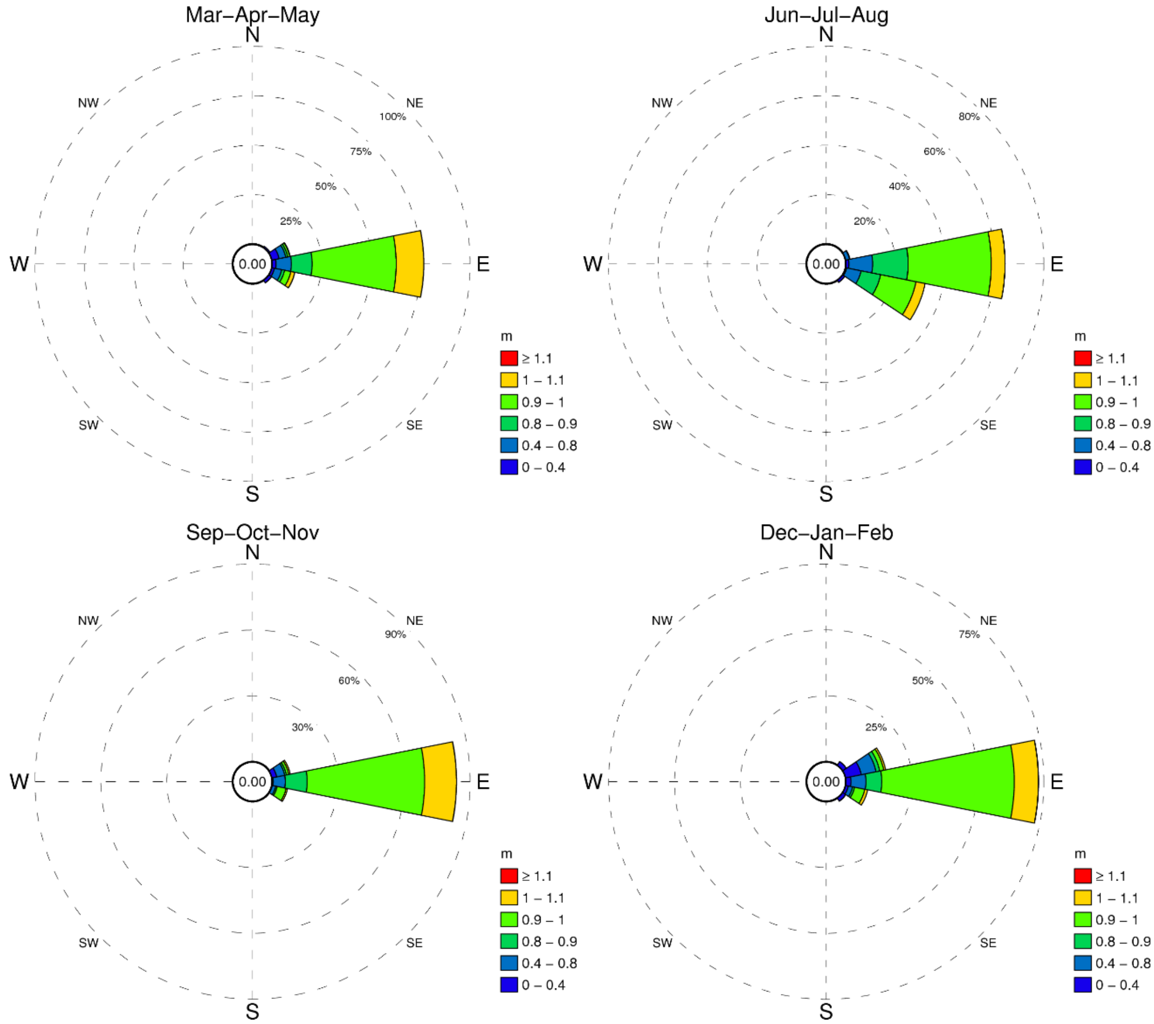

Significant Wave Height
Station sw131 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
January
February
March
April
N
NE
E
SE
S
SW
W
NW
25%
50%
75%
100%
0.00
m
≥ 1.1
1 – 1.1
0.9 – 1
0.8 – 0.9
0.4 – 0.8
0 – 0.4

Significant Wave Height
Station sw131 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018




Significant Wave Height
Station sw131 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018
September
October
November
December
N
NE
E
SE
S
SW
W
NW
30%
60%
90%
25%
50%
75%
100%
0.00
m
≥ 1.1
1 – 1.1
0.9 – 1
0.8 – 0.9
0.4 – 0.8
0 – 0.4

Significant Wave Height
Station sw131 – Hindcast
Period 01–Feb–2005 to 01–Jan–2018



APPENDIX E

STORM SURGE AND EXTREME WAVES RESULTS

Storm still water level - 50-year return wind speed - Leeward Harbor															
Wind Directions	East						South								
	LH1	LH2	LH3	LH4	LH5	LH6	LH7	LH8	LH9	LH10	LH11	LH12	LH13	LH14	LH15
N	1.24	1.25	1.25	1.27	1.28	1.17	1.22	1.22	1.22	1.21	1.23	1.22	1.22	1.21	1.23
NNE	1.15	1.18	1.17	1.19	1.21	1.19	1.23	1.22	1.23	1.23	1.23	1.21	1.22	1.22	1.23
NE	1.09	1.12	1.12	1.14	1.16	1.20	1.18	1.24	1.23	1.24	1.26	1.24	1.22	1.20	1.23
ENE	1.03	1.03	1.03	1.03	1.04	1.04	1.09	1.29	1.30	1.31	1.32	1.31	1.25	1.19	1.24
E	0.98	0.98	0.96	0.96	0.95	0.91	1.14	1.37	1.39	1.48	1.50	1.47	1.34	1.20	1.30
ESE	0.99	0.98	0.96	0.94	0.93	0.82	1.31	1.47	1.53	1.72	1.83	1.72	1.54	1.27	1.47
SE	1.13	1.11	1.08	1.07	1.05	0.95	1.55	1.75	1.88	2.12	2.23	2.07	1.89	1.50	1.80
SSE	1.38	1.30	1.32	1.30	1.28	1.19	1.78	2.06	2.18	2.38	2.52	2.39	2.12	1.74	2.08
S	1.68	1.65	1.64	1.62	1.60	1.51	1.90	2.17	2.27	2.42	2.53	2.45	2.19	1.93	2.17
SSW	2.03	2.05	2.05	2.07	2.07	2.02	2.17	2.17	2.27	2.37	2.31	2.24	2.17	2.30	2.22
SW	2.06	2.08	2.07	2.06	2.06	2.02	1.97	1.94	1.93	2.07	2.05	2.10	2.11	2.09	1.92
WSW	1.91	1.91	1.88	1.85	1.80	1.58	1.58	1.51	1.60	1.69	1.67	1.71	1.69	1.66	1.55
W	1.78	1.79	1.74	1.72	1.66	1.39	1.42	1.38	1.47	1.42	1.43	1.53	1.52	1.44	1.27
WNW	1.68	1.69	1.66	1.65	1.61	1.32	1.35	1.32	1.38	1.34	1.33	1.42	1.42	1.34	1.22
NW	1.54	1.55	1.53	1.54	1.50	1.23	1.26	1.24	1.28	1.29	1.27	1.34	1.33	1.25	1.22
NNW	1.38	1.40	1.39	1.40	1.39	1.18	1.24	1.23	1.24	1.25	1.25	1.24	1.25	1.22	1.23
max (m, MSL)	**2.06**	**2.08**	**2.07**	**2.07**	**2.07**	**2.02**	**2.17**	**2.17**	**2.27**	**2.42**	**2.53**	**2.45**	**2.19**	**2.30**	**2.22**
max (ft, MSL)	**6.76**	**6.82**	**6.79**	**6.79**	**6.80**	**6.64**	**7.11**	**7.13**	**7.45**	**7.93**	**8.31**	**8.03**	**7.19**	**7.54**	**7.28**

Storm still water level - 100-year return wind speed - Leeward Harbor															
Wind Directions	East						South								
	LH1	LH2	LH3	LH4	LH5	LH6	LH7	LH8	LH9	LH10	LH11	LH12	LH13	LH14	LH15
N	1.33	1.34	1.35	1.38	1.39	1.26	1.33	1.33	1.33	1.32	1.34	1.33	1.33	1.32	1.34
NNE	1.24	1.27	1.27	1.30	1.32	1.29	1.34	1.33	1.33	1.34	1.34	1.32	1.33	1.33	1.34
NE	1.19	1.22	1.23	1.24	1.26	1.31	1.28	1.35	1.34	1.35	1.37	1.36	1.33	1.31	1.34
ENE	1.11	1.12	1.12	1.12	1.13	1.13	1.18	1.40	1.41	1.42	1.45	1.43	1.36	1.29	1.35
E	1.06	1.06	1.04	1.04	1.03	0.99	1.26	1.49	1.52	1.62	1.68	1.63	1.46	1.30	1.43
ESE	1.08	1.07	1.05	1.03	1.02	0.92	1.44	1.62	1.71	1.92	2.03	1.90	1.70	1.40	1.63
SE	1.21	1.12	1.15	1.13	1.11	1.00	1.68	1.91	2.07	2.30	2.43	2.25	2.03	1.62	1.95
SSE	1.45	1.34	1.38	1.36	1.34	1.25	1.91	2.23	2.34	2.55	2.68	2.53	2.23	1.86	2.22
S	1.78	1.73	1.73	1.72	1.70	1.60	2.03	2.35	2.44	2.59	2.70	2.61	2.30	2.05	2.32
SSW	2.19	2.21	2.22	2.25	2.27	2.24	2.35	2.33	2.42	2.52	2.48	2.41	2.33	2.46	2.38
SW	2.26	2.27	2.26	2.26	2.24	2.20	2.14	2.10	2.08	2.23	2.20	2.23	2.26	2.25	2.09
WSW	2.07	2.08	2.04	2.01	1.95	1.70	1.71	1.63	1.66	1.73	1.78	1.84	1.82	1.78	1.69
W	1.91	1.93	1.89	1.87	1.82	1.50	1.56	1.50	1.57	1.54	1.56	1.67	1.66	1.58	1.42
WNW	1.80	1.83	1.78	1.78	1.73	1.40	1.45	1.41	1.47	1.44	1.46	1.54	1.53	1.45	1.31
NW	1.65	1.68	1.64	1.66	1.62	1.31	1.36	1.34	1.38	1.39	1.39	1.44	1.44	1.36	1.34
NNW	1.49	1.50	1.49	1.51	1.50	1.27	1.34	1.33	1.34	1.34	1.36	1.34	1.36	1.32	1.33
max (m, MSL)	**2.26**	**2.27**	**2.26**	**2.26**	**2.27**	**2.24**	**2.35**	**2.35**	**2.44**	**2.59**	**2.70**	**2.61**	**2.33**	**2.46**	**2.38**
max (ft, MSL)	**7.42**	**7.46**	**7.43**	**7.40**	**7.43**	**7.35**	**7.70**	**7.71**	**8.00**	**8.51**	**8.87**	**8.55**	**7.65**	**8.08**	**7.81**

Storm still water level - 50-year return wind speed - Conch Sound Point										
Wind Directions	CSP1	CSP2	CSP3	CSP4	CSP5	CSP6	CSP7	CSP8	CSP9	CSP10
N	1.72	1.75	1.76	1.72	1.72	1.71	1.74	1.69	1.64	1.61
NNE	1.92	1.94	1.95	1.92	1.90	1.90	1.94	1.89	1.84	1.83
NE	2.10	2.11	2.12	2.09	2.07	2.08	2.12	2.08	2.05	2.04
ENE	2.20	2.22	2.21	2.20	2.18	2.20	2.23	2.19	2.19	2.18
E	2.12	2.15	2.13	2.16	2.12	2.09	2.16	2.12	2.11	2.12
ESE	1.95	1.97	1.96	1.99	1.95	1.95	1.98	1.94	1.92	1.91
SE	1.76	1.78	1.77	1.79	1.74	1.75	1.77	1.73	1.71	1.67
SSE	1.57	1.58	1.57	1.58	1.53	1.53	1.53	1.49	1.49	1.48
S	1.41	1.41	1.41	1.40	1.35	1.35	1.35	1.29	1.31	1.33
SSW	1.35	1.35	1.34	1.33	1.28	1.29	1.28	1.23	1.25	1.28
SW	1.31	1.32	1.31	1.30	1.25	1.26	1.25	1.20	1.22	1.25
WSW	1.27	1.27	1.26	1.26	1.22	1.22	1.22	1.17	1.19	1.21
W	1.18	1.20	1.18	1.21	1.19	1.19	1.19	1.18	1.17	1.19
WNW	1.25	1.26	1.26	1.23	1.22	1.23	1.24	1.21	1.21	1.21
NW	1.37	1.40	1.41	1.36	1.37	1.37	1.41	1.36	1.31	1.30
NNW	1.55	1.58	1.59	1.55	1.55	1.55	1.58	1.53	1.47	1.44
max (m, MSL)	**2.20**	**2.22**	**2.21**	**2.20**	**2.18**	**2.20**	**2.23**	**2.19**	**2.19**	**2.18**
max (ft, MSL)	**7.22**	**7.28**	**7.25**	**7.23**	**7.16**	**7.21**	**7.31**	**7.19**	**7.18**	**7.14**

Storm still water level - 100-year return wind speed - Conch Sound Point										
Wind Directions	CSP1	CSP2	CSP3	CSP4	CSP5	CSP6	CSP7	CSP8	CSP9	CSP10
N	1.87	1.89	1.91	1.87	1.86	1.86	1.90	1.84	1.79	1.77
NNE	2.07	2.08	2.10	2.06	2.05	2.05	2.09	2.03	1.99	1.99
NE	2.26	2.26	2.28	2.24	2.22	2.24	2.27	2.24	2.21	2.20
ENE	2.36	2.37	2.37	2.36	2.34	2.36	2.39	2.36	2.35	2.32
E	2.27	2.30	2.29	2.31	2.27	2.27	2.32	2.27	2.27	2.28
ESE	2.07	2.10	2.09	2.12	2.07	2.08	2.11	2.07	2.04	2.01
SE	1.86	1.88	1.88	1.89	1.84	1.85	1.87	1.82	1.80	1.74
SSE	1.67	1.67	1.67	1.67	1.61	1.62	1.63	1.58	1.58	1.54
S	1.51	1.51	1.51	1.50	1.44	1.45	1.45	1.39	1.41	1.41
SSW	1.45	1.45	1.44	1.43	1.38	1.39	1.38	1.33	1.35	1.37
SW	1.41	1.41	1.40	1.39	1.35	1.35	1.35	1.29	1.31	1.34
WSW	1.36	1.37	1.36	1.35	1.31	1.32	1.31	1.27	1.29	1.30
W	1.28	1.30	1.29	1.31	1.29	1.29	1.30	1.28	1.29	1.28
WNW	1.36	1.37	1.38	1.33	1.34	1.34	1.36	1.32	1.32	1.31
NW	1.50	1.52	1.54	1.49	1.49	1.50	1.53	1.48	1.44	1.41
NNW	1.68	1.71	1.72	1.68	1.68	1.68	1.71	1.66	1.60	1.57
max (m, MSL)	**2.36**	**2.37**	**2.37**	**2.36**	**2.34**	**2.36**	**2.39**	**2.36**	**2.35**	**2.32**
max (ft, MSL)	**7.75**	**7.79**	**7.78**	**7.74**	**7.66**	**7.74**	**7.84**	**7.74**	**7.72**	**7.62**

Storm still water level - 50-year return wind speed - High Bank Bay										
Wind Directions	HBB1	HBB2	HBB3	HBB4	HBB5	HBB6	HBB7	HBB8	HBB9	HBB10
N	1.54	1.57	1.47	1.51	1.50	1.51	1.51	1.51	1.47	1.49
NNE	1.69	1.71	1.61	1.66	1.65	1.66	1.66	1.66	1.61	1.63
NE	1.89	1.90	1.83	1.87	1.85	1.86	1.86	1.86	1.83	1.85
ENE	2.10	2.11	2.07	2.10	2.08	2.09	2.09	2.09	2.06	2.09
E	2.21	2.22	2.20	2.20	2.20	2.21	2.21	2.20	2.18	2.21
ESE	2.07	2.09	2.07	2.11	2.10	2.11	2.12	2.13	2.10	2.13
SE	1.85	1.89	1.87	1.93	1.92	1.92	1.93	1.95	1.89	1.94
SSE	1.56	1.59	1.60	1.66	1.64	1.64	1.65	1.66	1.59	1.65
S	1.32	1.33	1.39	1.43	1.41	1.40	1.41	1.41	1.34	1.39
SSW	1.24	1.25	1.32	1.35	1.34	1.32	1.33	1.33	1.27	1.31
SW	1.21	1.21	1.27	1.30	1.29	1.28	1.27	1.28	1.23	1.26
WSW	1.18	1.18	1.21	1.23	1.23	1.22	1.22	1.22	1.18	1.21
W	1.18	1.19	1.17	1.18	1.18	1.18	1.17	1.17	1.17	1.17
WNW	1.21	1.24	1.17	1.19	1.19	1.21	1.20	1.20	1.18	1.20
NW	1.28	1.32	1.23	1.26	1.26	1.28	1.28	1.28	1.25	1.27
NNW	1.41	1.44	1.35	1.38	1.38	1.39	1.39	1.39	1.36	1.38
max (m, MSL)	**2.21**	**2.22**	**2.20**	**2.20**	**2.20**	**2.21**	**2.21**	**2.20**	**2.18**	**2.21**
max (ft, MSL)	**7.26**	**7.29**	**7.21**	**7.23**	**7.21**	**7.24**	**7.25**	**7.22**	**7.15**	**7.26**

Storm still water level - 100-year return wind speed - High Bank Bay										
Wind Directions	HBB1	HBB2	HBB3	HBB4	HBB5	HBB6	HBB7	HBB8	HBB9	HBB10
N	1.66	1.69	1.59	1.63	1.62	1.63	1.64	1.64	1.59	1.61
NNE	1.81	1.83	1.74	1.79	1.77	1.78	1.79	1.79	1.74	1.76
NE	2.02	2.03	1.96	2.01	1.99	1.99	2.00	2.00	1.96	1.98
ENE	2.25	2.26	2.21	2.24	2.23	2.23	2.24	2.23	2.21	2.24
E	2.37	2.38	2.36	2.37	2.36	2.37	2.37	2.36	2.34	2.37
ESE	2.21	2.24	2.21	2.25	2.25	2.26	2.27	2.28	2.24	2.28
SE	1.97	2.01	1.98	2.05	2.05	2.04	2.06	2.07	2.01	2.07
SSE	1.67	1.70	1.71	1.78	1.76	1.74	1.77	1.78	1.70	1.77
S	1.43	1.44	1.49	1.54	1.52	1.50	1.52	1.53	1.45	1.51
SSW	1.35	1.35	1.42	1.47	1.44	1.43	1.44	1.44	1.37	1.43
SW	1.31	1.31	1.37	1.40	1.39	1.37	1.38	1.38	1.33	1.37
WSW	1.28	1.28	1.31	1.33	1.33	1.32	1.32	1.32	1.28	1.31
W	1.28	1.30	1.27	1.28	1.28	1.28	1.28	1.28	1.27	1.28
WNW	1.31	1.35	1.28	1.30	1.30	1.31	1.31	1.30	1.29	1.31
NW	1.40	1.44	1.35	1.38	1.37	1.39	1.39	1.39	1.37	1.38
NNW	1.53	1.56	1.46	1.50	1.49	1.51	1.51	1.51	1.47	1.49
max (m, MSL)	**2.37**	**2.38**	**2.36**	**2.37**	**2.36**	**2.37**	**2.37**	**2.36**	**2.34**	**2.37**
max (ft, MSL)	**7.79**	**7.82**	**7.75**	**7.77**	**7.74**	**7.77**	**7.79**	**7.76**	**7.68**	**7.79**

Extreme wave analysis - 50-year return wind speed - Leeward Harbor

Wind Directions	East						South								
	LH1	LH2	LH3	LH4	LH5	LH6	LH7	LH8	LH9	LH10	LH11	LH12	LH13	LH14	LH15
N	0.74	0.61	0.68	0.76	0.73	0.71	0.67	0.68	0.70	0.67	0.40	0.54	0.62	0.79	0.61
NNE	0.62	0.56	0.59	0.67	0.65	0.68	0.64	0.62	0.68	0.56	0.34	0.50	0.59	0.64	0.52
NE	0.47	0.50	0.49	0.54	0.56	0.60	0.65	0.88	0.84	0.77	0.83	0.60	0.63	0.85	1.06
ENE	0.43	0.37	0.49	0.51	0.46	0.47	0.70	1.05	0.98	1.03	1.51	0.77	0.75	1.20	1.78
E	0.40	0.29	0.43	0.43	0.36	0.44	0.83	1.23	1.21	1.10	2.01	0.91	0.95	1.51	2.57
ESE	0.41	0.29	0.46	0.43	0.35	0.37	0.95	1.47	1.29	1.23	2.32	1.14	1.12	1.52	2.54
SE	0.56	0.44	0.62	0.54	0.43	0.48	1.14	1.75	1.58	1.54	2.75	1.47	1.34	1.68	2.78
SSE	0.81	0.70	0.74	0.69	0.56	0.71	1.34	2.04	1.85	1.80	3.00	1.71	1.68	1.91	3.06
S	0.98	1.05	0.89	0.81	0.68	0.91	1.45	2.07	1.92	1.83	2.88	1.74	1.79	2.11	3.17
SSW	1.03	0.98	0.86	0.78	0.69	0.93	1.44	2.03	1.95	1.83	2.43	1.54	1.62	2.36	3.23
SW	1.14	1.11	1.04	0.99	0.86	0.91	1.13	1.68	1.58	1.57	1.97	1.41	1.64	2.28	2.91
WSW	1.17	1.11	1.09	1.08	0.96	0.94	1.04	1.41	1.31	1.22	1.75	1.11	1.31	1.94	2.61
W	1.21	1.12	1.12	1.11	0.98	0.89	1.02	1.31	1.17	0.92	2.44	0.99	1.21	1.74	2.35
WNW	1.16	1.06	1.10	1.13	1.04	0.90	0.97	1.27	1.10	0.83	2.01	0.81	1.07	1.61	2.28
NW	1.02	0.95	0.98	1.03	0.96	0.82	0.81	1.17	1.00	0.80	1.52	0.77	1.01	1.61	1.69
NNW	0.89	0.77	0.82	0.90	0.85	0.76	0.71	0.89	0.94	0.77	0.65	0.69	0.81	1.16	1.08
max	**1.21**	**1.12**	**1.12**	**1.13**	**1.04**	**0.94**	**1.45**	**2.07**	**1.95**	**1.83**	**3.00**	**1.74**	**1.79**	**2.36**	**3.23**
Significant wave height						**max East**	**1.21**	**m**		**3.96**	**ft**				
						max South	**3.23**	**m**		**10.59**	**ft**				

Extreme wave analysis - 100-year return wind speed - Leeward Harbor

Wind Directions	East						South								
	LH1	LH2	LH3	LH4	LH5	LH6	LH7	LH8	LH9	LH10	LH11	LH12	LH13	LH14	LH15
N	0.77	0.71	0.76	0.85	0.83	0.79	0.72	0.69	0.73	0.71	0.38	0.56	0.64	0.82	0.62
NNE	0.62	0.56	0.64	0.73	0.72	0.75	0.69	0.62	0.71	0.56	0.34	0.53	0.59	0.60	0.52
NE	0.51	0.45	0.49	0.52	0.59	0.68	0.71	0.96	0.92	0.86	0.94	0.67	0.69	0.93	1.20
ENE	0.45	0.46	0.52	0.54	0.49	0.52	0.77	1.12	1.07	1.15	1.67	0.87	0.81	1.32	1.95
E	0.47	0.37	0.46	0.45	0.39	0.48	0.92	1.34	1.33	1.22	2.16	1.03	1.05	1.58	2.65
ESE	0.50	0.38	0.55	0.49	0.38	0.47	1.06	1.58	1.45	1.40	2.55	1.31	1.16	1.63	2.69
SE	0.65	0.50	0.65	0.60	0.49	0.53	1.25	1.90	1.75	1.72	3.01	1.62	1.37	1.80	2.94
SSE	0.93	0.79	0.82	0.76	0.64	0.80	1.45	2.15	2.00	1.96	3.21	1.83	1.75	2.02	3.21
S	1.13	1.22	0.99	0.90	0.75	1.02	1.57	2.20	2.08	2.01	3.09	1.88	1.90	2.23	3.34
SSW	1.14	1.11	0.96	0.87	0.75	1.03	1.48	2.15	2.11	2.00	2.59	1.69	1.79	2.61	3.41
SW	1.26	1.20	1.15	1.11	0.98	1.06	1.39	1.67	1.78	1.66	2.27	1.43	1.67	2.48	3.14
WSW	1.39	1.28	1.33	1.36	1.22	1.16	1.06	1.54	1.40	1.28	1.80	1.23	1.44	2.07	2.76
W	1.33	1.23	1.30	1.32	1.20	1.06	1.05	1.43	1.28	1.02	2.56	0.95	1.35	1.89	2.50
WNW	1.25	1.15	1.23	1.27	1.18	0.99	0.97	1.35	1.18	0.94	2.12	1.01	1.21	1.78	2.49
NW	1.10	1.02	1.08	1.15	1.08	0.91	0.85	1.18	1.09	0.89	1.58	0.86	1.13	1.77	1.79
NNW	0.94	0.86	0.91	1.01	0.96	0.85	0.75	0.92	0.99	0.87	0.69	0.77	0.84	1.25	1.15
max	**1.39**	**1.28**	**1.33**	**1.36**	**1.22**	**1.16**	**1.57**	**2.20**	**2.11**	**2.01**	**3.21**	**1.88**	**1.90**	**2.61**	**3.41**
Significant wave height						**max East**	**1.39**	**m**		**4.55**	**ft**				
						max South	**3.41**	**m**		**11.20**	**ft**				

Extreme wave analysis - 50-year return wind speed - Conch Sound Point										
Wind Directions	CSP1	CSP2	CSP3	CSP4	CSP5	CSP6	CSP7	CSP8	CSP9	CSP10
N	1.23	0.99	1.33	1.12	1.28	1.36	1.22	1.32	1.41	1.35
NNE	1.41	1.17	1.48	1.30	1.46	1.51	1.35	1.44	1.55	1.51
NE	1.54	1.33	1.60	1.47	1.63	1.60	1.48	1.50	1.65	1.66
ENE	1.63	1.44	1.68	1.59	1.74	1.67	1.53	1.72	1.76	1.65
E	1.62	1.37	1.64	1.49	1.66	1.72	1.48	1.75	1.75	1.68
ESE	1.43	1.18	1.49	1.31	1.48	1.61	1.36	1.56	1.59	1.53
SE	1.25	1.00	1.31	1.12	1.28	1.41	1.22	1.36	1.39	1.33
SSE	1.07	0.83	1.12	0.93	1.08	1.20	1.08	1.16	1.19	1.14
S	0.94	0.69	0.98	0.78	0.93	1.05	0.97	1.00	1.04	1.02
SSW	0.88	0.64	0.93	0.73	0.88	0.99	0.92	0.95	0.99	0.98
SW	0.85	0.62	0.90	0.70	0.85	0.96	0.91	0.93	0.96	0.94
WSW	0.81	0.58	0.86	0.67	0.82	0.93	0.87	0.90	0.94	0.89
W	0.73	0.54	0.74	0.65	0.74	0.79	0.70	0.90	0.78	0.77
WNW	0.84	0.66	0.90	0.78	0.95	0.89	0.78	1.07	0.92	0.84
NW	0.97	0.73	1.07	0.84	1.02	1.11	0.94	1.09	1.11	1.03
NNW	1.08	0.85	1.19	0.97	1.14	1.22	1.10	1.19	1.27	1.17
max	**1.63**	**1.44**	**1.68**	**1.59**	**1.74**	**1.72**	**1.53**	**1.75**	**1.76**	**1.68**
Significant wave height				**max**	**1.76**	**m**		**5.78**	**ft**	

Extreme wave analysis - 100-year return wind speed - Conch Sound Point										
Wind Directions	CSP1	CSP2	CSP3	CSP4	CSP5	CSP6	CSP7	CSP8	CSP9	CSP10
N	1.37	1.12	1.43	1.25	1.42	1.48	1.30	1.44	1.51	1.45
NNE	1.50	1.30	1.57	1.44	1.60	1.60	1.44	1.53	1.63	1.58
NE	1.63	1.47	1.70	1.62	1.77	1.70	1.58	1.59	1.75	1.74
ENE	1.73	1.59	1.78	1.75	1.90	1.77	1.63	1.80	1.87	1.70
E	1.72	1.51	1.74	1.64	1.81	1.75	1.59	1.91	1.84	1.77
ESE	1.56	1.29	1.61	1.42	1.60	1.73	1.43	1.68	1.68	1.59
SE	1.35	1.09	1.41	1.21	1.37	1.50	1.28	1.45	1.48	1.39
SSE	1.16	0.91	1.21	1.01	1.16	1.29	1.13	1.24	1.27	1.22
S	1.03	0.78	1.07	0.87	1.02	1.14	1.02	1.09	1.13	1.11
SSW	0.98	0.72	1.02	0.81	0.96	1.08	0.98	1.04	1.08	1.06
SW	0.94	0.70	0.99	0.78	0.94	1.05	0.96	1.02	1.05	1.03
WSW	0.90	0.66	0.94	0.74	0.90	1.01	0.92	0.98	1.02	0.98
W	0.78	0.63	0.78	0.75	0.80	0.84	0.77	0.96	0.87	0.82
WNW	0.90	0.77	0.97	0.89	1.03	0.96	0.85	1.14	1.00	0.91
NW	1.08	0.83	1.15	0.95	1.13	1.21	1.02	1.20	1.19	1.10
NNW	1.20	0.96	1.30	1.09	1.26	1.34	1.17	1.31	1.40	1.32
max	**1.73**	**1.59**	**1.78**	**1.75**	**1.90**	**1.77**	**1.63**	**1.91**	**1.87**	**1.77**
Significant wave height				**max**	**1.91**	**m**		**6.27**	**ft**	

Extreme wave analysis - 50-year return wind speed - High Bank Bay										
Wind Directions	HBB1	HBB2	HBB3	HBB4	HBB5	HBB6	HBB7	HBB8	HBB9	HBB10
N	1.06	0.73	0.77	1.05	0.98	0.93	0.90	1.08	0.85	0.86
NNE	1.16	0.81	0.85	1.14	1.06	1.03	0.99	1.17	0.91	0.94
NE	1.28	0.92	0.99	1.25	1.19	1.13	1.10	1.30	1.00	1.04
ENE	1.34	1.06	1.16	1.38	1.35	1.24	1.23	1.44	1.14	1.17
E	1.29	1.13	1.32	1.48	1.45	1.34	1.28	1.43	1.35	1.23
ESE	1.10	0.95	1.37	1.37	1.50	1.26	1.26	1.17	1.33	1.18
SE	0.97	0.82	1.31	1.26	1.37	1.19	1.17	1.00	1.24	1.07
SSE	0.85	0.68	1.17	1.10	1.20	1.01	1.03	0.84	1.08	0.92
S	0.76	0.54	0.98	0.97	0.99	0.81	0.91	0.74	0.92	0.80
SSW	0.73	0.50	0.92	0.92	0.93	0.75	0.86	0.71	0.87	0.76
SW	0.70	0.47	0.87	0.89	0.87	0.70	0.83	0.69	0.84	0.73
WSW	0.68	0.44	0.81	0.86	0.82	0.65	0.80	0.67	0.81	0.71
W	0.71	0.43	0.79	0.82	0.80	0.65	0.76	0.69	0.76	0.68
WNW	0.88	0.56	0.64	0.92	0.82	0.75	0.77	0.89	0.83	0.74
NW	0.92	0.62	0.67	0.95	0.88	0.75	0.80	0.96	0.78	0.76
NNW	0.98	0.67	0.72	0.99	0.92	0.83	0.85	1.02	0.80	0.80
max	**1.34**	**1.13**	**1.37**	**1.48**	**1.50**	**1.34**	**1.28**	**1.44**	**1.35**	**1.23**
Significant wave height				**max**	**1.50**	**m**		**4.93**	**ft**	

Extreme wave analysis - 100-year return wind speed - High Bank Bay										
Wind Directions	HBB1	HBB2	HBB3	HBB4	HBB5	HBB6	HBB7	HBB8	HBB9	HBB10
N	1.13	0.78	0.82	1.11	1.03	1.01	0.96	1.15	0.91	0.92
NNE	1.24	0.87	0.90	1.20	1.12	1.10	1.05	1.25	0.97	1.00
NE	1.37	0.99	1.05	1.32	1.26	1.21	1.17	1.39	1.06	1.12
ENE	1.43	1.14	1.24	1.46	1.43	1.32	1.31	1.53	1.21	1.25
E	1.38	1.21	1.42	1.58	1.54	1.43	1.37	1.52	1.46	1.32
ESE	1.17	1.01	1.46	1.45	1.58	1.35	1.35	1.23	1.43	1.26
SE	1.03	0.87	1.40	1.32	1.43	1.26	1.24	1.05	1.31	1.14
SSE	0.91	0.73	1.27	1.16	1.24	1.11	1.09	0.89	1.14	0.98
S	0.81	0.60	1.09	1.02	1.09	0.91	0.97	0.79	0.98	0.86
SSW	0.77	0.56	1.02	0.97	1.03	0.84	0.92	0.75	0.93	0.81
SW	0.75	0.52	0.96	0.94	0.97	0.79	0.88	0.72	0.90	0.78
WSW	0.72	0.48	0.90	0.91	0.91	0.74	0.85	0.71	0.86	0.75
W	0.74	0.47	0.89	0.87	0.90	0.74	0.81	0.73	0.81	0.73
WNW	0.94	0.61	0.67	0.97	0.87	0.84	0.82	0.95	0.88	0.79
NW	0.99	0.66	0.70	1.00	0.92	0.85	0.85	1.02	0.83	0.81
NNW	1.05	0.72	0.76	1.05	0.97	0.93	0.90	1.08	0.85	0.86
max	**1.43**	**1.21**	**1.46**	**1.58**	**1.58**	**1.43**	**1.37**	**1.53**	**1.46**	**1.32**
Significant wave height				**max**	**1.58**	**m**		**5.19**	**ft**	

Flood Elevation - 50-year return wind speed - Leeward Harbor

Wind Directions	East						South								
	LH1	LH2	LH3	LH4	LH5	LH6	LH7	LH8	LH9	LH10	LH11	LH12	LH13	LH14	LH15
N	1.75	1.68	1.73	1.80	1.79	1.66	1.69	1.69	1.71	1.68	1.51	1.60	1.65	1.77	1.66
NNE	1.58	1.57	1.59	1.66	1.67	1.66	1.68	1.65	1.70	1.62	1.47	1.56	1.63	1.67	1.59
NE	1.43	1.47	1.47	1.52	1.55	1.62	1.64	1.86	1.82	1.78	1.84	1.66	1.66	1.79	1.98
ENE	1.33	1.29	1.37	1.39	1.36	1.37	1.58	2.03	1.98	2.03	2.38	1.85	1.78	2.03	2.49
E	1.26	1.18	1.27	1.25	1.20	1.22	1.72	2.23	2.24	2.25	2.91	2.11	2.00	2.26	3.10
ESE	1.28	1.18	1.28	1.24	1.17	1.08	1.97	2.50	2.43	2.58	3.45	2.52	2.32	2.33	3.25
SE	1.53	1.41	1.52	1.45	1.35	1.28	2.35	2.97	2.99	3.19	4.15	3.10	2.83	2.68	3.75
SSE	1.95	1.79	1.84	1.79	1.68	1.69	2.72	3.49	3.48	3.64	4.62	3.58	3.29	3.08	4.22
S	2.37	2.38	2.26	2.19	2.08	2.15	2.91	3.63	3.61	3.70	4.55	3.67	3.44	3.40	4.39
SSW	2.74	2.73	2.65	2.61	2.56	2.68	3.18	3.59	3.63	3.65	4.00	3.32	3.31	3.95	4.48
SW	2.86	2.86	2.79	2.76	2.66	2.66	2.76	3.11	3.03	3.17	3.43	3.09	3.26	3.69	3.96
WSW	2.73	2.69	2.64	2.61	2.47	2.24	2.31	2.50	2.51	2.54	2.89	2.49	2.61	3.02	3.37
W	2.62	2.57	2.53	2.50	2.35	2.01	2.14	2.29	2.29	2.07	3.14	2.22	2.36	2.66	2.92
WNW	2.49	2.43	2.42	2.44	2.33	1.95	2.03	2.21	2.15	1.92	2.74	1.99	2.17	2.47	2.81
NW	2.26	2.22	2.21	2.26	2.18	1.80	1.83	2.06	1.98	1.85	2.33	1.88	2.04	2.38	2.40
NNW	2.00	1.94	1.97	2.03	1.98	1.71	1.74	1.85	1.90	1.79	1.70	1.72	1.81	2.03	1.98
max (m)	**2.86**	**2.86**	**2.79**	**2.76**	**2.66**	**2.68**	**3.18**	**3.63**	**3.63**	**3.70**	**4.62**	**3.67**	**3.44**	**3.95**	**4.48**
max(ft)	**9.39**	**9.37**	**9.17**	**9.04**	**8.72**	**8.78**	**10.43**	**11.89**	**11.92**	**12.14**	**15.15**	**12.03**	**11.30**	**12.97**	**14.69**

Flood Elevation - 100-year return wind speed - Leeward Harbor

Wind Directions	East						South								
	LH1	LH2	LH3	LH4	LH5	LH6	LH7	LH8	LH9	LH10	LH11	LH12	LH13	LH14	LH15
N	1.87	1.84	1.88	1.98	1.96	1.81	1.83	1.81	1.84	1.81	1.60	1.72	1.78	1.89	1.77
NNE	1.68	1.66	1.72	1.81	1.83	1.82	1.82	1.77	1.83	1.73	1.58	1.69	1.74	1.75	1.71
NE	1.55	1.53	1.57	1.61	1.68	1.78	1.78	2.02	1.99	1.95	2.03	1.82	1.81	1.96	2.18
ENE	1.43	1.44	1.48	1.50	1.47	1.49	1.72	2.19	2.16	2.23	2.62	2.04	1.93	2.21	2.72
E	1.39	1.32	1.36	1.35	1.30	1.33	1.90	2.42	2.45	2.47	3.20	2.35	2.20	2.41	3.29
ESE	1.43	1.34	1.43	1.37	1.29	1.25	2.18	2.72	2.73	2.90	3.82	2.82	2.51	2.54	3.51
SE	1.66	1.47	1.60	1.55	1.45	1.37	2.56	3.24	3.29	3.51	4.53	3.38	2.99	2.88	4.01
SSE	2.09	1.89	1.95	1.89	1.78	1.81	2.93	3.74	3.74	3.93	4.93	3.81	3.46	3.27	4.46
S	2.57	2.58	2.42	2.35	2.22	2.32	3.13	3.89	3.90	4.00	4.87	3.92	3.63	3.61	4.65
SSW	2.99	2.98	2.89	2.85	2.79	2.96	3.39	3.84	3.90	3.92	4.29	3.59	3.59	4.29	4.77
SW	3.14	3.11	3.07	3.03	2.93	2.95	3.11	3.27	3.32	3.40	3.79	3.23	3.42	3.99	4.29
WSW	3.04	2.98	2.97	2.96	2.81	2.51	2.46	2.71	2.64	2.62	3.04	2.70	2.83	3.22	3.62
W	2.84	2.79	2.80	2.79	2.65	2.24	2.29	2.50	2.47	2.25	3.35	2.33	2.61	2.90	3.17
WNW	2.67	2.63	2.65	2.67	2.55	2.09	2.13	2.36	2.30	2.10	2.94	2.25	2.38	2.70	3.06
NW	2.43	2.39	2.40	2.46	2.37	1.95	1.96	2.17	2.14	2.01	2.50	2.04	2.23	2.60	2.59
NNW	2.15	2.11	2.13	2.22	2.17	1.86	1.87	1.97	2.04	1.95	1.84	1.89	1.94	2.19	2.14
max (m)	**3.14**	**3.11**	**3.07**	**3.03**	**2.93**	**2.96**	**3.39**	**3.89**	**3.90**	**4.00**	**4.93**	**3.92**	**3.63**	**4.29**	**4.77**
max(ft)	**10.30**	**10.22**	**10.06**	**9.94**	**9.61**	**9.73**	**11.11**	**12.76**	**12.79**	**13.12**	**16.18**	**12.88**	**11.92**	**14.06**	**15.66**

Flood Elevation - 50-year return wind speed - Conch Sound Point										
Wind Directions	CSP1	CSP2	CSP3	CSP4	CSP5	CSP6	CSP7	CSP8	CSP9	CSP10
N	2.58	2.44	2.69	2.50	2.61	2.66	2.60	2.62	2.63	2.55
NNE	2.91	2.76	2.99	2.82	2.92	2.96	2.88	2.89	2.92	2.88
NE	3.18	3.04	3.24	3.12	3.21	3.20	3.15	3.13	3.21	3.21
ENE	3.34	3.22	3.38	3.31	3.40	3.37	3.30	3.40	3.42	3.33
E	3.26	3.11	3.28	3.20	3.29	3.29	3.20	3.34	3.34	3.30
ESE	2.95	2.80	3.01	2.91	2.98	3.08	2.93	3.04	3.04	2.98
SE	2.64	2.48	2.69	2.58	2.64	2.74	2.62	2.68	2.68	2.60
SSE	2.32	2.16	2.36	2.23	2.28	2.37	2.29	2.30	2.32	2.28
S	2.07	1.90	2.10	1.95	2.00	2.08	2.02	1.99	2.04	2.04
SSW	1.97	1.80	2.00	1.85	1.90	1.98	1.93	1.89	1.94	1.96
SW	1.91	1.75	1.94	1.79	1.85	1.93	1.88	1.85	1.89	1.91
WSW	1.83	1.68	1.86	1.72	1.79	1.87	1.83	1.80	1.85	1.84
W	1.69	1.58	1.70	1.66	1.70	1.74	1.68	1.81	1.72	1.72
WNW	1.83	1.73	1.89	1.77	1.89	1.85	1.79	1.96	1.86	1.80
NW	2.05	1.91	2.16	1.95	2.08	2.15	2.07	2.13	2.09	2.02
NNW	2.31	2.17	2.42	2.23	2.35	2.40	2.35	2.36	2.37	2.26
max (m)	**3.34**	**3.22**	**3.38**	**3.31**	**3.40**	**3.37**	**3.30**	**3.40**	**3.42**	**3.33**
max(ft)	**10.96**	**10.58**	**11.10**	**10.87**	**11.16**	**11.04**	**10.83**	**11.15**	**11.23**	**10.94**

Flood Elevation - 100-year return wind speed - Conch Sound Point										
Wind Directions	CSP1	CSP2	CSP3	CSP4	CSP5	CSP6	CSP7	CSP8	CSP9	CSP10
N	2.82	2.67	2.91	2.75	2.85	2.89	2.81	2.84	2.84	2.78
NNE	3.12	3.00	3.20	3.07	3.17	3.17	3.09	3.10	3.13	3.09
NE	3.40	3.29	3.46	3.37	3.47	3.43	3.38	3.35	3.43	3.43
ENE	3.57	3.49	3.62	3.58	3.67	3.60	3.53	3.62	3.66	3.51
E	3.48	3.36	3.51	3.46	3.54	3.49	3.43	3.61	3.56	3.52
ESE	3.16	3.00	3.22	3.12	3.19	3.29	3.12	3.25	3.22	3.13
SE	2.81	2.64	2.86	2.74	2.80	2.90	2.76	2.84	2.83	2.72
SSE	2.48	2.31	2.51	2.38	2.43	2.52	2.42	2.45	2.47	2.40
S	2.23	2.06	2.26	2.11	2.15	2.24	2.16	2.15	2.20	2.19
SSW	2.13	1.95	2.16	2.00	2.05	2.14	2.07	2.05	2.10	2.11
SW	2.07	1.90	2.10	1.94	2.00	2.08	2.01	2.00	2.05	2.06
WSW	1.99	1.83	2.02	1.87	1.94	2.02	1.96	1.95	2.00	1.99
W	1.83	1.75	1.83	1.83	1.85	1.88	1.84	1.95	1.90	1.86
WNW	1.99	1.91	2.06	1.96	2.05	2.01	1.96	2.12	2.03	1.95
NW	2.25	2.10	2.34	2.15	2.28	2.35	2.24	2.32	2.27	2.18
NNW	2.52	2.38	2.63	2.44	2.56	2.61	2.53	2.57	2.58	2.50
max (m)	**3.57**	**3.49**	**3.62**	**3.58**	**3.67**	**3.60**	**3.53**	**3.62**	**3.66**	**3.52**
max(ft)	**11.72**	**11.44**	**11.86**	**11.75**	**12.03**	**11.81**	**11.59**	**11.89**	**12.00**	**11.55**

Flood Elevation - 50-year return wind speed - High Bank Bay										
Wind Directions	HBB1	HBB2	HBB3	HBB4	HBB5	HBB6	HBB7	HBB8	HBB9	HBB10
N	2.28	2.08	2.00	2.24	2.18	2.16	2.14	2.27	2.07	2.09
NNE	2.50	2.27	2.21	2.46	2.39	2.38	2.35	2.48	2.25	2.29
NE	2.78	2.54	2.52	2.75	2.69	2.65	2.64	2.78	2.52	2.58
ENE	3.04	2.85	2.88	3.06	3.03	2.95	2.95	3.09	2.86	2.91
E	3.12	3.01	3.12	3.24	3.21	3.14	3.10	3.20	3.12	3.07
ESE	2.84	2.75	3.02	3.06	3.15	2.99	3.01	2.95	3.03	2.96
SE	2.54	2.46	2.79	2.81	2.88	2.75	2.75	2.65	2.75	2.69
SSE	2.15	2.06	2.42	2.43	2.48	2.34	2.37	2.25	2.34	2.30
S	1.85	1.71	2.08	2.10	2.11	1.97	2.04	1.93	1.99	1.96
SSW	1.75	1.59	1.96	1.99	1.99	1.85	1.93	1.83	1.88	1.85
SW	1.70	1.54	1.88	1.92	1.90	1.77	1.86	1.76	1.82	1.78
WSW	1.65	1.49	1.78	1.83	1.80	1.68	1.77	1.69	1.75	1.70
W	1.68	1.49	1.73	1.75	1.75	1.64	1.70	1.65	1.70	1.65
WNW	1.82	1.64	1.62	1.83	1.77	1.73	1.73	1.82	1.76	1.72
NW	1.93	1.75	1.70	1.93	1.88	1.81	1.84	1.95	1.80	1.80
NNW	2.10	1.91	1.85	2.08	2.02	1.97	1.98	2.11	1.92	1.94
max (m)	**3.12**	**3.01**	**3.12**	**3.24**	**3.21**	**3.14**	**3.10**	**3.20**	**3.12**	**3.07**
max(ft)	**10.22**	**9.87**	**10.24**	**10.64**	**10.54**	**10.32**	**10.18**	**10.49**	**10.24**	**10.07**

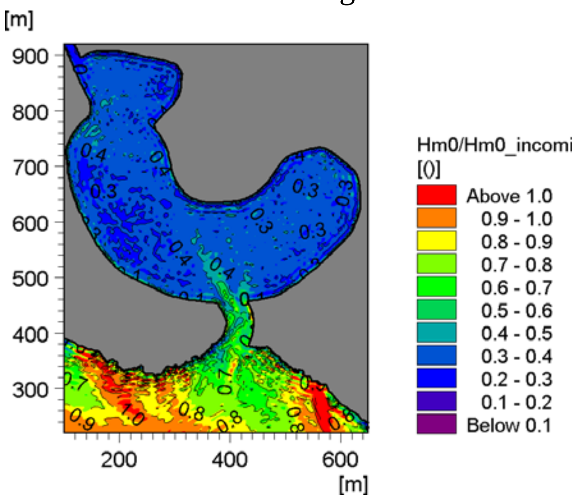
Flood Elevation - 100-year return wind speed - High Bank Bay										
Wind Directions	HBB1	HBB2	HBB3	HBB4	HBB5	HBB6	HBB7	HBB8	HBB9	HBB10
N	2.45	2.24	2.16	2.41	2.34	2.34	2.31	2.44	2.23	2.25
NNE	2.68	2.44	2.37	2.63	2.56	2.55	2.52	2.66	2.42	2.46
NE	2.98	2.73	2.69	2.93	2.87	2.84	2.82	2.97	2.70	2.77
ENE	3.26	3.05	3.08	3.27	3.23	3.16	3.16	3.31	3.06	3.11
E	3.34	3.23	3.35	3.47	3.44	3.37	3.33	3.43	3.36	3.30
ESE	3.03	2.94	3.23	3.26	3.36	3.20	3.21	3.14	3.24	3.16
SE	2.69	2.61	2.96	2.97	3.04	2.92	2.93	2.81	2.93	2.86
SSE	2.30	2.21	2.60	2.58	2.63	2.52	2.53	2.40	2.50	2.45
S	1.99	1.86	2.25	2.26	2.28	2.14	2.19	2.08	2.14	2.11
SSW	1.89	1.74	2.14	2.14	2.16	2.02	2.08	1.97	2.03	1.99
SW	1.83	1.67	2.04	2.06	2.06	1.93	2.00	1.89	1.96	1.91
WSW	1.78	1.62	1.94	1.97	1.96	1.84	1.91	1.82	1.88	1.84
W	1.80	1.63	1.90	1.89	1.91	1.80	1.84	1.79	1.84	1.79
WNW	1.97	1.78	1.75	1.98	1.91	1.90	1.88	1.97	1.90	1.86
NW	2.09	1.90	1.84	2.08	2.02	1.99	1.99	2.10	1.95	1.95
NNW	2.26	2.07	1.99	2.23	2.17	2.16	2.14	2.27	2.07	2.09
max (m)	**3.34**	**3.23**	**3.35**	**3.47**	**3.44**	**3.37**	**3.33**	**3.43**	**3.36**	**3.30**
max(ft)	**10.97**	**10.61**	**11.00**	**11.39**	**11.29**	**11.06**	**10.93**	**11.26**	**11.02**	**10.81**

APPENDIX F

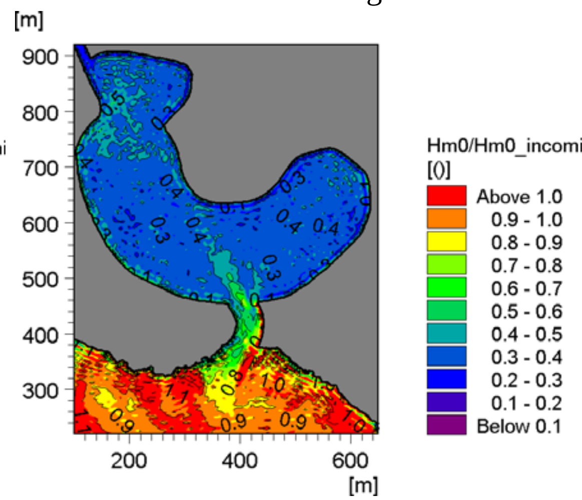
BW MODEL RESULTS

Base Case – Peak Period = 4 seconds

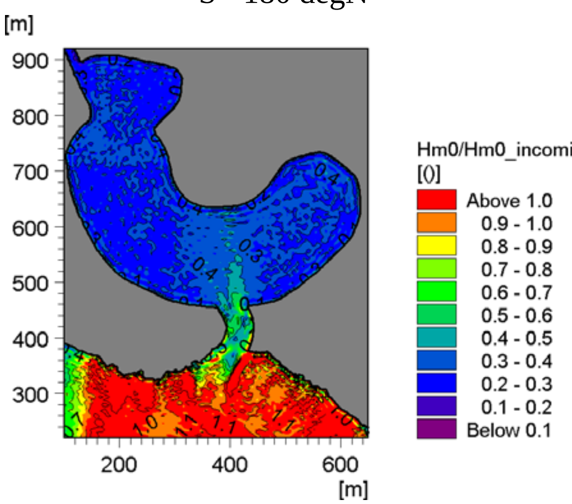
SE - 135 degN



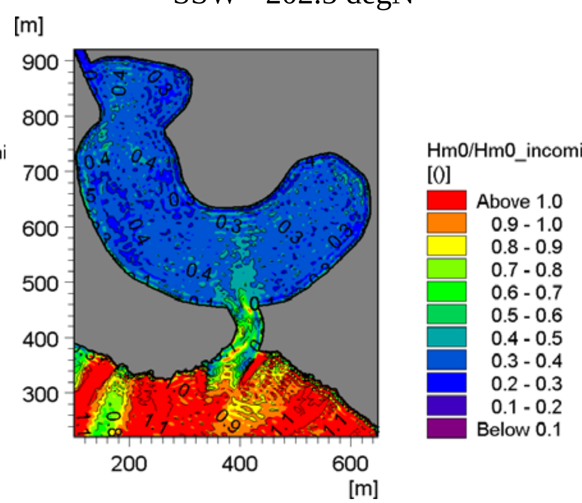
SSE -157.5 degN



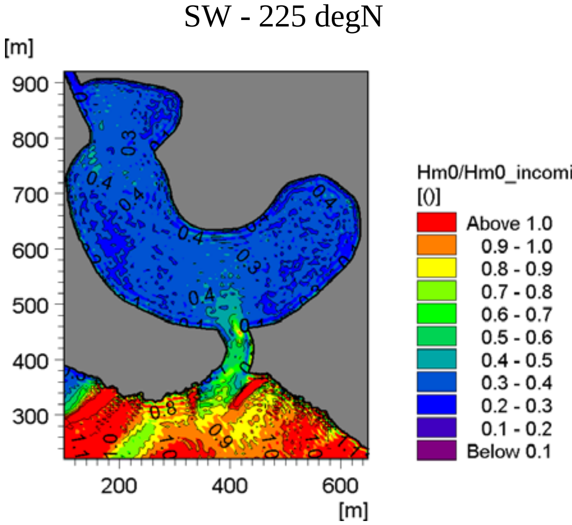
S - 180 degN



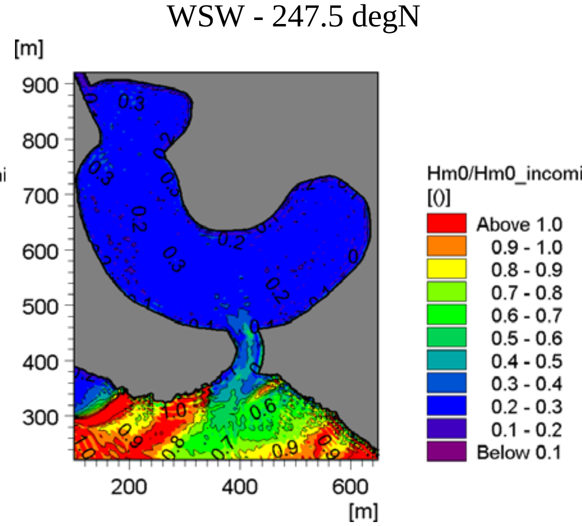
SSW - 202.5 degN



SW - 225 degN

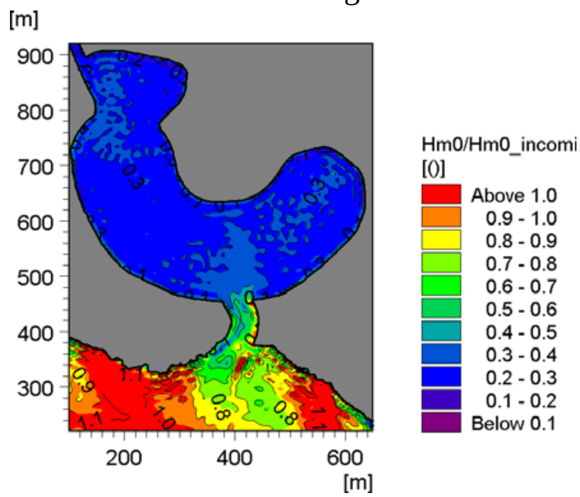


WSW - 247.5 degN

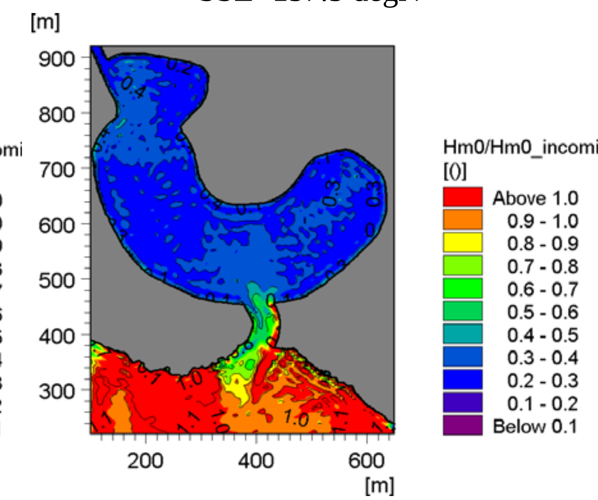


Base Case – Peak Period = 6 seconds

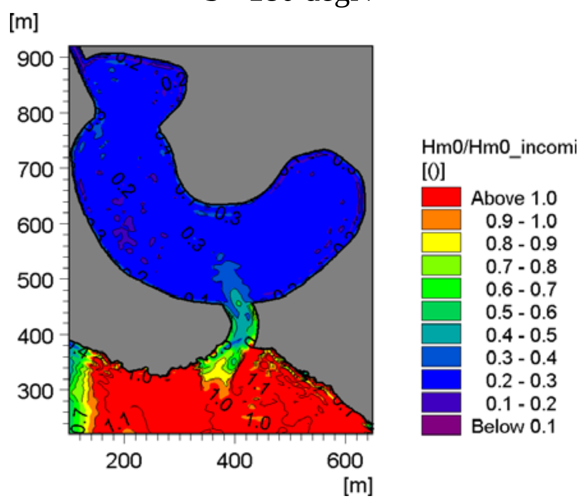
SE - 135 degN



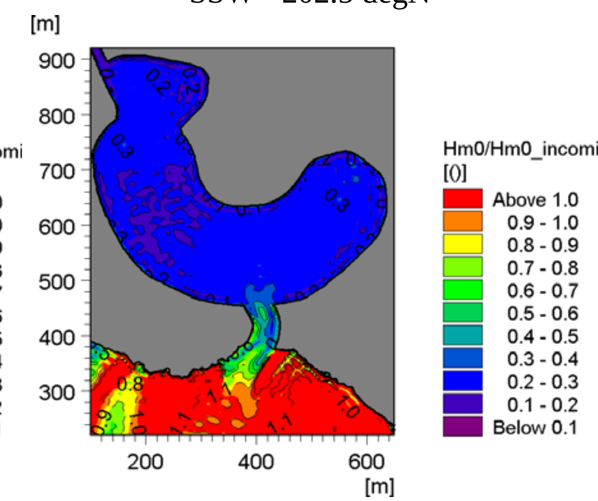
SSE -157.5 degN



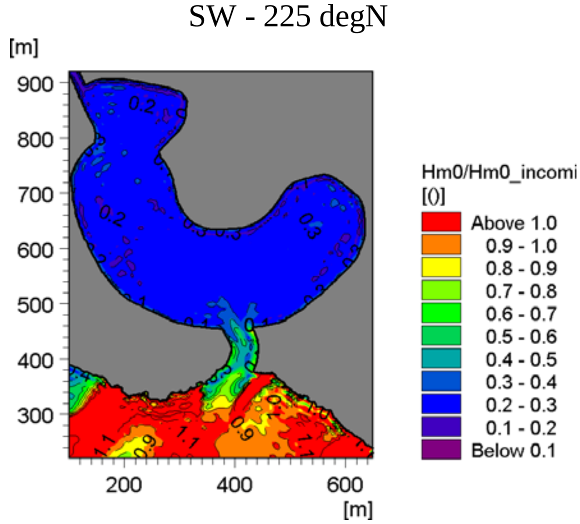
S - 180 degN



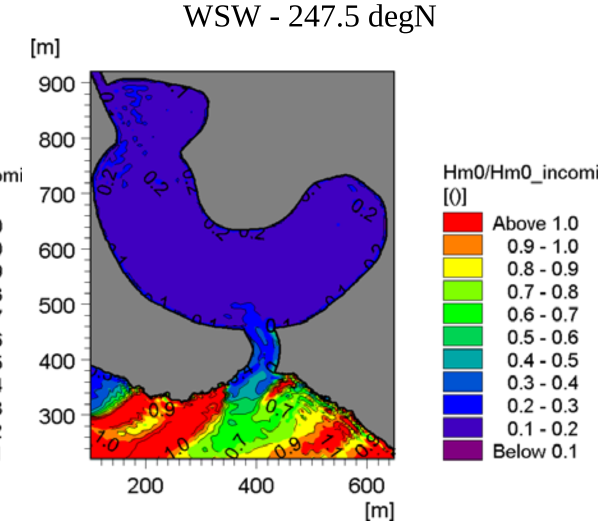
SSW - 202.5 degN



SW - 225 degN

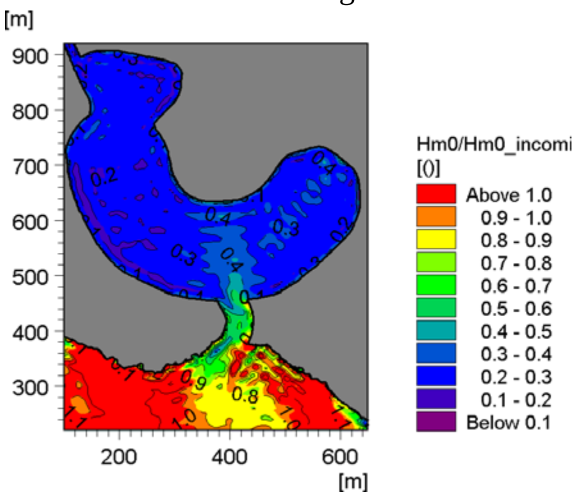


WSW - 247.5 degN

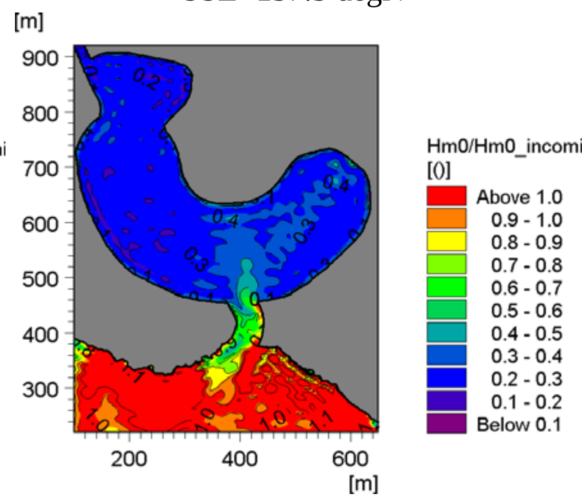


Base Case – Peak Period = 8 seconds

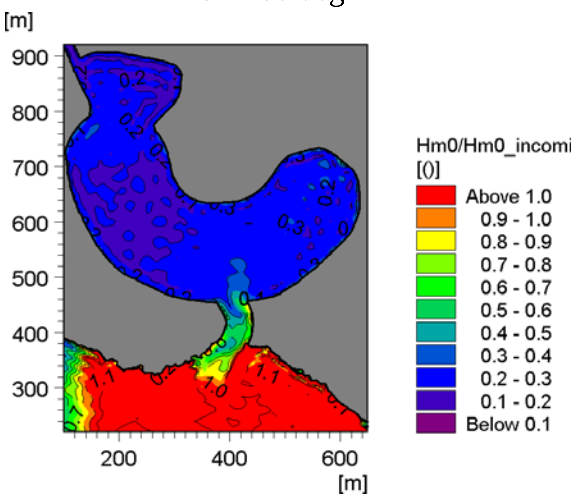
SE - 135 degN



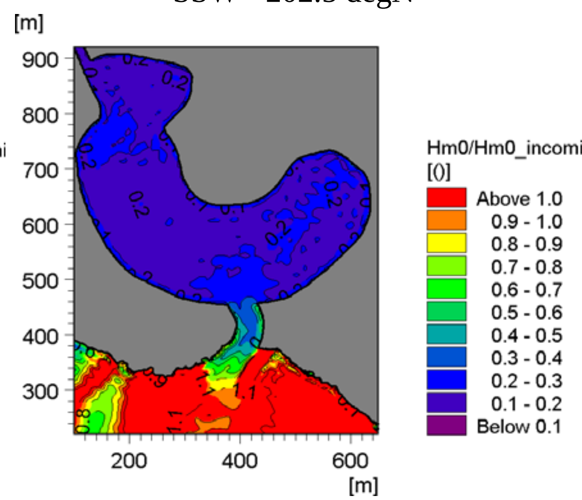
SSE -157.5 degN



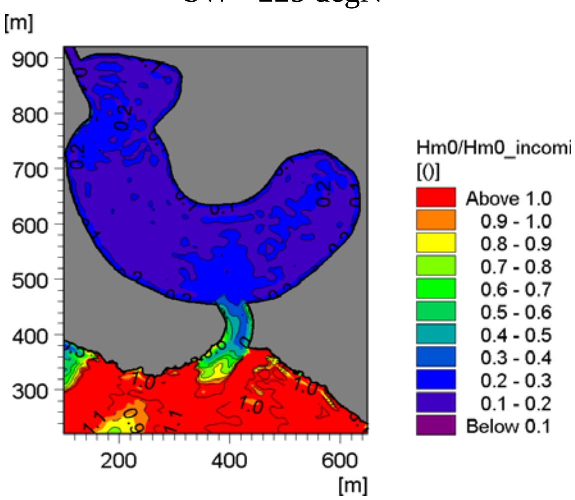
S - 180 degN



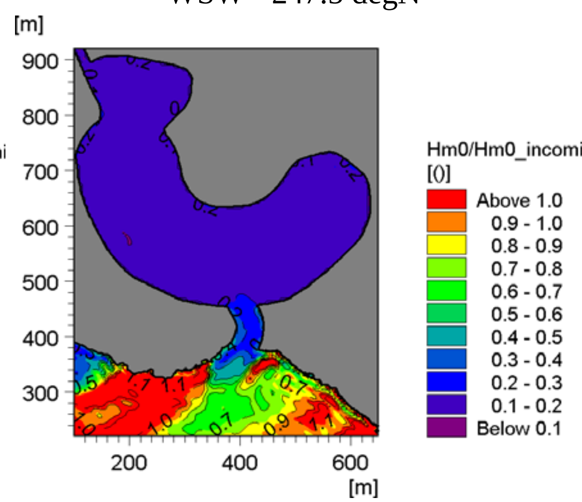
SSW - 202.5 degN



SW - 225 degN

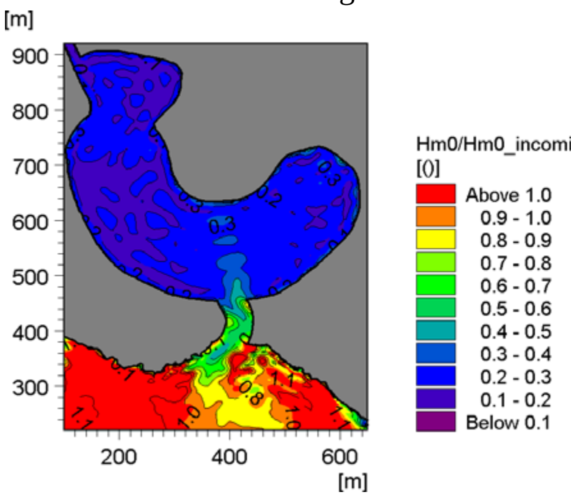


WSW - 247.5 degN

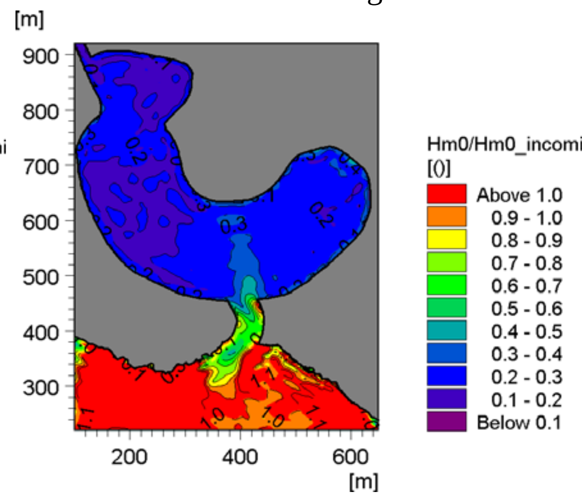


Base Case – Peak Period = 10 seconds

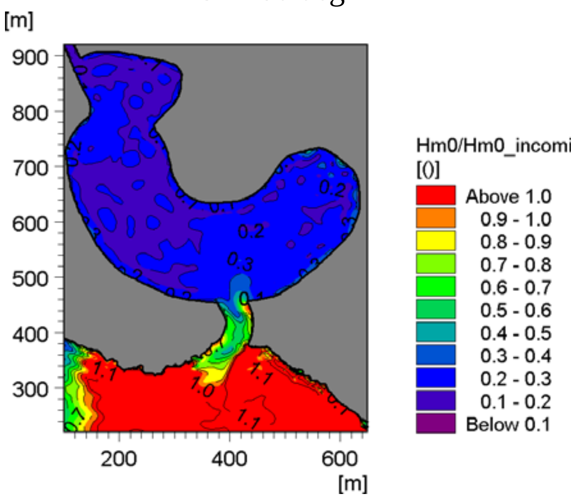
SE - 135 degN



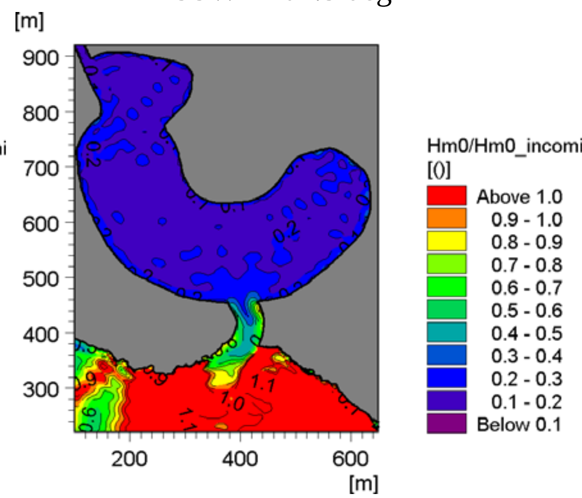
SSE -157.5 degN



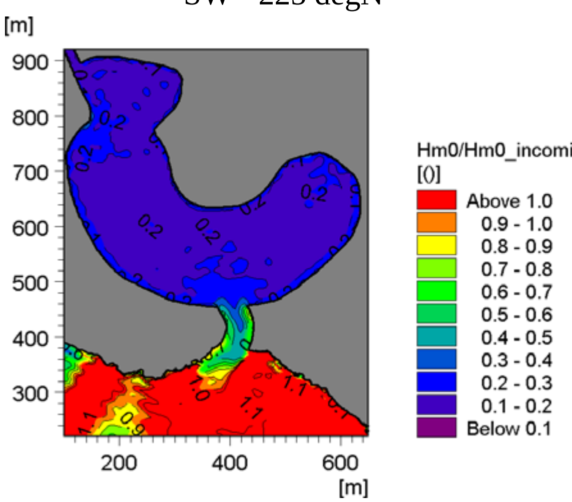
S - 180 degN



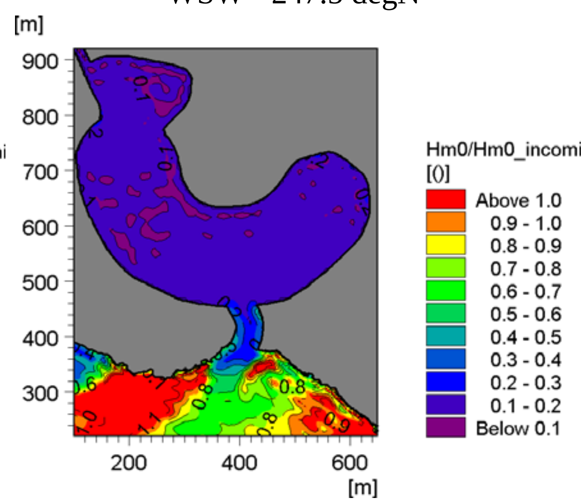
SSW - 202.5 degN



SW - 225 degN

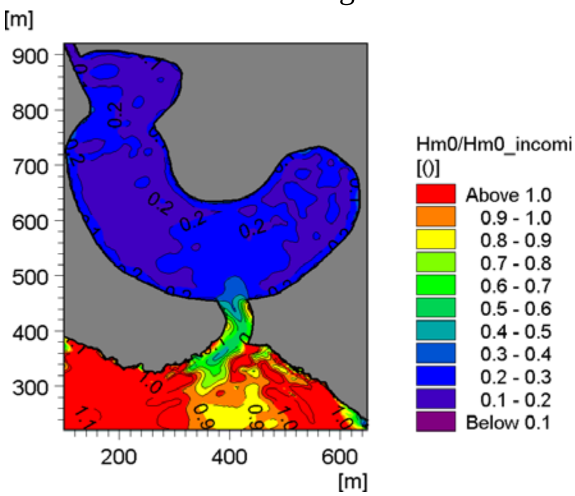


WSW - 247.5 degN

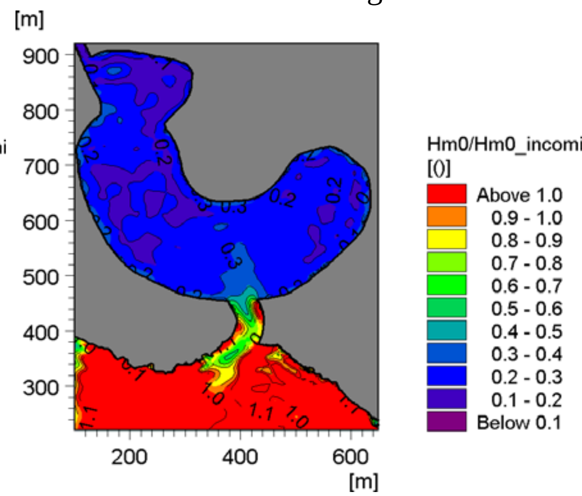


Base Case – Peak Period = 12 seconds

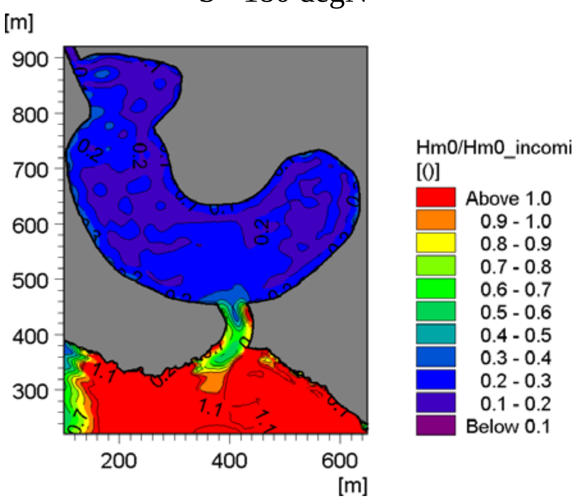
SE - 135 degN



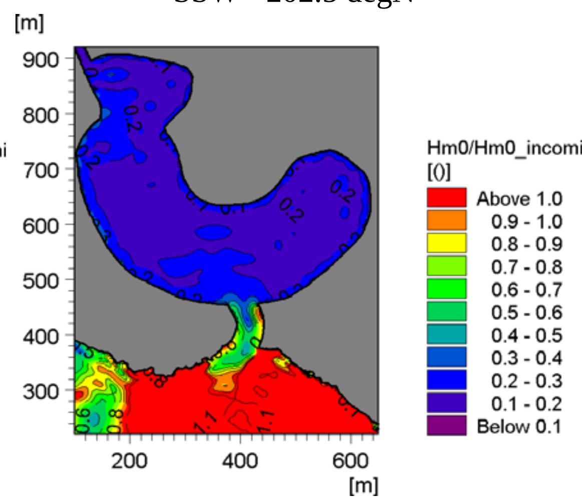
SSE -157.5 degN



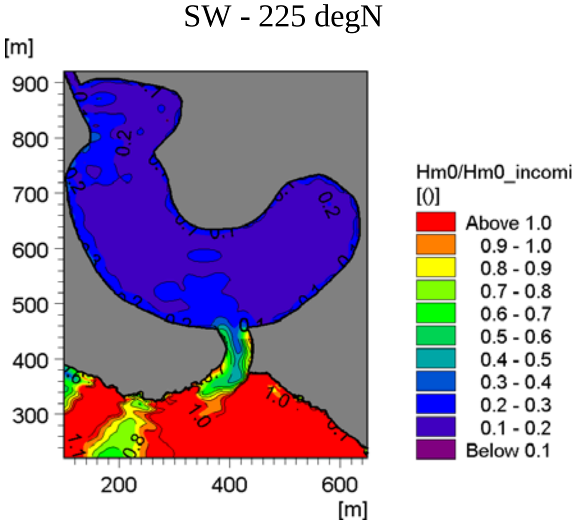
S - 180 degN



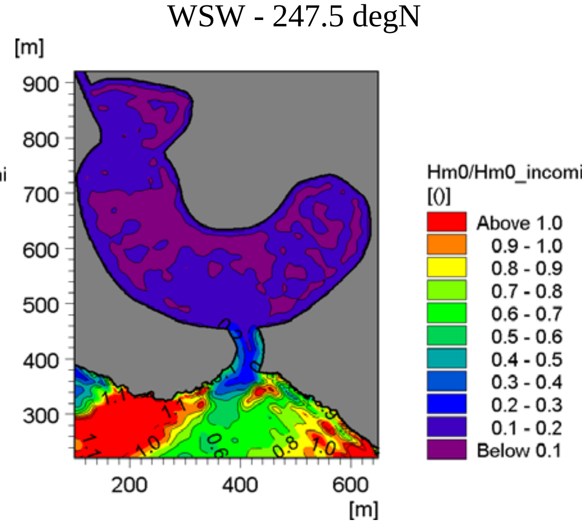
SSW - 202.5 degN



SW - 225 degN

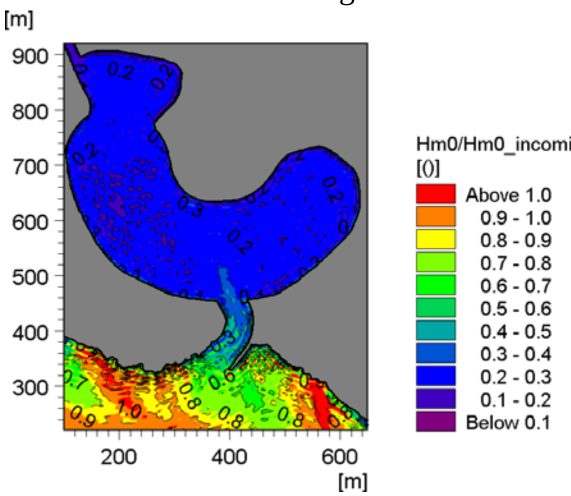


WSW - 247.5 degN

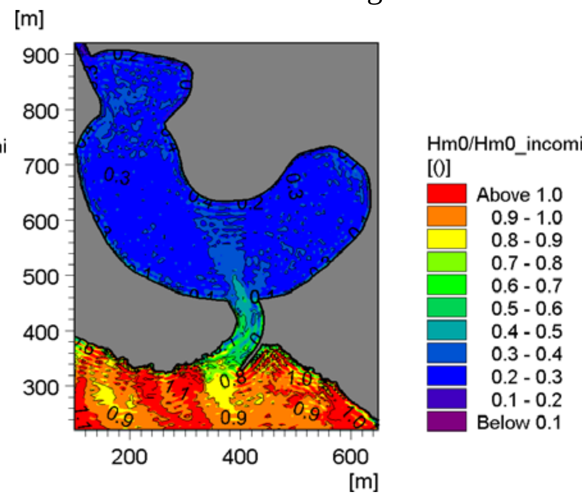


Jetty – Peak Period = 4 seconds

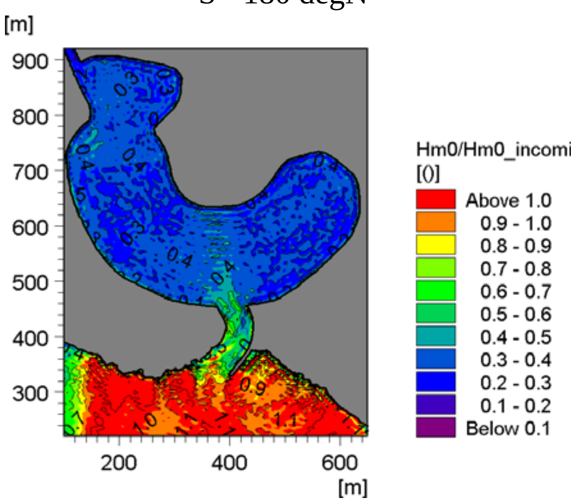
SE - 135 degN



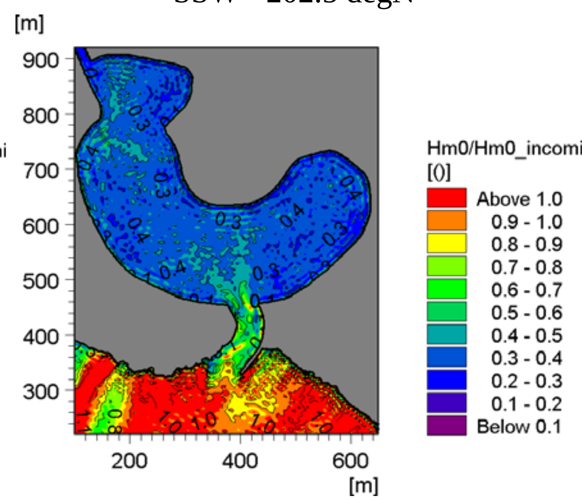
SSE -157.5 degN



S - 180 degN



SSW - 202.5 degN



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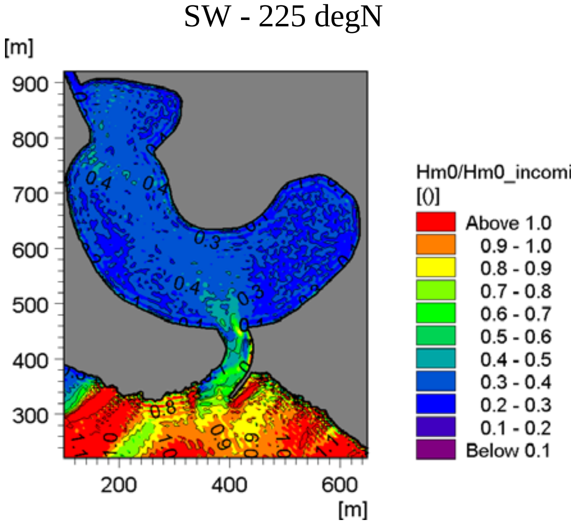

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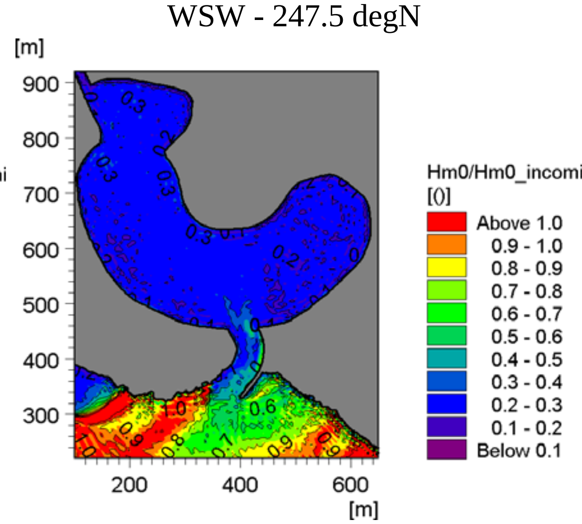

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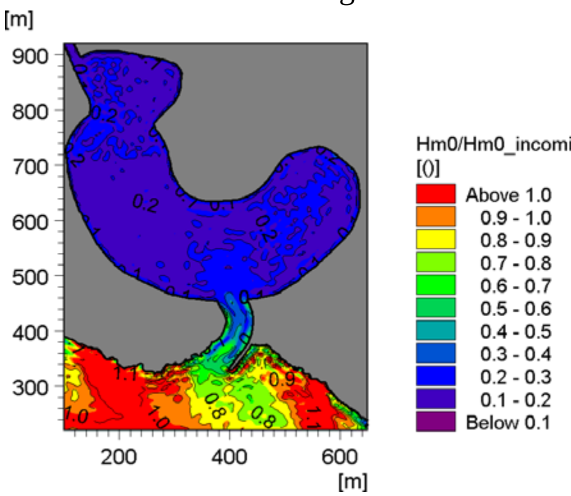

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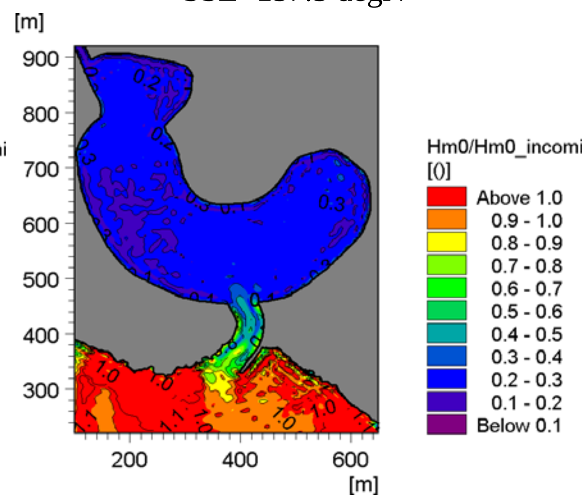

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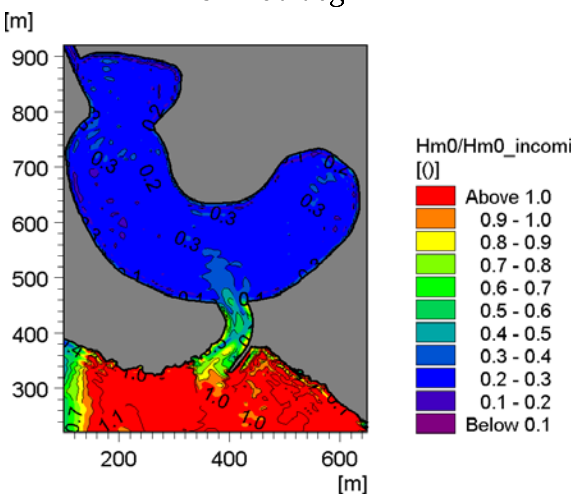

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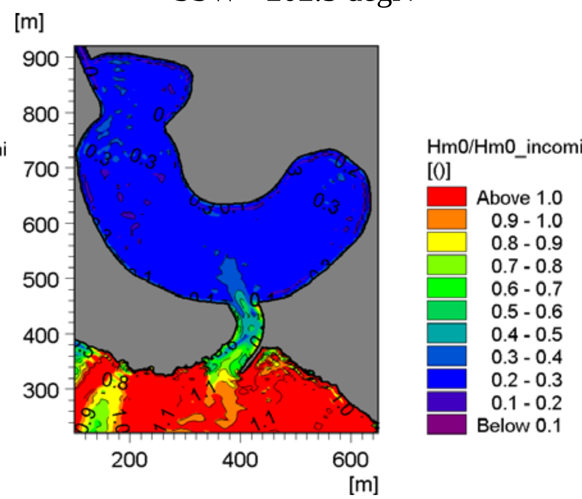

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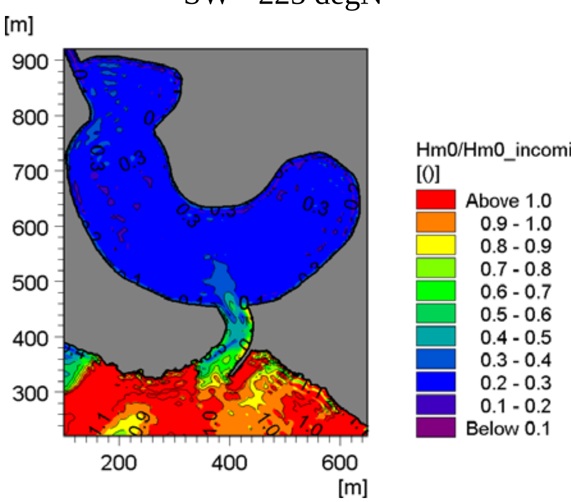

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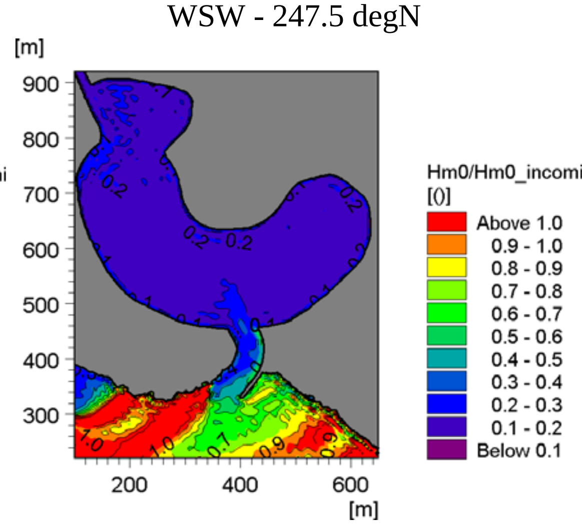

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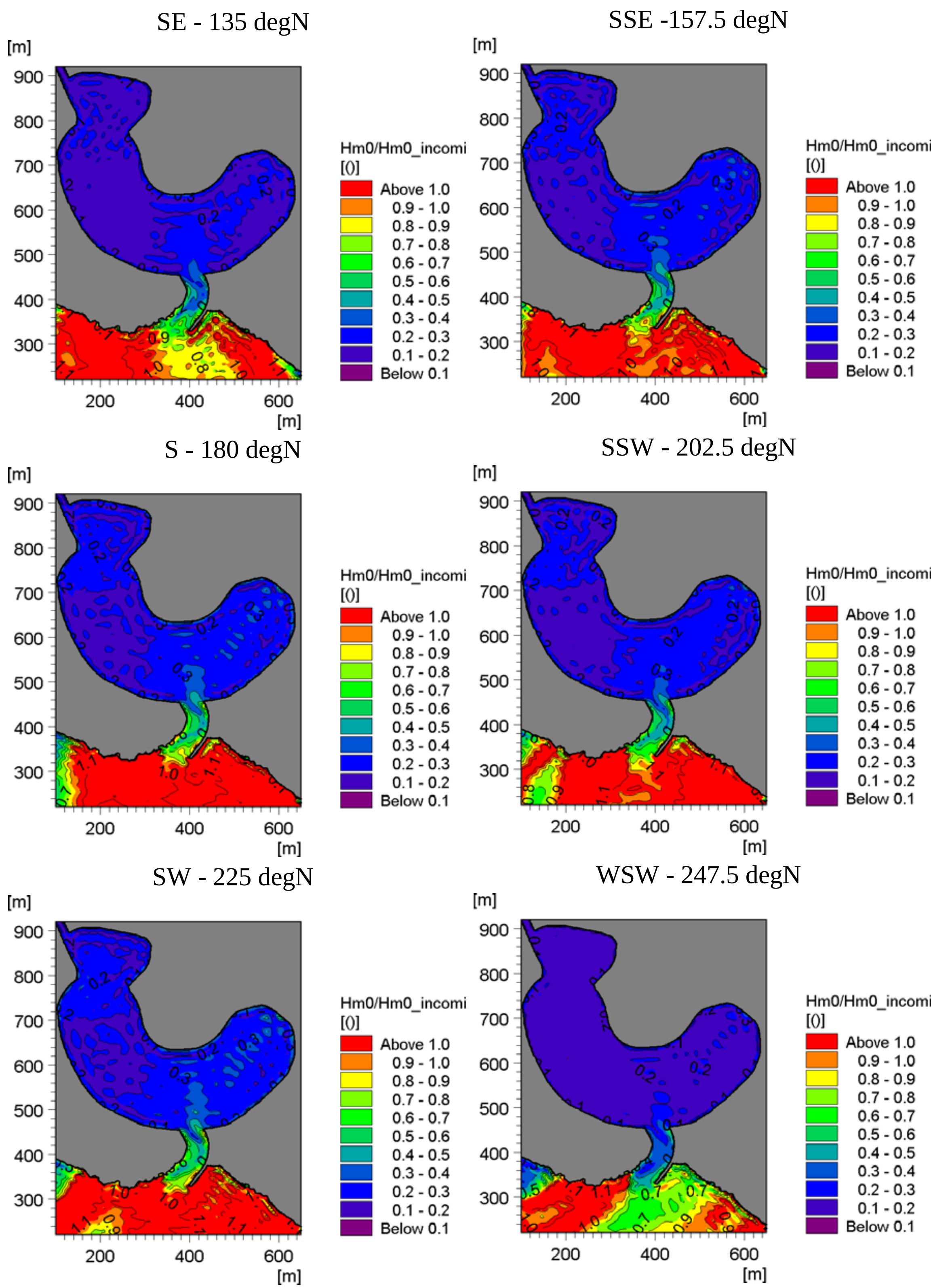

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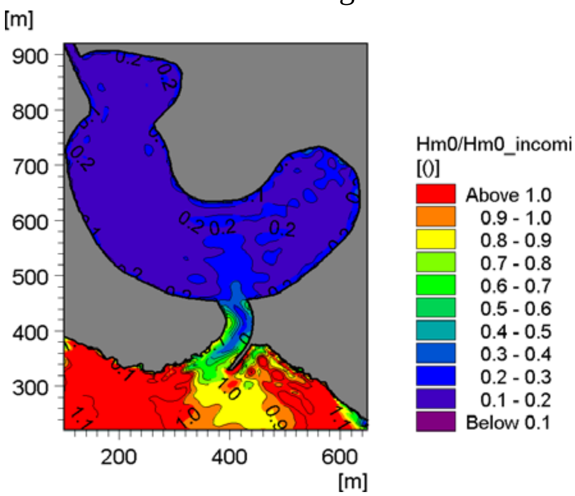

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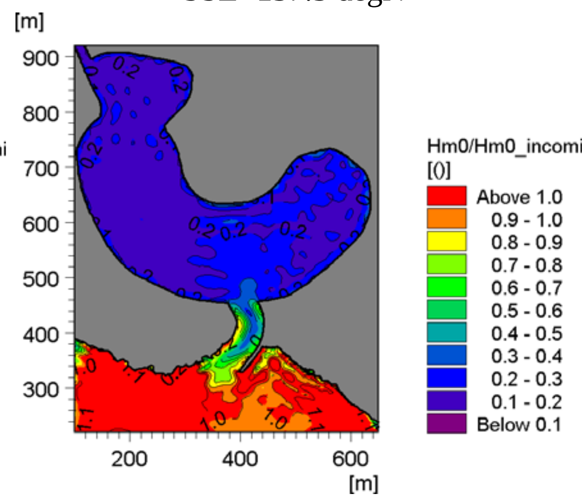

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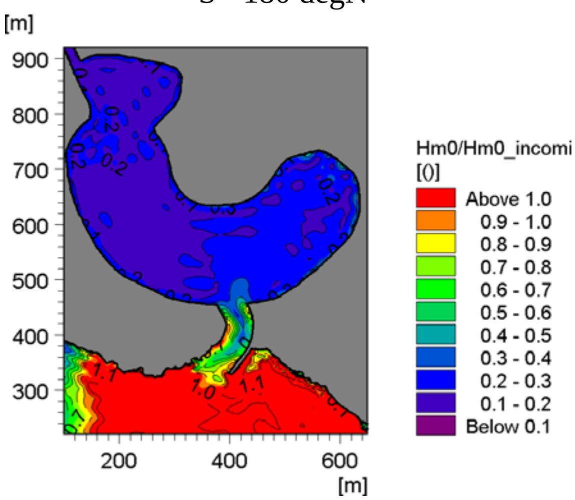

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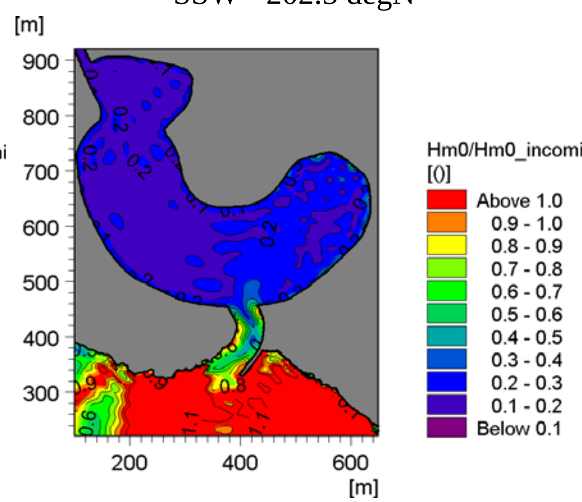

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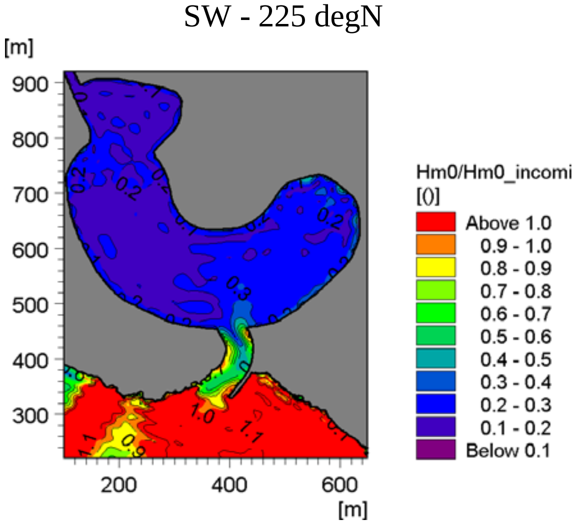

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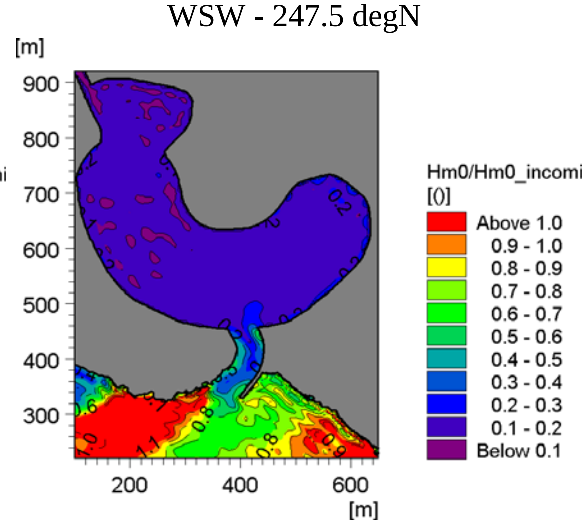
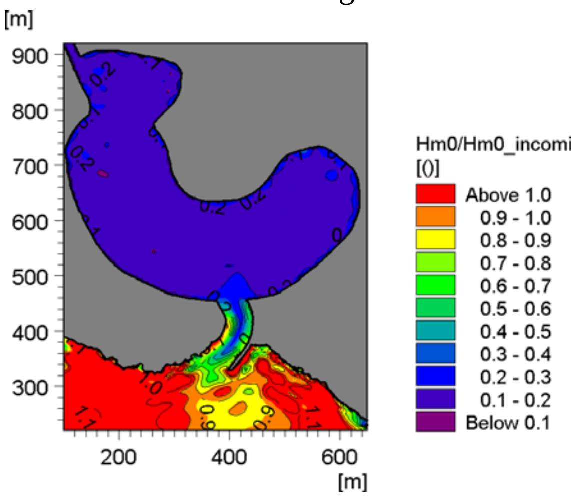


Jetty – Peak Period = 12 seconds

SE - 135 degN



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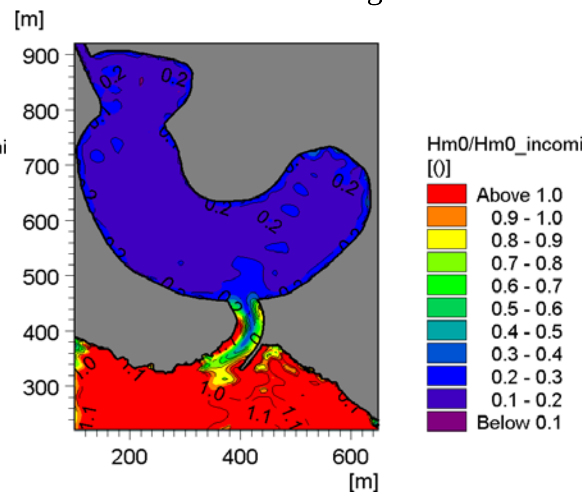

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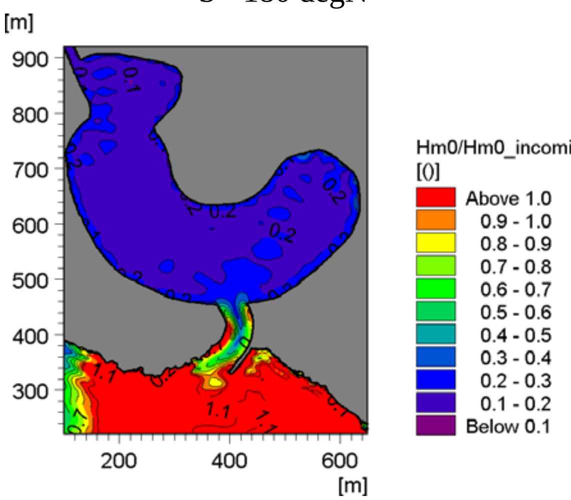

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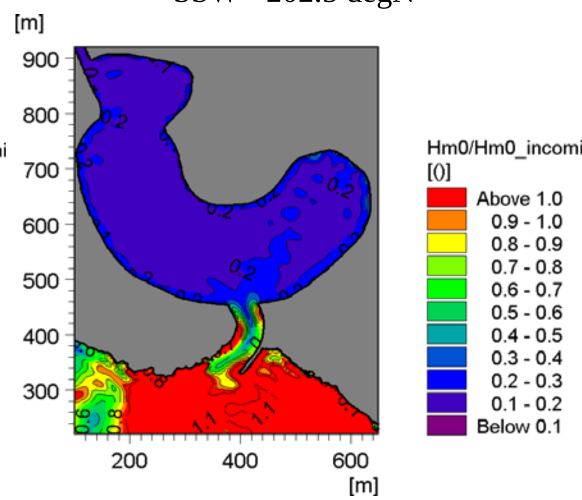

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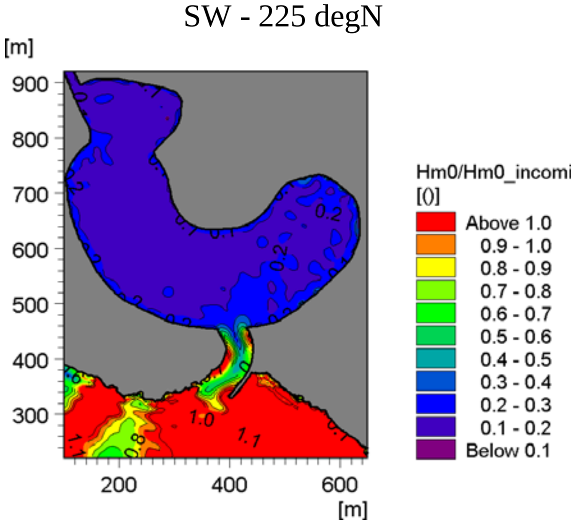

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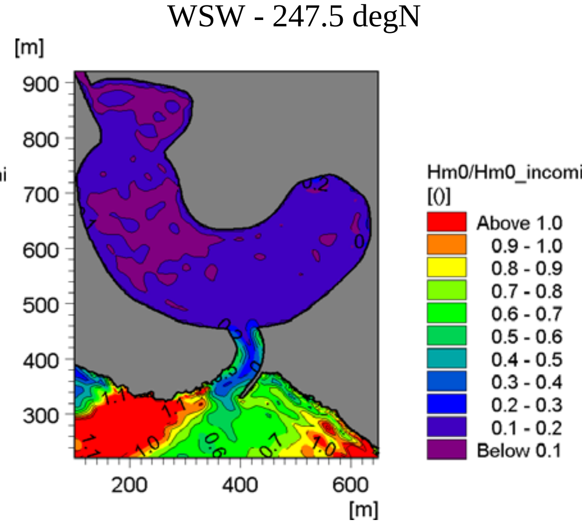


APPENDIX G

SEA LEVEL RISE AND RESILIENCY STUDY

1.0 INTRODUCTION

These Sea Level Rise (SLR) vulnerability assessment recommendations are supportive of the Coastal Engineering Report. This review provides recommendations to assess the vulnerability to SLR and identifies adaptation mitigation strategies for planning the development with associated infrastructure. The scientific literature strongly suggests that SLR will accelerate through the end of the 21st Century as a result of climate change (IPCC 2014, NRC 2012). At the time of this review, there are no probabilities attached to future SLR projections. The uncertainty in the SLR projections is a result of future global emissions of carbon dioxide (a function of future social behavior) and the non-linear response of the ocean to warmer temperatures and contributions from land-based ice sources. Thus, planning for SLR must consider both the high and low estimates of SLR. Planning for a range of potential future conditions will allow the Kakona development to adapt to changing conditions.

The SLR Vulnerability Assessment includes the following:

1. Summarizes current scientific guidance for SLR Projections
2. Provides recommendations to assess SLR Vulnerability
3. Identifies Adaptation Strategies for planning the development

The SLR Assessment methodology review was limited to desktop-level studies. Numerical modeling of SLR vulnerability was not included.

1.1 Sea-Level Rise Science and Projections

Sea levels are projected to rise in coming decades as a result of increased global temperatures associated with climate change (IPCC 2014). When discussing SLR (and when reviewing SLR projections), it is important to distinguish the differences between global and local SLR rates. Local SLR rates consider local effects such as tectonics (i.e., land uplift/subsidence), water temperatures, and wind stress patterns that can act to subdue or amplify the global SLR global averages. Local (or relative) SLR refers to the observed changes in sea level relative to the shoreline in a specific region and takes into account these local factors.

Myriad planning and policy-level guidance on SLR have been released by international, federal, and state entities. These guidance documents are generally based on research and publications generated from the scientific community. The most applicable guidance to the Abacos is the SLR in the Caribbean document produced by Caribsave and the United Nations Development Programme (UNDP) in 2010. This guidance document is primarily based on the IPCC AR4 study, which provided global SLR projections for the United States, however provides key points for policy makers in the Caribbean Region.

It should be noted that guidance related to SLR evolves as new science is released. The most relevant science and guidance from the international, federal, and state levels at the time of this report is summarized in this section.

1.1.1 International Sea-Level Rise Science

The most significant international SLR guidance to this development is released by the Inter-governmental Panel on Climate Change (IPCC). The IPCC is an aggregator of peer reviewed scientific literature and provides estimates of global SLR every five or six years in detailed assessment reports.

The IPCC recently released its 5th Assessment Report (5AR) in 2013. The study updated global climate models with a set of new global emission scenarios called Representative Concentration Pathways (RCPs). These emission scenarios make a number of assumptions of future release of carbon dioxide into the atmosphere. The uncertainty in future SLR estimates is largely due to the global release of future emissions being a function of social behavior. Global SLR projections according to the 5AR through year 2100 are shown in Table G-1.

Table G-1: Global SLR Projections (IPCC 2013)

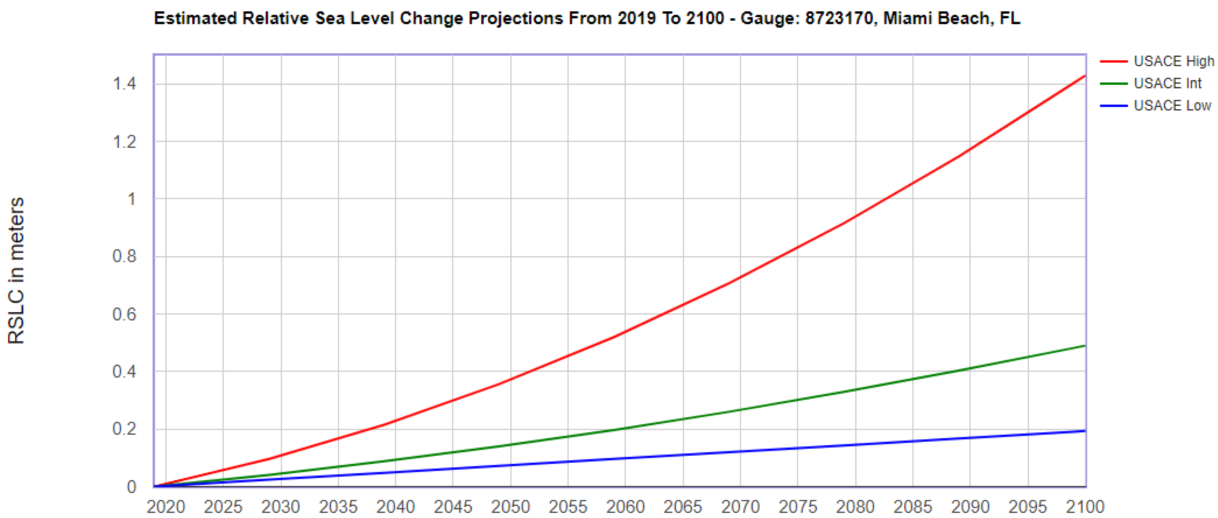
Scenario	2046- 2065		2081-2100	
	Mean SLR (ft)	Likely Range (ft)	Mean SLR (ft)	Likely Range (ft)
RCP 2.6	0.79	0.56 to 1.05	1.31	0.85 to 1.8
RCP 4.5	0.85	0.62 to 1.08	1.54	1.05 to 2.07
RCP 6.0	0.82	0.59 to 1.05	1.47	1.08 to 2.07
RCP 8.5	0.98	0.72 to 1.25	2.07	1.48 to 2.69

Since the 5AR is a recent release, the 4th Assessment Report (released in 2007) is still commonly used for SLR guidance documents. The global emission scenarios in this assessment report form the foundation of the National Research Council (2012) report, as discussed in more detail in the following section.

1.1.2 Federal Guidance

U.S. Army Corps of Engineers – Engineering Regulation (ER) No. 1100-2-8162 (USACE 2013)

The U.S. Army Corps of Engineers (Corps) released Engineering Regulation (ER) No. 1100-2-8162 in December 2013 (USACE 2013), which provides guidance on the direct and indirect physical effects of SLR throughout a project's life cycle from year 2020 to 2100. The ER recommends consideration of three SLR scenarios (low, intermediate, and high). These scenarios are shown in Figure G-1 for the closest NOAA station to the project area (Miami Beach - 8723170).



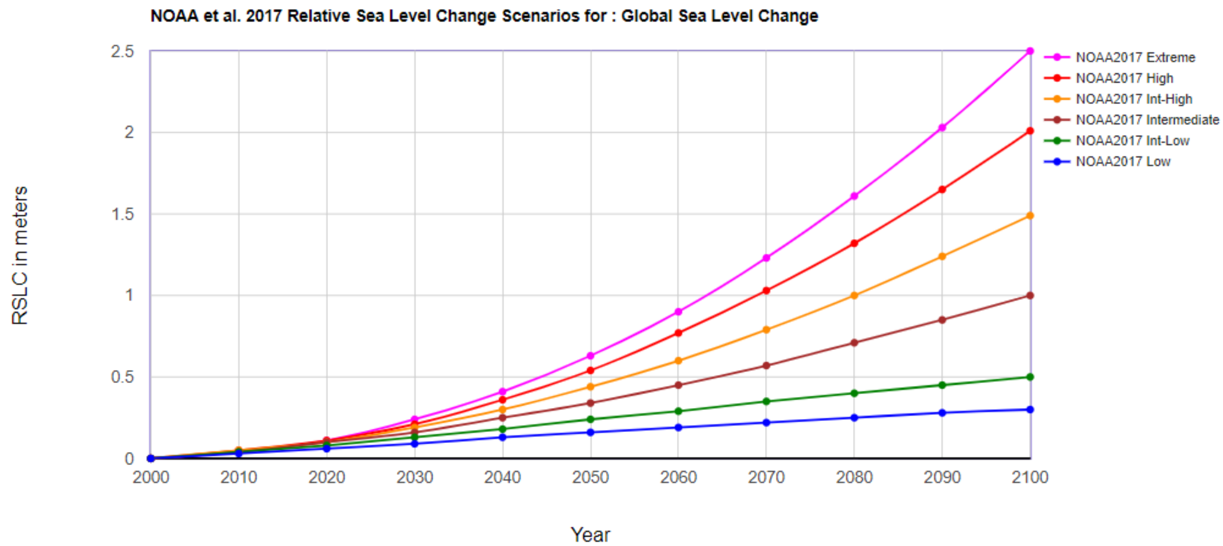
Year	USACE Low	USACE Int	USACE High
2019	0.00	0.00	0.00
2029	0.02	0.04	0.10
2039	0.05	0.09	0.22
2049	0.07	0.14	0.36
2059	0.10	0.20	0.52
2069	0.12	0.26	0.71
2079	0.14	0.33	0.92
2089	0.17	0.40	1.15
2099	0.19	0.48	1.40
2100	0.19	0.49	1.43

Figure G-1: Projected SLR Rates from 2019 to 2100 (Derived from USACE 2013)[8]

National Oceanic and Atmospheric Administration – Technical Report NOS CO-OPS 083 (NOAA 2017)

The National Oceanic and Atmospheric Administration (NOAA) released Technical Report NOS CO-OPS 083 in January 2017 (NOAA 2017), which updates scenarios of global mean sea level (GMSL) rise. The study provides six representative GMSL rise scenarios from year 2000 to 2100 as depicted in Figure G-2.

8 http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html



Kakona
Scenarios for Global Sea Level Change
All values are expressed in meters

Year	NOAA2017 Low	NOAA2017 Int-Low	NOAA2017 Intermediate	NOAA2017 Int-High	NOAA2017 High	NOAA2017 Extreme
2000	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.03	0.04	0.04	0.05	0.05	0.04
2020	0.06	0.08	0.10	0.10	0.11	0.11
2030	0.09	0.13	0.16	0.19	0.21	0.24
2040	0.13	0.18	0.25	0.30	0.36	0.41
2050	0.16	0.24	0.34	0.44	0.54	0.63
2060	0.19	0.29	0.45	0.60	0.77	0.90
2070	0.22	0.35	0.57	0.79	1.03	1.23
2080	0.25	0.40	0.71	1.00	1.32	1.61
2090	0.28	0.45	0.85	1.24	1.65	2.03
2100	0.30	0.50	1.00	1.49	2.01	2.50

Figure G-2: NOAA Global Mean Sea Level (GMSL) Scenarios for 2100[9]

1.1.3 Regional Guidance

The most recent study for SLR in the Caribbean was produced by Caribsave and the United Nations Development Programme (UNDP) in 2010. Based on this report, the total SLR by the end of the century could reach as much as 1.5m to 2m above present levels (UNDP, 2010). This report compared recent SLR projections with the IPCC Fourth Assessment (AR4), therefore are not as recent as the previously mentioned international and federal projections. However, the Caribbean Region SLR Vulnerability is assessed based on 1m and 2m SLR scenarios to encompass the recent SLR projection studies range over the 21st Century.

9 http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html

1.2 Vulnerability and Risk Assessment Methodology

This section discusses methods to assess the vulnerability and risk for the Kakona upland development.

1.2.1 Vulnerability Assessment

Methodology for assessing vulnerabilities and risk is based on the following guidelines:

- *Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Seal Level Rise in the Caribbean* by Caribsave and the United Nations Development Programme (UNDP).

- *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* published by ICLEI-Local Governments for Sustainability (Snover, A.k. et al, 2007).

The overall vulnerability should be assessed as a function of each asset's exposure, sensitivity, and adaptive capacity. These terms are defined as follows in the context of how they are used to develop a vulnerability assessment:

- **Exposure** is the degree to which a system or asset is exposed to SLR. In this study, asset exposure to projected SLR was determined through desktop-research of recent scientific studies and is defined in terms of flooding and inundation.

- **Sensitivity** is the degree an asset would be impaired by the impacts of SLR. Systems that are greatly impaired by small changes in SLR have a high sensitivity, while systems that are minimally impaired by the same small change in SLR have a low sensitivity.

- **Adaptive capacity** is the ability of an asset to respond to SLR, to moderate potential damages, to take advantage of opportunities, and to cope with the consequences. This does not mean that the system must look the same as before the impact, but it must provide comparable service and function with minimum disruption or additional cost.

The vulnerability of an asset increases as the sensitivity increases. Adaptive capacity is inversely related to vulnerability in that as the adaptive capacity increases, the vulnerability decreases. For example, beaches along the coastline are sensitive to small changes in sea level but would be assigned a moderate vulnerability because of their relatively high adaptive capacity. These relationships are shown graphically in Figure G-3.

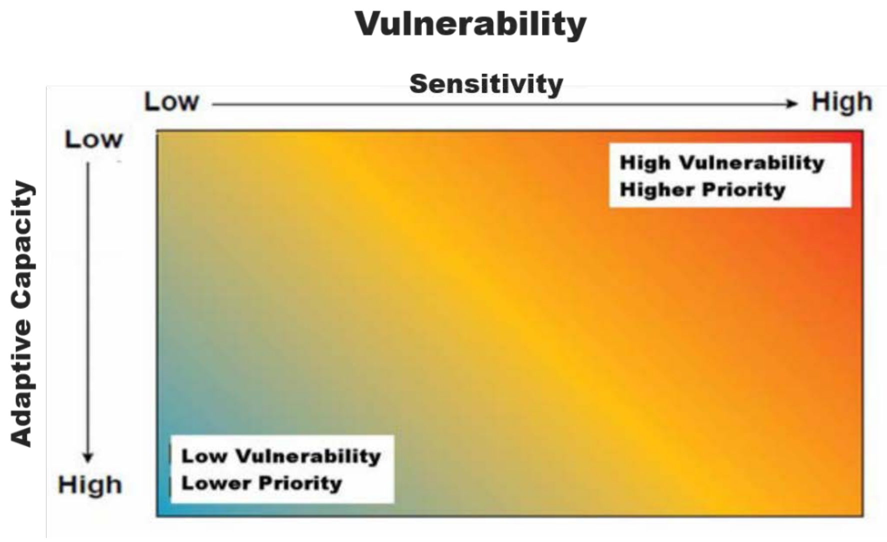


Figure G-3: Relationship Between Sensitivity, Adaptive Capacity, and Vulnerability (ICLEI 2012)

The vulnerability assessment should consider the potential for SLR impacts for the 25, 50 and 100-year scenarios combined with the mean high water level.

1.2.2 SLR Projections

Three SLR scenarios should be considered for the vulnerability assessment; however, 50 years is a common design life for waterfront developments. The SLR projects for a 50-year service life (Year 2020 to 2070) ranges from 0.12 m (USACE Low) to 1.23 m (NOAA Extreme) with the NOAA intermediate scenario near the average at 0.57 m.

The three SLR scenarios are shown in Table G-2 for the NOAA 2017 Intermediate and should be combined with a high tide.

Table G-2: Sea-Level Rise Projected Water Levels

Scenario	Time Horizon	Sea Level Rise Scenario (NOAA 2017)	Future Sea Level Rise (m)
1	25 Years (2045)	Intermediate	0.30*
2	**50 Years (2070)**	**Intermediate**	**0.57**
3	~100 Years (2100)	Intermediate	1.00

* approx. interpolated value

The SLR Projections should be verified by numerical modeling.

1.2.3 Asset Inventory and Vulnerability Mapping Methodology

SLR Projections should be mapped on a geo-referenced shoreline to identify potentially impacted resources on the island. Assets that should be included are beaches, roads, pedestrian paths, bike paths, parking lots, buildings, walls, revetments, storm drains, and sensitive habitats. Potentially impacted assets should be analyzed for their critical elevation, structure type, year built, replacement cost, and existing condition.

1.3 Mitigation Strategies

This section discusses recommendations to adapt mitigation strategies for planning the development with associated infrastructure. There are numerous methods of protecting and managing coastal assets depending on the time horizons of the response scenario. Extreme storm events that would require emergency actions can be classified as a short-term response. Long-term planning time horizons would be more applicable to future adaptability and SLR response.

There are four general response categories to address SLR:

Category 1 - Move the structure away from the threat – This is generally referred to as “managed retreat” which entails moving primary structures landward and out harm’s way.

Category 2 - Move the threat away from the structure – This can be done by widening the beach or raising the site grade.

Category 3 - Hold the line – This category includes shoreline protective devices including seawalls and rock revetment, intended to protect property behind them both from erosion and coastal flooding.

Category 4 - Deal with it – This final category includes measures to accommodate the threat of coastal flooding by raising structures out of the flood elevation, flood-proofing, designing robust structural foundations to accommodate future adaptability, etc.

Due to the likelihood of extreme storm events and vulnerability of SLR effects, it is recommended to adapt a combination of short-term and long-term mitigation strategies using Category 4 responses.

1.4 Recommendations and Next Steps

Based on the review of SLR Assessment methods and mitigation strategies, recommendations and next steps for the Kakona Development are as follows:

- Prepare Geo-referenced Inventory of Coastal Infrastructure Potentially Affected by SLR
- Model SLR Scenarios in Conjunction with other Coastal Flooding Factors using the most recent SLR Projections (currently NOAA Projections)
- Conduct SLR Vulnerability Assessment
- Implement Appropriate Adaptation Policies using Category 4 Responses

APPENDIX I - KLG INVESTMENT WATER QUALITY RESULTS

NAME: Bron Limited **DATE:** May 11th, 2023

LOCATION: Bag 1 **EMAIL:** fpalomino@bebron.com

LAB TEST	RESULTS	E.P.A STANDARDS Desirable Level	W.H.O. STANDARDS Maximum Permissible Level
Bacteria			
COLIFORM/100 ML	***135**/100ml	NONE	NONE
FECAL COLIFORM/100 ML	0/100ml	NONE	NONE
NON-COLIFORM	0/100ml		
*L 1-50 COLONIES OF BACTERIA			
*M 51-200 COLONIES OF BACTERIA			
*TNTC-TOO NUMEROUS TO COUNT			
Chemical			
pH	7.8	6.5 – 8.5	6.5 – 8.5
TOTAL DISSOLVED SOLIDS-PPM (TDS)	***24,200ppm**	500	1,200
SODIUM CHLORIDE (SALINITY)-PPM	***13,800ppm**	250	<600
TOTAL HARDNESS-PPM	***1,036ppm**	100	<200
NITRATE-PPM	0.5pm	10	10
IRON-PPM	0.02ppm	0.3	0.5
APPEARANCE	Clear	CLEAR	CLEAR
ODOR	None	NONE	NONE
CHLORINE RESIDUAL-PPM *IBWA	NIL	*0.1	4.0
TURBIDITY-FNU	3FNU	5.0	5.0
NOTE: **W.H.O.** - WORLD HEALTH ORGANIZATION			
NOTE: **E.P.A.**-ENVIRONMENTAL PROTECTION AGENCY			

COMMENTS:

Numerous amounts of coliform bacteria were isolated in the water sample. Coliform bacteria are indicators of disease-causing organisms.

The chemical components of the water all fell within the W.H.O. standards for drinking water with the exception of the TDS and sodium chloride.

Hence, the water did not meet all health standards due to the presence of coliform bacteria and the high chloride content and is therefore not acceptable for human consumption.

We recommend that the water source be chlorinated and retested after one week to verify adequate disinfection. Additionally, we suggest that measures be employed to reduce the TDS and chloride content to a safer level.

Quality Control Laboratory

Thank you for choosing KLG Investments Limited.

NAME: Bron Limited **DATE:** May 11th, 2023

LOCATION: Bag 2 **EMAIL:** fpalomino@bebron.com

LAB TEST	RESULTS	E.P.A STANDARDS Desirable Level	W.H.O. STANDARDS Maximum Permissible Level
Bacteria			
COLIFORM/100 ML	***10**/100ml	NONE	NONE
FECAL COLIFORM/100 ML	0/100ml	NONE	NONE
NON-COLIFORM	0/100ml		
*L 1-50 COLONIES OF BACTERIA			
*M 51-200 COLONIES OF BACTERIA			
*TNTC-TOO NUMEROUS TO COUNT			
Chemical			
pH	7.7	6.5 – 8.5	6.5 – 8.5
TOTAL DISSOLVED SOLIDS-PPM (TDS)	***24,300ppm**	500	1,200
SODIUM CHLORIDE (SALINITY)-PPM	***12,000ppm**	250	<600
TOTAL HARDNESS-PPM	***856ppm**	100	<200
NITRATE-PPM	0.2pm	10	10
IRON-PPM	0.00ppm	0.3	0.5
APPEARANCE	Clear	CLEAR	CLEAR
ODOR	None	NONE	NONE
CHLORINE RESIDUAL-PPM *IBWA	NIL	*0.1	4.0
TURBIDITY-FNU	0FNU	5.0	5.0
NOTE: **W.H.O.** - WORLD HEALTH ORGANIZATION			
NOTE: **E.P.A.**-ENVIRONMENTAL PROTECTION AGENCY			

COMMENTS:

There were fifty-two colonies of coliform bacteria isolated in the water sample. Coliform bacteria are indicators of disease-causing organisms.

The chemical components of the water fell within the W.H.O. standards for drinking water with the exception of the TDS, sodium chloride and hardness.

Hence, the water *did not* meet all health standards due to the presence of coliform bacteria and the high chloride content and is therefore not acceptable for human consumption.

We recommend that the water source be chlorinated and retested after one week to verify adequate disinfection. Additionally, we suggest that measures be employed to reduce the TDS, hardness and chloride content to a safer level.

Quality Control Laboratory

Thank you for choosing KLG Investments Limited.

Appendix J - Historical Survey Report

A Survey of Heritage Resources at High Bank and Lantern Head Properties, South Abaco, The Bahamas

By Colin Brooker and James J. Miller

June Maura, Research Associate

Prepared under contract with
Ferreira & Company
Attorneys At Law &
Environmental Consultants
Nassau, The Bahamas

for
Valencia Capital Group, LLC
Atlanta, GA

by
James J. Miller, PHD, LLC
Tallahassee, FL

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ACKNOWLEDGEMENTS

It is a pleasure to gratefully acknowledge the participation and assistance of many people in Abaco and The Bahamas for assistance, advice, cooperation and other aid. Dr. Keith Tinker, Director of the Antiquities, Monuments and Museums Corporation (AMMC), Nassau, recognized the potential historical importance of the proposed development tracts, recommended that investigations be conducted, and kindly facilitated several aspects of the project. Ms. Nancy Albury of Man-of-War Cay represented AMMC and their local partners Friends of the Environment and was of great assistance in coordinating local arrangements and connections, as well as assisting in the field survey. Mrs. Bethel of AMMC assisted with travel arrangements, and Ms. Anita Knowles of Friends of the Environment provided valuable logistical support. Mr. Tom Boynton of Valencia Capital Group supplied rectified aerial photography, surveyor's boundaries and topographic contours, all in digital format, which added greatly to the usefulness of the GIS, and for which we are very grateful. Mr. Keith Bishop, Islands by Design, has shared his enthusiasm for the environment and heritage of south Abaco over several years, and graciously provided information he had collected.

Staff at the Department of Archives in Nassau were of great help in searching for, locating and making available obscure documents in their collections pertaining to South Abaco and Alexandria. At the Department of Lands and Surveys in Nassau Mr. Roscoe Turnquest was helpful, as always, in locating and making available historic aerial photographs of south Abaco. At the UK Hydrographic Office, Taunton, Somerset, staff were of great assistance in locating and providing high quality copies of historic maps of the region. Because the documentary record is not extensive, relevant records were difficult to find, but all the more valuable for their rarity. We appreciate all the advice and assistance that allowed a historic context to be pieced together for the region. For this final report, we are happy to acknowledge the assistance of Mr. Ashley Heffner for preparation of the architectural drawings.

At the High Bank property, we greatly benefited by the field participation of Mr. David Bethel of Marsh Harbour, who has personally discovered and investigated many of the prehistoric and historic sites on Abaco, and who was kind to lead us to structures of which he was aware. Being in south Abaco, even for a short time, was a wonderful experience, and it is a pleasure to thank the people of Sandy Point for their hospitality, friendliness and assistance with lodging, food and transportation.

INTRODUCTION

Today south Abaco is virtually uninhabited, marked by extensive pine forests, windswept coastal dunes, and a few rough roads. Its remote appearance and dense vegetation mask the remains of a rich historical landscape from more than a century ago. For the last quarter of the nineteenth century, south Abaco was well-settled region with extensive private landholdings and at least two platted communities. In this study we seek to recover the largely forgotten history of south Abaco and to evaluate the heritage remains on specific lands planned for development.

In the fall of 2007, the proposed development of three tracts in south Abaco was reviewed by various agencies of The Bahamas, including the Antiquities, Monuments and Museums Corporation (AMMC). At the time, ruins were already confirmed on one tract (Brooker n.d.) and remains of buildings or walls were believed to exist on at least one other property. At the request of AMMC, a proposal was prepared to conduct a historical study, record historical resources, and provide recommendations for preservation and management. Our study team included Dr. James J. Miller, heritage planner and archaeologist, Mr. Colin Brooker, historic architect, and Ms. June Maura, historical researcher. In the field we were greatly assisted by David Bethel who had previously visited all of the sites we investigated and by Nancy Albury who had previously visited the property and who represented AMMC. The work was carried out under the terms of a research permit issued by AMMC on May 5, 2008.

Three tracts were initially included in the research permit application, but historical research and field work focused on the southern two properties, Lantern Head and High Bank. The third property scheduled for development, Conch Sound, was not visited. No evidence was found to indicate the prior habitation of the Conch Sound tract, either in historical records, on maps, on aerial photographs, or through local informants familiar with the property and the region.

Our project was conducted under subcontract between James J. Miller PHD LLC of Tallahassee, FL and Ferreira & Company of Nassau, who had been retained by Valencia Capital Group of Atlanta to prepare the environmental impact assessment. A certain level of historical research and architectural survey had already been completed by Brooker and Maura a year earlier, including a brief visit to the settlement of Alexandria and the site at Lantern Head. From this beginning, Maura expanded a search of records at Department of Lands and Surveys and Department of Archives to include the proposed development tracts, Lantern Head, High Bank and Conch Sound. Field work, made possible by logistical support by Ferreira & Company, was restricted to Lantern Head and High Bank, and was completed in early May, 2008. Neither historical research, local informants nor aerial photography indicated any historical occupation or remains at Conch Sound. Historical research by Brooker and Maura continued after field work, to follow leads generated by the survey and recording of physical remains, and the report was completed in September.

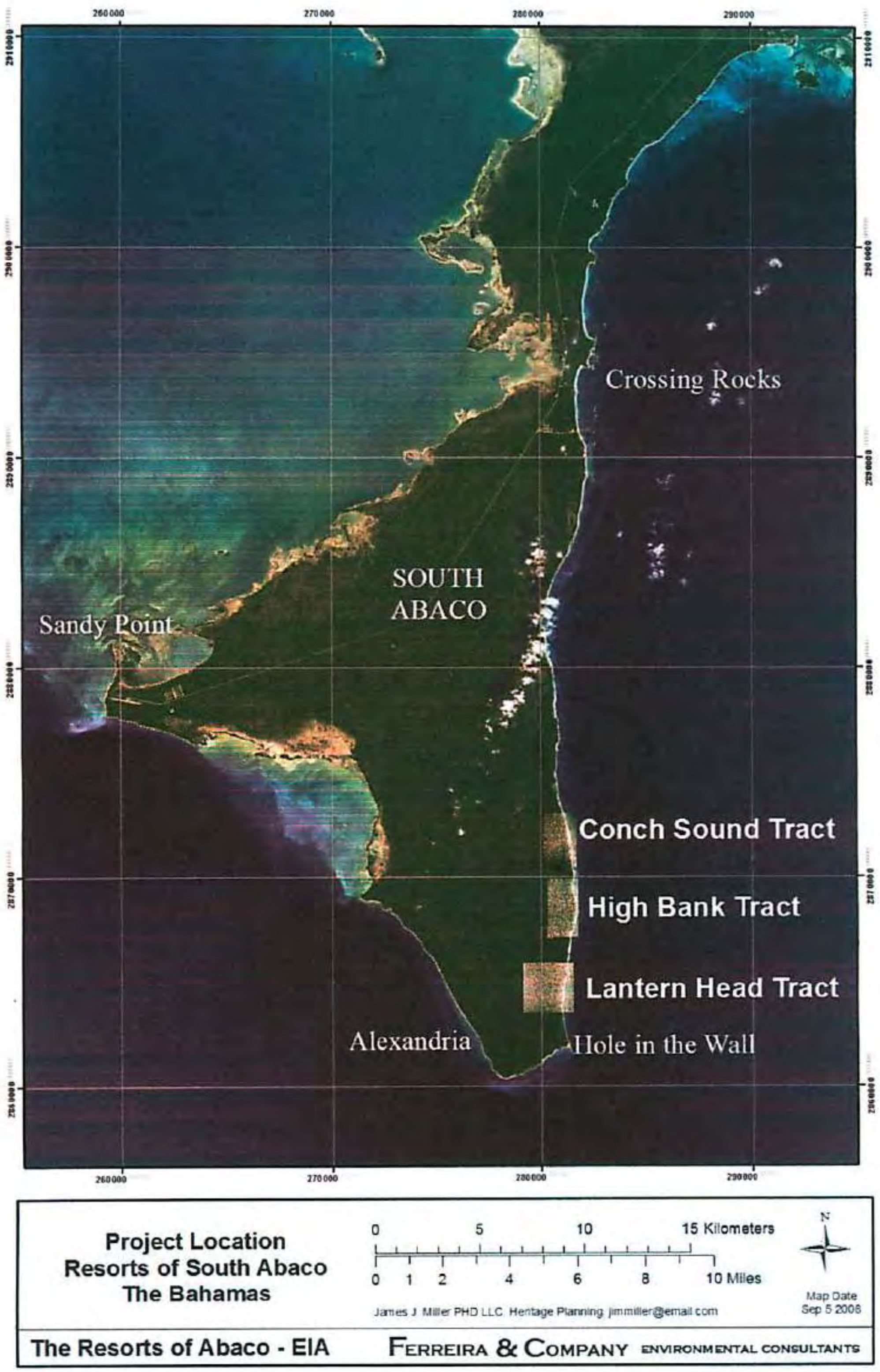


Figure 1, Location of three development tracts, South Abaco

Artifacts collected during the investigation have been transferred to AMMC for permanent curation. At the conclusion of the project, all photographs, documents, maps and other electronic and paper files will also be transferred to AMMC where they will be available to other researchers and the public in the future.

SUMMARY OF RESULTS AND RECOMMENDATIONS

South Abaco's past has become dim over the decades. We found no previous historical studies of the region, and precious few archival records that document what happened there before the region was abandoned. Through a combination of documentary research, study of building ruins and survey of walls and landscape features it has been possible to reconstruct the elements of south Abaco history. We now have a basic understanding of who settled there, where they lived and more or less how they made a living. Grant records as well as birth and death registers provided a rich record of individual and family names, as well as some insights into social organization, health and business. Study of buildings, wells, field walls, property boundaries, platted and visible roads, and other extant features revealed the complex natural and cultural landscape of nineteenth century south Abaco in some detail. With this research, we now have a historic context in which to place the ruins and settlements, and the picture that emerges is of a unique and well preserved complex of heritage resources that, when considered as a whole, is of great significance.

Lantern Head Recommendations

Ruins at Lantern Head include a stone wall enclosure of approximately one acre containing ruins of three structures and a well. The enclosure has openings for gates in the east wall toward the shoreline and the west wall toward the interior of the island. Cut building stones of large size are divided in two piles—one outside the enclosure near the back gate and one inside near the cistern. It is likely that a road ran north-south along the outside of the enclosure on the west side, possibly connecting to a reserved right of way running east-west about 800 feet to the south. The most prominent natural feature at Lantern Head, and the primary factor in the siting of the settlement, is the Lantern Head promontory with its striking profile, high elevation and protected shoreline.

All the features of historical significance at Lantern Head are on Crown Land. As heritage resources in public ownership, these already have the advantage of protection that legal title provides, and should not be conveyed. A recommended conservation area, within which no modification by development should occur is bounded on the west by the modern private property line, on the north by the recent east-west bulldozer cut, on the east by the sea, and on the south by a line 500 feet south of the north boundary.

Public access to the ruins and the preservation area is appropriate in the future, and the historic complex may form an attractive amenity for the community. In all planning and development maps, the preservation area should be marked "Heritage Preservation Area, Off Limits." Prior to onset of land clearing or any other element of construction, a chain link fence should be installed around the area and conspicuously marked "Heritage Preservation Area, Off Limits" with signs at corners and every 200 feet. The east side of the fence should be landward of the beach and shoreline.

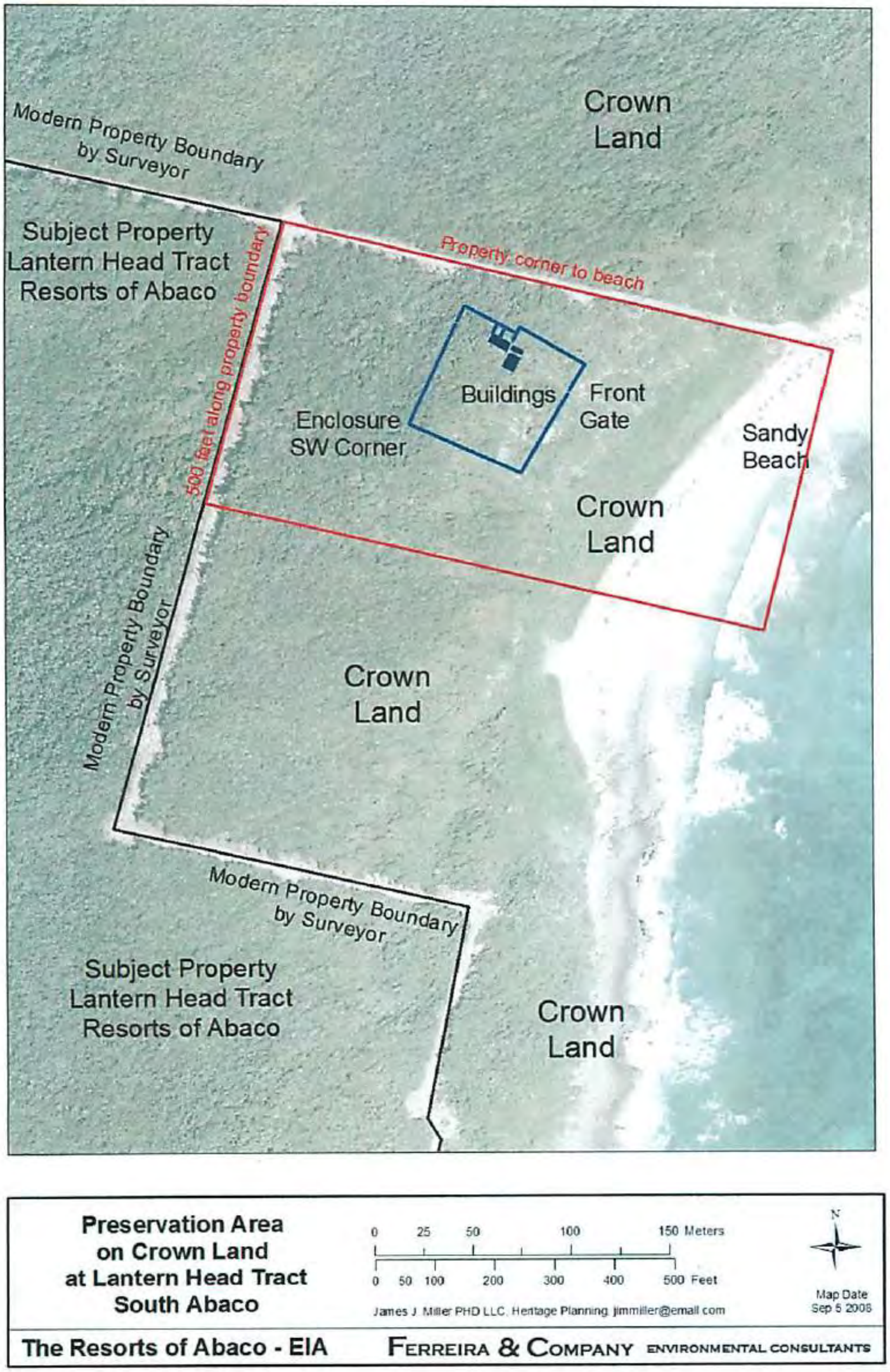


Figure 2, Preservation Area on Crown Land at Lantern Head Tract

As part of the development plan, engage a heritage planner acceptable to AMMC to create a plan for stabilization and interpretation. Preparing the site for public access will involve removing all artifacts from the site, recording their locations and sending them to AMMC for curation. If interpretive exhibits are planned that include artifacts, they can be borrowed from AMMC on a long-term loan basis for that purpose. A historic architect should identify building components warranting stabilization for preservation purposes as well as public safety reasons. This work should be completed by a restoration mason acceptable to AMMC. Dangerous conditions such as unstable field walls, open pits like the cisterns and the well, and other hazards should be identified and addressed in the heritage plan to ensure public safety. Interpretive facilities should be planned and installed, including outdoor signage explaining the history of the property and rules for public access. Additional interpretive products like a brochure or web site are optional.

The final heritage plan should be submitted to AMMC for approval and their recommendations incorporated before implementation.

High Bank Recommendations

The settlement known as Barque Bay at the southeast corner of the High Bank tract is more complex than the ruins at Lantern Head. Historically, the ruins were situated on a number of square lots approximately 100 feet on a side as well as on one or possibly two large grants. Today, the ownership of heritage resources includes Crown Land for the southern part of the complex and the subject High Bank Tract for the northern part. On Crown Land are found Lots 3 through 12 of the platted settlement of Barque Bay as well as most of the stone wall enclosure that surrounded the entire community. On the privately-owned High Bank Tract are included platted Lots 1 and 2, as well two complexes of larger structures we have termed Building Group A and Building Group B.

Those heritage resources on Crown Land already enjoy the full protection afforded by public ownership and should not be conveyed. A preservation area is recommended that measures 900 feet east-west by 1100 feet north-south. The northwest corner of the preservation area should be located 500 feet north of the High Bank Tract south property boundary and 500 feet west of the High Bank Tract east property boundary. In this configuration, that portion of the preservation area on the subject development property is a square 500 feet on a side, and incorporates all known resources as well as a buffer approximately 100 feet beyond them. That portion of the preservation area on Crown Land includes all known resources as well as the adjacent stretch of sandy beach that was no doubt an integral part of the historic settlement. Those components on the development tract should be the subject of a dedicated and recorded conservation easement that will run with the land for all subsequent owners.

Public access to the ruins and the conservation area is appropriate in the future, and the historic complex may form an attractive amenity for the community. In all planning and development maps, the preservation area should be marked "Heritage Preservation Area,

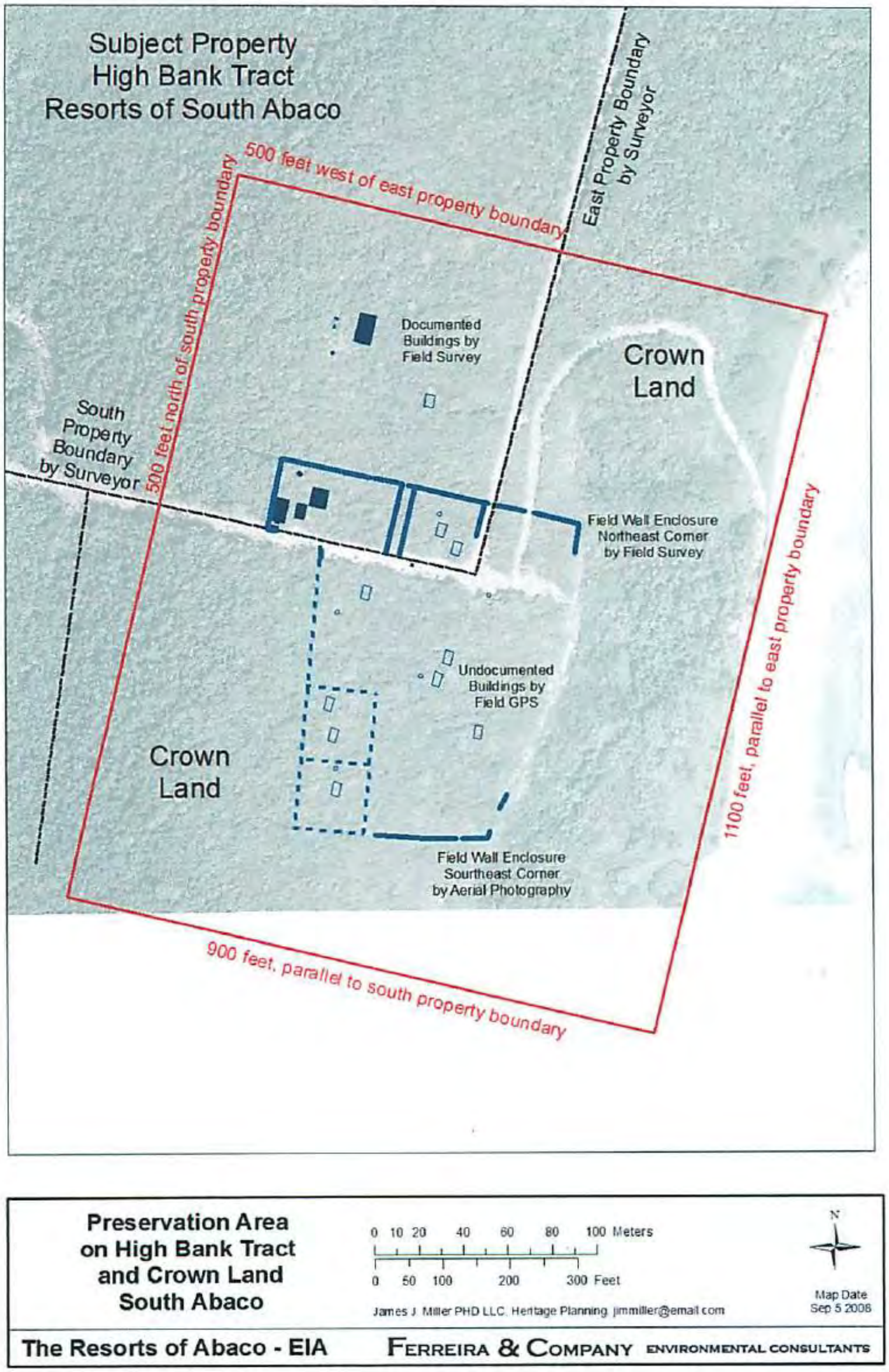


Figure 3, Preservation Area on High Bank Tract and Crown Land

Off Limits." Prior to onset of land clearing or any other element of construction, a chain link fence should be installed on three sides of the preservation area, including that portion on Crown Lands. The fence should be conspicuously marked "Heritage Preservation Area, Off Limits" with signs at each corner and every 200 feet. The east side of the fence should be landward of the beach and shoreline.

As part of the development plan, engage a heritage planner acceptable to AMMC to create a plan for stabilization and interpretation of resources on the development tract and on Crown Land. Preparing the site for public access will involve removing all artifacts from the site, recording their locations and sending them to AMMC for curation. If interpretive exhibits are planned that include artifacts, they can be returned on a long-term loan basis. A historic architect should identify building components warranting stabilization for preservation as well as public safety reasons. This work should be completed by a restoration mason acceptable to AMMC. Dangerous conditions such as unstable field walls, open pits like cisterns and wells, and other hazards should be identified and addressed in the heritage plan to ensure public safety. Interpretive facilities should be planned and installed, including access points, a trail system and outdoor signage explaining the history of the property and rules for public access. Additional interpretive products like a brochure or web site are optional.

The final heritage plan should be submitted to AMMC for approval and their recommendations incorporated before implementation. Maintenance of heritage resources, as well as natural resources, has continuing costs, and consideration should be given to the establishment of a preservation trust. A property transfer tax that will involve resales as well as initial sales has been shown to be an effective funding mechanism for such long-term conservation efforts.

See the section Management Recommendations at the end of this report for further details.

THE ABANDONED SETTLEMENTS OF SOUTH ABACO: HISTORIC BACKGROUND

Early Settlement

Although part granted to the Loyalist Lt. Col. Thomas Brown as early as 1788, there is nothing in the historic record to indicate that the southern extremity of Great Abaco saw more than transient occupation by loggers, hunters, whalers or wreckers until the mid-1830's. This lack of permanent population is well illustrated by Anthony DeMayne's survey made for the Royal Navy in 1817/1818.[1] Always a careful and reliable observer, DeMayne shows no settlement along the east coast south of Cherokee Sound. Nevertheless,

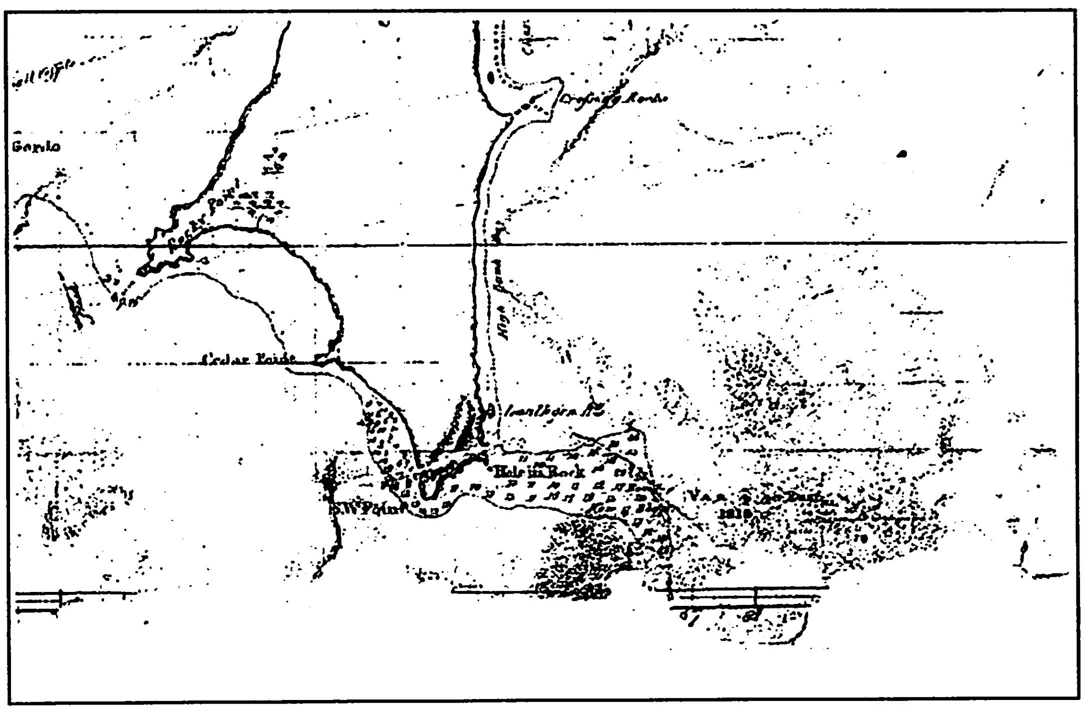


Figure 4, Detail, Survey of Abaco Island and Great Bahama.
Anthony DeMayne, 1817/1818

variants of several familiar place names are given by his chart including Hole in Rock (now Hole-in-the-Wall), Lanthorn (now Lantern) Head,[2] High Bank Bay and Crossing Rocks. These descriptive designations attest that the coast was well known to mariners of the period who must have feared its high surfs, shoals, reefs and rocks on which so many ships foundered, not to mention the wreckers who preyed upon distressed vessels at every opportunity.

An early reference to such activities concerns a sloop called *The Goodrich* which was wrecked in 1789 "*about ten miles to the northward of Hole in the Rock.*" In an advertisement published by the Bahama *Gazette*, Thomas Bowles, warned "*all persons against breaking up the wreck*" cautioning them against removing or taking away any of her spars, anchors, cables or rigging under pain of "*rigorous prosecution.*"[3]

No information is given about the fate of the crew, but a later notice dated November 18, 1826 reports how the brig *Thomas* of Liverpool, William Pyke master, bound for Havana was "*totally wrecked*" near the same place. The master and an unspecified number of crew members reached shore "*where they remained some days*" before finding settlements to the north (presumably Cherokee Sound) from where they were transported to Nassau. How many of the crew were saved is not clear, an attempt to take them off by the brig *Somerset* of Wilmington proving abortive. Numerous similar incidents (such as the loss of the American brig *Russell,* Barstow master,[4] sailing from New York to Mobile) led to calls for installation of a navigational light marking the entrance to the Northwest Providence Channel, a heavily used sea lane giving access from the Atlantic Ocean to Nassau, Havana and other Carribean ports beyond.

In 1824 for instance, the United States approached colonial authorities with a proposal to purchase land at Hole-in-the-Wall with the object of erecting a lighthouse, but this request was refused on the grounds that it infringed British sovereignty and could impose a threat to Bahamian security. Nevertheless, the need for navigational lights in the Abacos remained obvious and construction of the present lighthouse at Hole-in-the-Wall was approved some time before 20 April, 1836 when the *Royal Gazette* reported work to be in "*great fowardness*" . . . . "*Captain Walpole of the Royal Engineers*" having safely landed "*the remainder of its splendid apparatus.*"

Figure 5, Hole-in-the-Wall Lighthouse, completed 1836

Constructed of imported, pre-cut stone blocks, the present structure is about 85 feet (25.9 m) high and stands at an elevation of approximately 124 feet above a rocky promontory which must have presented nearly insuperable difficulties to the builders as they tried to land heavy equipment and massive amounts of construction material when heavy seas were running.[5] To alleviate this situation, it appears that a staging area was developed several miles to the west, on Great Abaco's opposite shore where the coast was somewhat sheltered from prevailing winds by high ground known as Fishers Hill. The anchorage here could never have been very safe but was probably more accessible and safer than any other, coasts north of the light being dominated by high limestone cliffs with few beaches, jagged rocks occurring to the west.

Access to the new landing involved cutting a road westwards from the lighthouse site through dense coppice. The following notice for tenders was published in the *Royal Gazette* for 17 February, 1836:

> *Royal Engineers Office Nassau*
> *Tenders will be received at this office on Saturday 20th instant for making a road on the island of Abaco, a distance of from 2 1/2 to 2 miles at per 100 yards, the road to be made of materials to be procured on the spot and not less than 12' wide. The line of the road is already marked, and about 1 1/2 miles cut through the bush. For any further information enquire at this office.*
> *Stanley Hornby*
> *Lt. Royal Artillery*
> *Commanding Royal Engineers.*

While the exact route is not specified, there can be no doubt that, given its name and length, the road in question was the present Soldier Road linking Hole-in-the-Wall with the now abandoned township called Alexandria, which was probably the first of several similar settlements established in the vicinity. Others included one at Barque Bay north of Lantern Head, another further north at Crossing Rocks and a fourth located on the west coast south of Sandy Point known as Cross Harbour.[6] All four settlements are (or were before being depopulated sometime near the beginning of the 20th century) distinguished by relatively small lots arranged in grid patterns, these being regular at Crossing Rocks and Barque Bay, and less so at Alexandria and Cross Harbour.

Soldier Road is intersected about halfway along by another track called William's New Road on late nineteenth century maps. This cut across country in a northeasterly direction toward Lantern Head (a prominent landmark rising about 74 feet above the Atlantic) and terminated at the edge of a property owned during the 1870's by the Hon. Thomas Williams who presumably was responsible for its installation.

Except for logging roads, no other permanent tracks linking the southernmost part of Great Abaco with settlements to the north, such as Sandy Point and Cherokee Sound, seem to have existed before the second quarter of the twentieth century. The abandoned settlements were probably linked for the most part by pathways along the coast. A reference map from the Department of Lands and Surveys, Nassau (date uncertain) shows what is called a *"shore traverse from Sandy Point"* terminating at the western extremity of Soldier Road.[6]

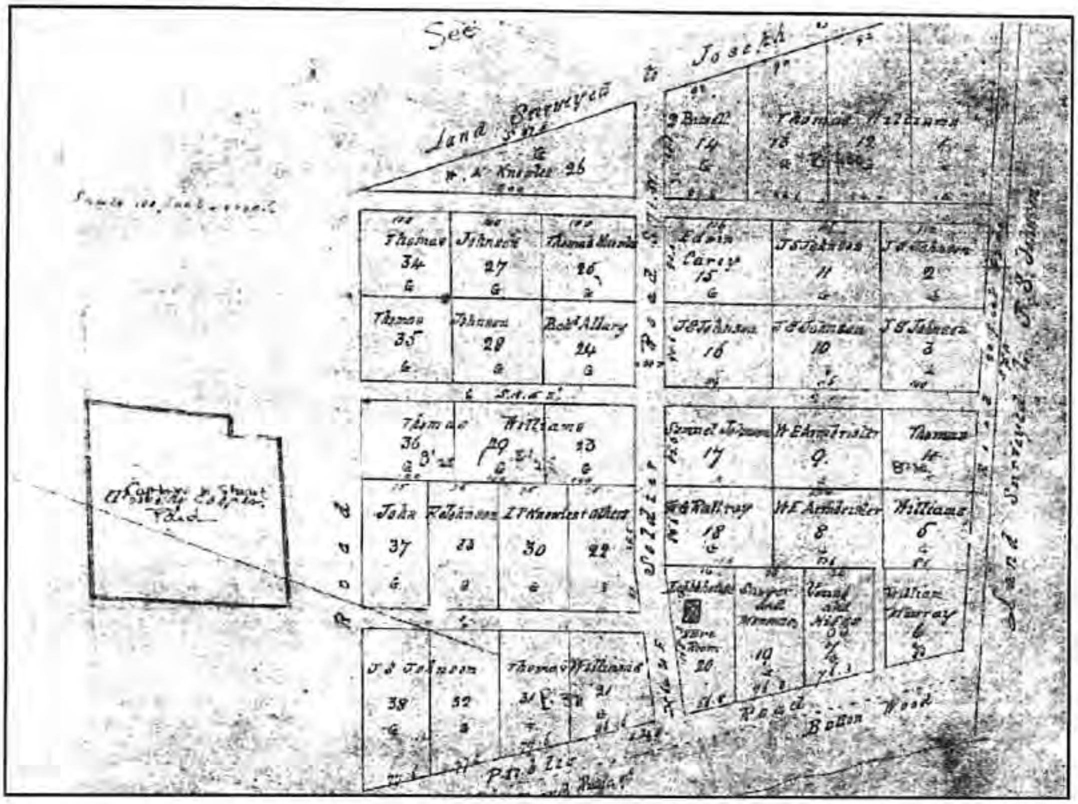


Figure 6, Alexandria Township, plot plan of 1880,
Department of Lands and Surveys, Nassau

The same map indicates that lands bordering the sea extending southeast of Hole-in-the-Wall were *"all cultivated by squatters"* when applied for by (L?) H. Knowles in May, 1873.[7] *"Cultivated white lands"* are also shown in the vicinity of High Bank Bay in the 1870's.

Who exactly these squatters and cultivators were remains to be determined. Nor is it known if they were related to or otherwise connected with occupants of the settlements under discussion. However building techniques (notably the use of wattle and daub walling) and ship drawings seen at Alexandria and Barque Bay are of a kind often associated with slaves and the descendants of slaves, suggesting that the population here was, like the population at Sandy Point near the opening of the 20th century, mostly of African descent, though perhaps not exclusively so since the names of several prominent white landowners are attached to lots granted in Alexandria.[8] Whatever the case, settlements at Barque Bay, Alexandria and Crossing Rocks probably reached their fullest development over the last quarter of the nineteenth century at a time when local owners entered into large scale cultivation of pineapples and sisal.

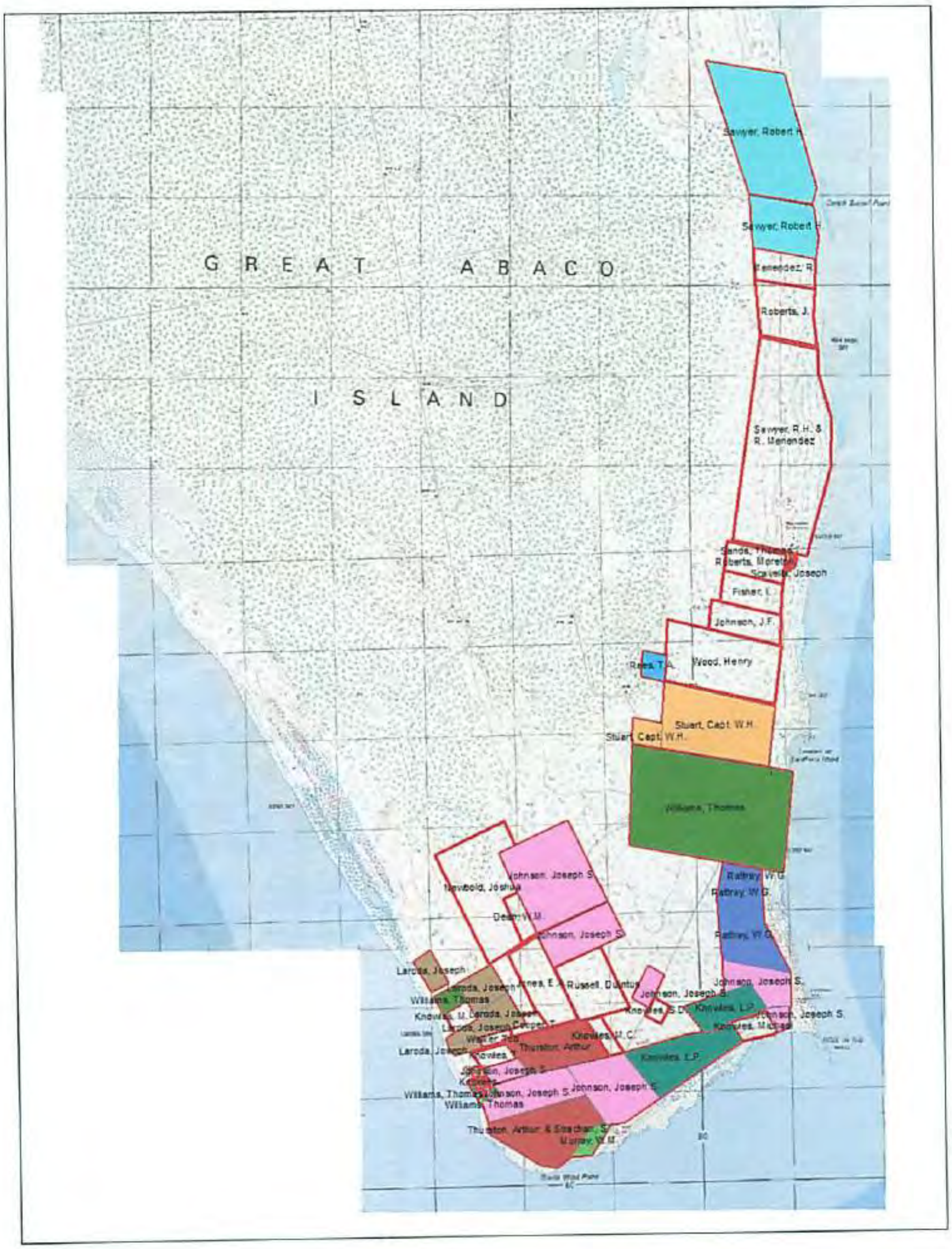
Grants

The most informative historical documentation about the settlement of south Abaco is in the form of grants, index maps and indexes. Although there is no information in the grant records about whether individual grants were actually occupied, or whether, as was quite common, they were never settled, the regional pattern is very revealing. For example, the time period that grants were issued, beginning in about the early 1870s, suggests there was not an extensive prior occupation. Squatters and other less permanent residents were present, but through the grant records we can fix a beginning date for serious private ownership and investment. Moreover, the timing of the grants implies a historical and economic context for The Bahamas that is well known from other areas. Pineapple cultivation was an important economic activity at this time, but sisal would not appear for another generation.

Although the record is somewhat incomplete, plats and indexes account for 40 large tract grants ranging in size from 10 to 500 acres in south Abaco, mostly issued during the last quarter of the nineteenth century. These account for 3,783 acres total, and take up all of the coastal ridge from Conch Sound to Hole-in-the-Wall to Alexandria and northward. The only area not of interest, apparently, is some of the interior pine barren. There are some 40 different grantees, although a few names may be variants of the same person, such as William Murray and W.M. Murray or Thomas Knowles and T. Knowles. Grants also represent conveyance of platted lots to individuals, and we have information on 38 lots granted at Alexandria and Barque Bay. Many grantees applied for and received multiple tracts, and a common pattern is for an active grantee to receive several large tracts and a few lots in the nearby settlement. Individual grants with grantees, acreage and type (tract or lot) are listed in Appendix I.

The most active grantee, by far, is Joseph S. Johnson, a commercial grower who was granted eight separate tracts totaling 602 acres plus three town lots in Alexandria. Thomas Williams, after whom Williams Road was named, was granted two large tracts totaling 465 acres and four Alexandria lots. Joseph Laroda received 88 acres in five tracts but apparently did not live in Alexandria or Barque Bay, as he had no town lot. Nor is the last name Laroda represented in the available birth and death registers. Capt. W.H. Stuart, who was probably connected with the Imperial Lighthouse Service, was granted 210 acres just west of the Lantern Head ruins; in total he had 300 acres in three tracts and two lots in Alexandria. A few other landowners owned land in similar pattern and quantity. In contrast to Alexandria, lots in the settlement at Barque Bay were mostly granted to persons who did not receive large tracts. The exception is Thomas A. Rees who received Lot 5 at Barque Bay as well as a nearby tract of 20 acres.

Available grant information is mapped in Figure 7 where holdings of certain grantees are color-coded to show patterns of ownership. Table 1 lists grantees with multiple tracts in south Abaco.



Patterns of Grant and Lot Ownership South Abaco

0 0.5 1 2 3 Kilometers

0 0.5 1 2 Miles

James J. Miller PHD LLC Heritage Planning jimmiller@email.com

Map Date May 19 2008

The Resorts of Abaco - EIA FERREIRA & COMPANY ENVIRONMENTAL CONSULTANTS

Figure 7, Patterns of grant and lot ownership, South Abaco

NAME	TOTAL GRANTS	# TRACTS	# LOTS	TOTAL ACRES
Johnson, Joseph S.	11	8	3 AL	602
Williams, Thomas	6	2	4 AL	465
Laroda, Joseph	5	5		88
Rattray, W.G.	4	3	1 AL	142
Sawyer, Robert H. incl. 1 w/ RM	3	2	1 AL	300
Stuart, Capt. W.H.	3	2	1 AL	230
Knowles, L.P.	2	2		196
Sands, Thomas	2		2 BB	

Table 1, Grantees with multiple properties, South Abaco

The People of South Abaco

Although south Abaco was well settled in the late nineteenth century, all indications are that it was abandoned more than a century ago. Its history has faded from local and family memory, although some of the people who lived and worked here are known by name from a few official records and archival documents. Published references to south Abaco are sparse, and we are not aware of personal accounts like letters, journals, diaries, or traveler's descriptions pertaining to the region, although some may exist. Perhaps someone who reads this study will be able to contribute such valuable material to the meager historical record that is now available to researchers.

As it is now, we can only describe the broad outlines of what happened in south Abaco in the past, based largely on land records, birth and death registers, and the physical remains of buildings and settlements. Our discussion is limited to the few patterns and inferences that we can glean from the historical data. It is possible to offer some observations on family names and social relations, and on births and deaths. We can identify common occupations, and make some general statements about infant mortality, life expectancy and common causes of death. We can only hope that this framework, and the historical record that has been assembled, will be a beginning for a more personal and human account of the people who inhabited this beautiful region.

Family Names

Two documents were used to identify individuals by name. We did not use land records for this purpose, as many grantees were absentee, as indicated by their absence from the birth and death registers. The first source of family names is the Alexandria Township Register of Births. These cover the period 1866-1901 only (Appendix II). Registers for prior or later years, if any, were not found. The Birth Register lists date of birth, name of newborn, father's full name and occupation and mother's full name. The second source is the Alexandria Township Register of Deaths, covering only the period 1875-1926 (Appendix III). The death register records full name, occupation, age at death and cause of death. By combining data from these sources and eliminating duplicate entries for the same person, a list of 280 instances of family name was compiled. Newborns, who would have the same last name as the father, were not included. There are probably a few duplicates remaining, as names with initials only were included, even when the initials matched a known first name.

Davis is the most common name on the list, accounting for 12.5% or one in every eight persons. Swain is the second most common family name, at 7.5% (21 of 280 people) followed by Mitchell at 6.4% (18 people) and Johnson at 4.3% (12 people). Willmore and Carey are equally represented at 4% (11 people) and Williams, Stuart and Sands all account for 3.6% (10 people). Sims, Green, McBride, Smith, Dames and Brown account for the rest of the names with more than 2% representation. These dozen names represent nearly 58%, far more than half, of the total list.

Comparing this group of names, who are no doubt residents of the township, with the list of grantees (Appendix I) is revealing. No person with the three most common last names, Davis, Swain and Mitchell, were granted land. Johnsons are well represented as lot owners at Alexandria (John, Samuel and Thomas) and Barque Bay (London or Loudon), although the largest landowner, Joseph S. Johnson, does not appear in birth or death records. None of the Willmores, Williams, Stuarts, Sands, Sims, Greens or McBrides on the birth and death registers received grants. Edwin Carey owned a lot in Alexandria. The pattern suggests that those families most represented in official records of births and deaths are not owners of large tracts of land, although they are among the owners of lots in Alexandria and Barque Bay.

Occupations

Occupation is recorded on the death register for all persons as well as for fathers on the birth register. A compilation of records included 135 persons, with a few possible duplicates due to initials. Farmers and planters are the two most common occupations, not surprisingly, but it was unclear from the list how these differed. In fact, they may be duplicate terms for the same occupation, reflecting a change in classification or usage. On the birth register there are 52 planters and four farmers. All farmers are recorded in the year 1888, suggesting perhaps the personal preference of the recorder, and the beginning of a shift in usage. On the death register, all agriculturalists prior to 1898 are planters, and after 1898 there are 14 farmers and two planters. For simplicity, the terms are combined here. For all persons whose occupation is recorded, 72% are planters and farmers. Seamen account for nearly one in six persons, 15.6%. Twelve birth records listed sponger as father's occupation, all in either 1886 or 1888, perhaps reflecting the boom/bust cycle of that industry. Joseph Willmore/Wilmore, husband of Henrietta Rolle, is listed as a sponger in March of 1888 and a planter in September of the same year. Two women had the occupation washer woman, according to the death register. Ship's carpenter, shop carpenter and printer's apprentice are represented by one person each. Obviously, the economy of south Abaco is largely agricultural in the period of record, and this is consistent with what we know about the pineapple and sisal operations mentioned in other historical sources. The occupation listings indicate that women as well as men were farmers and planters. Of the 26 women whose occupation is recorded, 24 were farmers and planters. The high proportion of persons employed as seaman is interesting. Whether this is typical of the time or reflects Alexandria's function as a port is not clear. This occupation as well as sponging are characterized by absence of the male family member for long periods.

Demography

Birth and death registers can be important tools for historical demography, but they are most reliable for large populations. The sample for Alexandria is small, and its completeness is not certain. It is not considered adequate for statistical analysis, but the data can be mined for some patterns that may warrant further study.

Without knowing the actual population size, it is not possible to determine the birth rate, but the birth register is helpful in indicating how many children were born to the same parents or parent. For the period 1866 to 1901, almost two generations, 46 men are listed as father of only one child. Sixteen fathers registered two children, but for four of these fathers one child was stillborn, and one man is listed as fathering three children. Two fathers registered four children, but in both cases two of the children were stillborn. As would be expected, the pattern for women listed as mothers is essentially identical. There is a high degree of variation in recording of mothers' names, as well as fathers' names, but there are relatively few cases of outside children. The birth register suggests that families were long-lasting though small owing to relatively small number of births as well as high infant mortality.

Age at death, as recorded in the death register, can indicate two key factors of public health: infant mortality and life expectancy. The number of people for whom age at death is recorded is 166, and the time period is 1875 to 1911. The following bar chart shows percentage of deaths by age with stillbirths included in the age category 1. Out of 166 recorded deaths, 17 were stillbirths and 44 more infants died before the second birthday. Fully half of the sample died at age five years or earlier. After early childhood, the survival rate improves rapidly with 20% of the people living beyond age 50. For those who survived into the sixth year, the average life expectancy was 42 years. Several individuals lived into their eighties and nineties. It should be noted that high infant mortality and average life expectancy in the 40s are not unusual for pre-industrial societies.

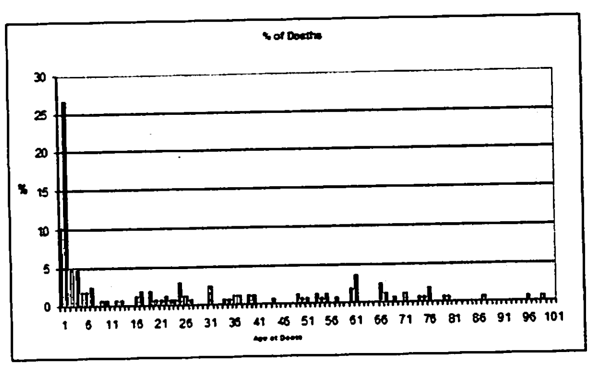


Figure 8, Percentage of deaths by age,
Death Register, Alexandria Township, 1875-1911

Cause of Death

The classification of cause of death recorded in the Death Register is very much a product of its time and place. During the period of record, 1875-1926, there was probably little access to medical care or medical opinion as to cause of death by trained professionals. Terminology is general and outdated. The most frequent cause is fever, recorded as causing more than one-fifth of all deaths, but we have no way of knowing the specific disease for which fever is a symptom. Consumption, now known as tuberculosis, is nearly as common, accounting for 19.6% of the total. The categories born sick and stillbirth add up to the same proportion, reflecting again the high rate of infant mortality. Cough (possibly whooping cough) is the next most frequent cause of death at just under 5%. Six people drowned, including three children, two seaman and a planter. Some other causes accounting for less than two percent of deaths include bowel complaint, heart failure, locked jaw (probably tetanus), paralysis, convulsion, fits, measles and asthma. Two cases of poisoning are recorded; both were male planters, age 24. They died within one month of each other. Deaths caused by stress or trauma such as burns, falls, overstrain, hunger, and sun are infrequent, at one case each. It is clear that infectious disease was the most frequent cause of death. The following table lists causes of death suffered by more than 1% of the sample.

Cause of Death	# of People	% of People
Fever	36	21.4%
Consumption	33	19.6%
Born Sick	17	10.1%
Still Born	16	9.5%
Cough	8	4.8%
Drowned	6	3.6%
Bowel Complaint	3	1.8%
Heart Failure	3	1.8%
Locked Jaw	3	1.8%
Paralyzed	3	1.8%
Convulsion	2	1.2%
Fits	2	1.2%
Infirmities of Age	2	1.2%
Measles	2	1.2%
Poison	2	1.2%
Rupeted (ruptured?)	2	1.2%
Spasm	2	1.2%
Stoppage of Water	2	1.2%

Table 2, Most frequent causes of death
Death Register, Alexandria Township, 1875-1911 (spelling corrected)

Agriculture in South Abaco 1845-1905

Pineapple Cultivation
Pineapple shipments from Eleuthera and Abaco to England are first recorded in 1844 when 15,000 dozen rooted plants earned for local growers one and one half dollars per dozen. Long a symbol of hospitality and luxury in Britain where they had been grown in hothouses and "stoves" since the mid-seventeenth century, pineapples found a ready market, the *Illustrated London News* for August 6, 1853 reporting that Messrs. John Adam and Company held annual sales of "*this luxuriant fruit*" at their premises in the City, explaining how "*the fastest sailing fruit schooners, of about 120 tons burden are fitted in a very superior manner, by which means both the beauty and the condition of the fruit are well preserved.*"[9] Markets were also established in the United States, these being mostly supplied with cut fruit selling at "*five eights of a dollar.*"

In a letter dated March 29, 1856, Thomas Chapman, Chief Engineer and Assistant Surveyor General of the Bahamas, noted:

> *The raising of pineapples is entered into with much spirit. It is a commonly received opinion that this fruit can only be profitably raised on a peculiar kind of soil, i.e. a red clayey loam, to which they give the name of pineapple land, but experience has proved at Abaco that this is one of . . . many mistaken notions. They have raised the Spanish pines, the Matanzas and the Baraco in all kinds of soil, and even cracks in the rocks, where sufficient depth of earth has accumulated. The Baraco is found to be the most profitable variety, producing a very large firm pine of good flavour, that keeps longer than any other, and is sold a shilling dearer than any other sort.*[10]

The method of planting described had been developed in the Bahamas through long experience, Daniel McKinnen visiting a "*pinery*" west of Nassau, New Providence as early as 1803 observing "*the plants were irregularly scattered among the rocks (which everywhere appear on the surface, and appeared to be in a thriving condition, although very little attention is bestowed on them.*"[11] This was doubtless the method used by growers on south Abaco who begun acquiring extensive tracts of previously undeveloped crown land located north east and west of Hole-in-the-Wall during the early1870's.

According to a report published by the Nassau *Guardian* on 13 May, 1871, the Hon. Thomas Williams, a member of the Legislative Council (who had been granted 445 acres at Lantern Head) then had ten acres there "*under cultivation in pineapples.*"[12] The same report states: "*20 more [acres] will be laid out in same. It is estimated that by the end of next year [1871] he will have under cultivation 50,000 dozen pineapples.*"

Just over one month later, it was observed: "*The hundred acres of land in the southern portion of Abaco recently laid out in sugarloaf and scarlet pineapples are looking quite verdant.*"[13] The same report attests that, in addition to Thomas Williams at Lantern Head, other local landowners were growing pineapples. At High Bank Bay, these included Sawyer & Menendez (who had been granted 500 acres there on 8 August, 1870) and J.

Figure 9, Sugarloaf pine, Sydenham Edwards, Published by Curtis 1823, Brooker collection

Figure 10, South Abaco land grants, "Old Survey," Department of Lands and Surveys. Nassau

Roberts. Immediately east and south east of Alexandria at Fisher's Hill, growers mentioned are M.C. Knowles (who owned 20 acres fronting Soldier Road just west of the junction with William's New Road) and Joseph S. Johnson whose extensive local holdings included acreage bordering Alexandria and the settlement at Crossing Rocks.

Like Thomas Williams, J. S. Johnson also held property in Alexandria itself, including Lots 10, 11, 23, 32 and 38. Sawyer and Menendez, had been granted a plot in Alexandria too (Lot 19) located overlooking the ocean behind the Lighthouse Store.

On 12 August , 1871, the Nassau *Guardian* further reported:

> *Messrs. M.C. Lewis and S.B. Knowles have recently planted at Fisher's Hill, Abaco 80,000 dozen pine slips. It is presumed that Messrs. T. Williams and Co; Messrs. Sawyer and Menendez and Captain J. S. Johnson have also gone into the cultivation of pineapples at the south end of Abaco so extensively, that the total planted will amount to at least 160,000 dozen this year.*

From the distribution of land holdings held by these growers, it seems that Alexandria must have played an important role in the shipping and perhaps processing of pineapples at this period. A native of Harbour Island, Eleuthera, Joseph S. Johnson was a key figure in the pineapple business opening the first cannery as early as 1857 at Governor's Harbour, Eleuthera and a far more successful one in Nassau during 1876. Craton (1962: 248) reports the company operated other factories at Harbour Island, Abaco and Rock Sound, production in Nassau reaching seventy-thousand cases at its peak. Craton (ibid) also quotes the following description of the canning process given by Lady Brassey:

> *The 'apples' as they are always call the pines here are first stripped of their leaves; then they are swiftly peeled; stalk and eyes are dextrously removed ; and the best fruit are thrown whole into coppers full of hot syrup where they are boiled ten times. They are then put singly into tins, which are afterwards hermetically sealed. Those of the second quality, are cut into slices and treated in the same manner. The third quality is cut into squares, the fourth is merely scraped; but all are cooked in syrup and are packed in tins decorated with attractive pictures.*

If fruit was processed in similar fashion at Alexandria and the other south Abaco settlements or alternatively shipped whole to overseas consumers (as often the case with pineapples grown on the so-called Out Islands) is not yet known. Unfortunately, Volume I of J. S. Johnson's business records which might supply the answer is missing from the Department of Archives, Nassau. It is probable that financial returns were relatively modest at first, 500 dozen pineapples exported from Abaco to Jacksonville, Florida in July1871 being valued at £32. 0. 0.[14]

Bahamian productivity improved rapidly over the next two decades, fruit exported from the colony in 1892 being valued at nearly £60,000. Production peaked in 1900 when 7,233,012 dozen pineapples were exported. But, this vast output both glutted and depressed overseas markets, prices falling from an average of 1s. 8 1/2d per dozen in1892 to 2d per dozen eight years later (Craton, 1962:248). What effect such price falls may have had on farmers at the southern end of Abaco, cannot be said. On Cat Island, the Resident Justice reported that:

> *Although the export is large there is no visible benefit among the small proprietors and the labouring classes who, here, as on some of the other Out Islands neglect other and necessary Agricultural pursuits - The consequence is that ground produce is very scarce, and should any unforseen circumstances arise to retard the growth of pine-apple crops in the fields, the usual method of bartering of the fruit of the coming season will have to be entirely adopted . . . .*[15]

Sisal Cultivation

To offset the slump in pineapple prices (made worse by the imposition of American tariffs in 1898) south Abaco's larger landowners switched to the cultivation of sisal some time before or just after 1900 when the Spanish American war drove up prices for the commodity to a previously unheard of figure of £38 per ton. Derived from the so-called century plant (*Agave sisalana)*, sisal required little intensive cultivation once established, the species thriving (like pineapple) in hot, dry and rocky situations. A contemporary observer wrote:

> *Unhurt by storm or calm, rain or drought, these plants offer the perennial harvest in return for less labour, and, in comparison with the value of the crop, far less outlay than any other product of the soil.*

Harvesting involved cutting the plant's succulent leaves (each plant producing about thirty per year) which, when crushed between rollers and scraped, yielded fibers used for making rope and floor coverings. Native to the Yucatan, sisal was grown extensively elsewhere in the Bahamas, the crops total export value gradually increasing from £40,140 to £42,057 between 1906 and 1910.

Figure 11, Land grants in vicinity of Hole-in-the-Wall showing property of J.S. Johnson west of Lighthouse, Department of Lands and Surveys, Nassau

Daybooks of J. S Johnson and Co. show that the latter established mechanized facilities for processing of sisal at "Hole-in-the-Wall" before 1905.[16] The exact location of this facility is open to question since no ruins or standing buildings which might have housed such activity have been reported in the vicinity of the present lighthouse.[18] But, several land grants to J. S. Johnson are recorded near the latter site, one relatively small holding of triangular shape incorporating twelve acres bordering Lighthouse property on its western side being a likely place for a mill, since an anchorage (albeit an insecure one) exists here just off shore.[17] J.S. Johnson also held several lots in Alexandria which may mean that his company's commercial interests in south Abaco were more varied than extant records suggest.

Figure 12, View of Hole-in-the-Wall and entrance to Northwest Providence Channel looking south, showing (right) land formerly owned by J.S. Johnson and sisal plants (middle right)

Elsewhere documentary evidence is wanting but plants still growing around the ruins at Lantern Head, along the nearby foreshore and in the vicinity of Barque Bay indicate that sisal planting was widespread though no local grower seems to have handled or planted as much as J. S. Johnson and Company. The latter used a boat named the *Pleides* (apparently based in Nassau) to service their operations, this vessel picking up 17, 172 lbs. of sisal from Hole-in-the-Wall on December 30, 1905. The company also entered into commercial relationships with John Bethel who, besides owning twenty acres at High Bank Bay, owned another one hundred twenty acres located north of Crossing Rocks. Accounts show Johnson and Co. bought hemp from Bethel worth £5-10-0 in September 1904, the *Pleides* picking up a further 855lbs. of sisal from him at 2 1/2 d on June 22, 1905 for which they charged commission of 5%.

It is not certain if Sawyer and Menendez had their own processing facilities at High Bank Bay and arranged their own shipping although the likelihood is strong since they are mentioned in the Johnson accounts only as purveyors of sundries and supplies.

Figure 13, Stand of sisal on dune at Lantern Head

The scale of Johnson's south Abaco operation is vividly attested by a document dated May 18, 1895 by which the company leased 10,000 acres of Crown Land located between Crossing Rocks and the north of Lantern Head. But, for unknown reasons this lease, according to a notation on the original, was cancelled by order of "*H.E. the Governor*" on 10.3.1899.

Nevertheless, there are indications that the facility at Hole-in-the-Wall was either repaired or enlarged in October 1905, when various building materials having a total value of £144-11-4d were shipped to the site (9 sheets iron, stanner, oakum, pitch, 1 level, rope 151 feet). Another shipment sent by the *Pleides* during the same month included a caulking iron, 2 gallons of paint, 201 ft. 1" x 10" timber, 20 sheets corrugated iron and 8 lbs. of nails. The *Pleides* also brought two mules for use of J. Roberts (at High Bank Bay) and small quantities of household supplies such as bagged rice, grits, pork and sugar, presumably for the company's own employees rather than locally contracted labour.

Yet despite improvements, completed only three years before, the Hole-in-the-Wall facility was apparently closed down, or at least its account transferred on December 31, 1908. The following month (January 1909) saw the sale of machinery and fixtures and "*1 lot old lumber at Hole in Wall*" to L.P. Knowles (who owned land on Soldier Road next to one of J. S. Johnson's holdings) for £7-10-0d. On March 4, 1909 the Johnson Company also cancelled a contract for the supply of pineapples from another local owner, Samuel D. Knowles, reckoning their breach would result in damages to the tune of £5.

This sudden change in direction doubtless reflected the effect of competition from the Philippines which, thanks to an infusion of American capital after 1903, drove world prices for the commodity downwards thereby cutting into and eroding local profits. Craton remarks (1962: 251) that as a result the large Bahamian estates, many of them badly sited on unsuitable soils with an insufficient labour force, fell into bankruptcy and the mills closed.

In the case of south Abaco the effect of such closure was profound, nothing being recorded concerning Alexandria Township or its surroundings by Commissioner's Reports (which date back to 1911), a circumstance which suggests that settlements hereabouts were abandoned during the first decade of the 20th century. A similar pattern emerges elsewhere, though perhaps at a somewhat later date, the community at Cross Harbour laid out in 1902 being reported (by Arthur Lightbourne of Sandy Point) deserted save for a certain Jasper Brown and family in 1923.

At Sandy Point itself, sisal continued in production until at least 1913 when the local Commissioner noted that there were no machines *"affordable to the poor man"* to clean the crop which was sent to Nassau for sale. Rather, the inhabitants chiefly followed the sponging business, *"they earn in this way"* he wrote *"enough to keep then going.*[18] The Bahamas Timber Company founded in 1906, probably attracted some local labour to Wilson City but this operation was short lived, operations ceasing in 1916. World War I doubtless saw out migration from south Abaco. Few migrants, it seems, ever returned, abandoned settlements such as Alexandria, Barque Bay, Lantern Head and Cross Harbour slipping away from local memory as they fell into decay.

Research Strategy

Research began with a search for historical documents and other information particular to three study areas (Lantern Head, High Bank and Conch Sound), but also about the surrounding region, especially with respect to Hole-in-the-Wall Lighthouse and the associated Alexandria settlement. Copies of old and modern maps, grant plats and descriptions, aerial photographs from 1942 to the present, property surveys, settlement plats, elevation contours, satellite images, and similar documents were collected. To organize and make the most efficient use of these highly varied sources, a computerized Geographic Information System (GIS) was created for south Abaco. Each document with spatial information, e.g., plats, maps, aerials, was added to the GIS as a separate layer and georeferenced. When all layers were at a consistent scale and properly placed with respect to the same geographic coordinate system (UTM NAD 1983), it was a simple matter to turn layers on and off to compare and contrast different data sets.

The GIS was used in conjunction with a handheld Global Positioning System (GPS) unit having an accuracy of several meters, by transferring and sharing data between the field device and the GIS software. This was accomplished in several specific ways. First, once the rectified aerial photographs were incorporated in the GIS and accurately scaled and located, they were exported to the handheld GPS unit as a background layer. This meant that whenever the GPS unit displayed a location or feature, it was on top of a recent aerial photo of sufficient resolution to recognize most features on the ground. It was always easy to tell where one was and where to go by viewing the aerial photos on the GPS in the field. Second, the GPS location information, consisting of points whose coordinates and attributes were recorded on the handheld unit, were downloaded each evening to the GIS. Third, with the tracklog function of the GPS, a record was kept for each field day of where the GPS unit, and its operator, had been more or less every second. Also, capturing points as features with the GPS made it possible to transfer locations recorded in the field to the GIS, creating a new layer for each day's data. Finally, other information was maintained in the GIS and on the handheld GPS, such as historic aerials, ordinance maps and property boundaries, to aid in determining where one was on the landscape at any time, and what that area might have looked like years or decades ago.

The most accurate means of recording location, and the most complete way of recording landscape information, was by tried and true methods of measurement by tape on the ground and sketching of features in measured drawings. As the architect recorded buildings by measured drawings of facades, openings and other features, the survey team measured and drew the relationships among buildings, field walls, natural features and surveyor's reference points. Field measurements from both sources were compiled in a scaled plan that was then added to the GIS as a layer to determine the most accurate placement of each recorded feature. Finally, all field walls, structures and other historical features were plotted in the GIS as point, line and polygon features with attribute data for later analysis.

The advantages of this back-and-forth reliance on surveyor's markers, taped measurements, rectified aerials, and GPS points (listed in order of decreasing accuracy) were evident in the field as well as in the subsequent creation of accurate maps. The best location for each feature was determined by relying on a combination of data sources. For example, remote features in dense vegetation could not be easily or accurately located by taped distances to other features, although they might be visible on aerial photography or the surveyor's contour map. For features not on the study property, it was possible to take a GPS reading, but not feasible to spend the time on a measured plan. Ultimately, each feature was mapped in the GIS at least within a few meters of its actual location, and some features were placed much more precisely, probably within a few tens of centimeters. The agreement between various types of location information was often gratifying, but it was obvious that no single method of measurement and plotting would have resulted in an adequate final representation.

On the first day of the field survey we were greatly assisted by Mr. David Bethel of Marsh Harbour, who had been hired as a local informant to show us historic resources that he knew about. Mr. Bethel had explored the area thoroughly in the past, and led us to most of the structures that were later mapped and documented. His opinion that there were no additional structures north or south of Barque Bay, except at Lantern Head, was shared by another team member, Glen, who had grown up in nearby Crossing Rock and who had hunted in the area for decades.

Following the field work, and after we understood what questions needed more attention, a second phase of historical research was conducted in the Archives and the Lands and Surveys departments in Nassau for missing data. At this point, the value of the field maps became even more apparent. A quick survey of remains at Barque Bay settlement, south of our High Bank study property, suggested some sort of gridded arrangement for dwellings, along with walls, ovens, cisterns and other remains. When the GPS points for each feature were added to the GIS, a rough shape and spacing of the grid was more apparent. However, as the second phase of archival research began to produce grant information corresponding to several lots at Barque Bay, it was possible to reconstruct the grid plan and to locate it with respect to adjoining large grant boundaries. Because most grantees were named in the available records, there was also the possibility of identifying the individuals who owned and lived on each lot.

Combining the best locations for field walls and structures with the hypothetical plat of the Barque Bay settlement was initially frustrating. There was no way to fit all structures on the hypothetical lot grid, and the principal field walls, which were expected to mark historic ownership boundaries, did not line up with modern property boundaries. Finally, it was determined that there was one, and only one, placement of the gridded plat that made the documentary evidence and the field evidence agree. This revealed that the historic grant boundaries are about 100 feet north and 300 feet east of their modern, precisely surveyed location. In addition, by analysis of aerial photography, it finally became clear that the gridded lot pattern and the adjacent large grant boundaries differed in orientation by some 8 degrees. This is reflected by the difference in bearings between the north and south walls of the field wall enclosure.

Lantern Head did not present such complicated problems, but a similar iterative approach was followed to determine best location for ruins and walls from a combination of surveyor's marks, taped field maps, aerial photos, surveyor's contour map, and GPS points.

Finally, as we expanded our focus beyond the physical remains at Barque Bay and Lantern Head to reconstruct a regional historical context, the GIS was most helpful in organizing and analyzing all grant records for south Abaco. Each grant, including lots at Barque Bay and Alexandria settlements, was recorded in the GIS (as available) with grantee name, date of grant, and nominal size in acres. Analysis of more than 70 grants showed distinct patterns of ownership including distribution of multiple grants by one owner as well as grantees with one or more lots in a settlement plus one or more large grants nearby.

Small samples of artifacts were collected from the surface at Barque Bay and at Lantern Head. At both properties, it was obvious that previous visitors had picked up, moved, and removed artifacts. A probe and rake used to search and dig for artifacts were found at one building ruin, and several team members who had visited the site earlier noted the smaller quantity of artifacts visible, compared to past visits. Nonetheless, at both properties there was a large quantity of artifacts on the ground as well as placed on building ruins and walls where they would be noticed. No attempt was made to recover all artifacts, as this would have entailed a large effort in recording position, processing, cataloging, and transporting objects to Nassau. Rather, distinctive artifacts that might be assigned to useful date ranges were collected in small quantities that could be processed and photographed in the field before being sent to the AMMC curation facility in Nassau.

LANTERN HEAD PROPERTY

Lantern Head Landscape and Yard

Located approximately two miles north of Hole-in-the-Wall on the east coast of Great Abaco Island, the promontory called Lantern Head rises about seventy-two feet above the Atlantic Ocean. On its south side the headland commands a long, curving bay fringed by white sand and tall dunes. But, the beach is steep and there is little shelter here from prevailing winds, even in the lee of Lantern Head itself, a fact demonstrated by stunted vegetation extending inland from the primary dune system. Noticeable too is a near total lack of modern development. However, Lantern Head's isolation has not always been complete. The name itself (in the form of *Lanthorn Head)* appears on Anthony DeMayne's chart of Abaco Island based on surveys made in 1817 and 1818, which, given the prevalence of wrecking during the early nineteenth century perhaps adds credence to the following remarks by Grace R. Turner (2004:6):

> *Lantern Head, a wind-swept cliff at the southeastern tip of Abaco, got is name from the practice, as I was told of placing a light there to lure ships onto the rocks.*

Be this as it may, occupation is definitely attested just west of the headland by a group of ruins situated at an elevation of about 30 feet above the bay already mentioned.

Lantern Head presented a fairly simple pattern of buildings and walls to be mapped. Three structures, possibly representing a single household, had already been roughly measured by Colin Brooker (Brooker, n.d.) and the extent of the field wall enclosure was partially evident from aerial photographs. During the current project, more accurate building documentation was completed, and the field walls were mapped by tape measure, as a system and in relation to the buildings.

The Lantern Head tract is made up of property originally included in three Crown Grants. The entire grant of 445 acres to Thomas Williams (Grant Book B-9) is the south two thirds of the tract, more or less. Williams' grant is traversed by a diagonal road, called Williams Road on early maps, that connected with Soldier Road to the south (running between Alexandria and the Lighthouse). The north boundary of Williams grant is bordered by a road reservation 20 feet wide, and this may have afforded access to the settlement in historic times. The northern part of the Lantern Head tract includes a grant of twenty acres to W.H. Stuart on the west edge, and part of the larger grant of 210 acres to W.H. Stuart for the remainder of the tract. The ruins of Lantern Head are located near the northeast corner of the Lantern Head property, but they are situated on vacant Crown Land, not on private property. The configuration of historic grants and ownership, and the setting of the Lantern Head ruins outside the northeast corner of the Lantern Head property is shown in Figure 14.

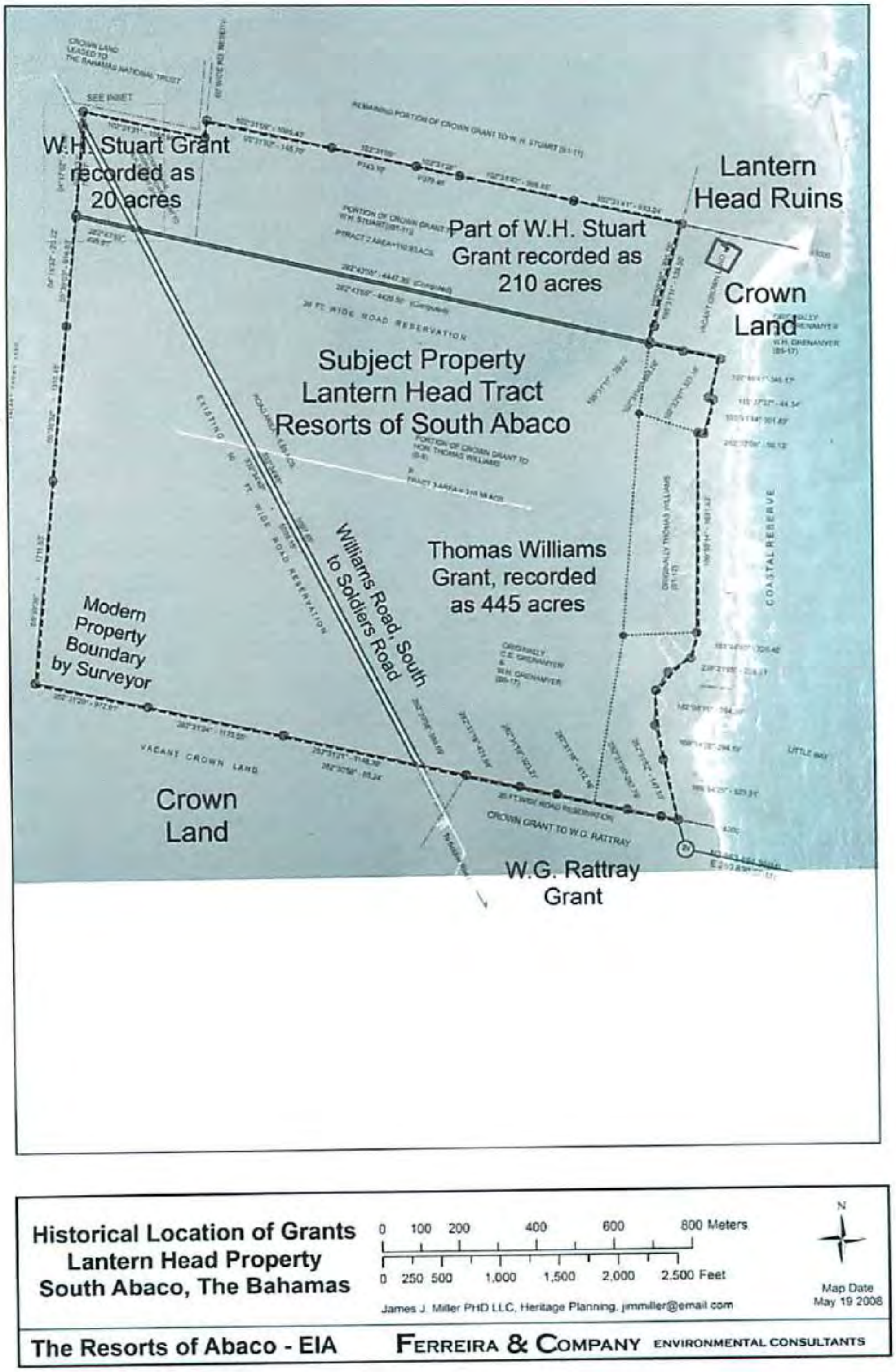


Figure 14, Historical location of grants at Lantern Head

The Lantern Head ruins are situated adjacent to a well-protected cove and a sandy beach, uncommon for the south Abaco Atlantic shoreline. The small bay is protected by Lantern Head, or Lanthorn Head as it was previously known, a rocky and rugged promontory representing a remnant of a former lithified beach ridge. From the sandy beach, the land rises to another ridge, and the yard and buildings are situated on the east slope at elevation 25 feet or so. The field wall system encloses 1.05 acres, more or less square, and measuring between 200 and 220 feet on each side. The enclosure is oriented parallel to the shoreline, and along the north-northeast side, several small walls connect to the north wall of the kitchen, possibly forming animal pens or garden plots. The buildings are grouped closely together inside the midpoint of the north field wall. Front and rear gate openings were found in the east and west walls respectively, aligned with the largest structure. At the front gate, which would have marked a path between the yard and the beach, two gate timbers remain. The rear gate, less distinct, was marked by a pile of large cut stones, identical to stones found inside the yard east of the buildings. It seems likely that they were transported to the property, probably from the Alexandria settlement or the Lighthouse and unloaded at the back gate. This would imply a road connection to the Lantern Head property from the south.

The field wall enclosure at Lantern Head is intact, with openings for front and rear gates. Three structures, labeled STR1, STR2 and STR3 are believed to represent the house, kitchen and well. These are tightly grouped together at the north center of the enclosure. The two principal buildings form an L. Outside the L, east of the kitchen and north of the house, the cistern is situated where it probably gathered rainwater from both roofs. The interior of the L arrangement forms a back yard, onto which one house door and two kitchen doors opened. Such areas are traditionally used for many domestic activities, and the yard probably contained fruit trees and other domesticated plants.

Figure 15, Protected sandy beach with Lantern Head promontory, toward north

Figure 16, East shoreline of south Abaco from inside Lantern Head enclosure south toward Hole-in-the-Wall Lighthouse in center distance

Lantern Head Buildings

Description of the ruins.
Still memorable for its loneliness, the ruined group of structures at Lantern Head is surrounded by what must have once been a rectangular enclosure defined by dry-stone walls now standing three to four feet high. This enclosure is oriented southeast/northwest and appears almost perfectly centered on the beach located immediately south of Lantern Head.

Within the enclosure stands a ruined steading, elements of which are arranged in an "L" shaped configuration. Built to face the sea, the largest and most imposing structure (LH Structure 1) incorporated (insofar as can be determined from present condition), one principal floor raised on a stone plinth 2'-0" above grade. Measuring 27'-1 1/2" x 21'-3" in plan at first floor level, this building features cut stone and rubble external walls (measuring 1'-6" in width above plinth level) stuccoed on outer faces and plastered internally. Barely visible traces of doorways (measuring 3'-4" in width) centered on east and west facades indicate a through hall or central passage plan, there being no visible evidence for further subdivision of the interior space.

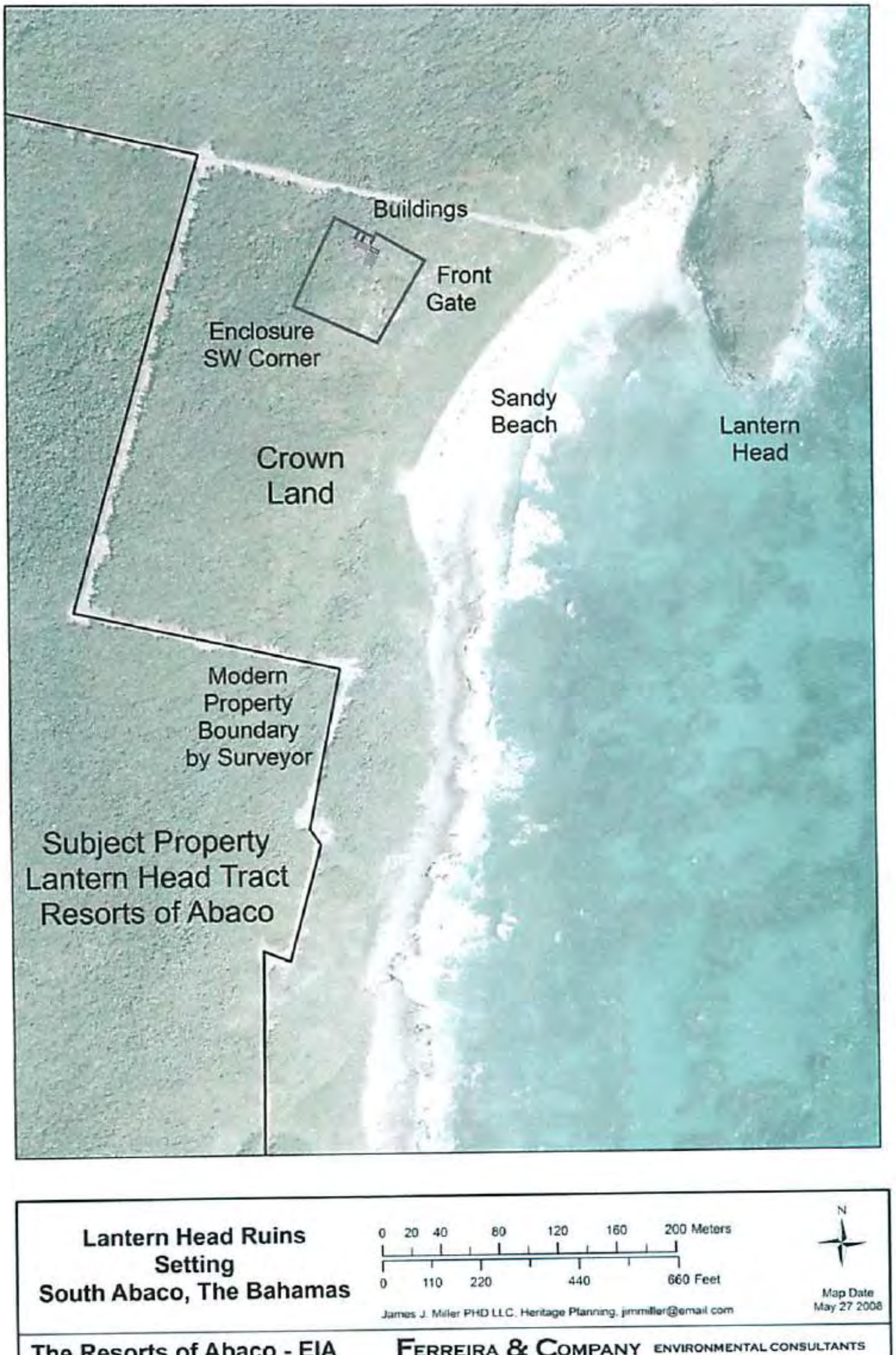


Figure 17. Setting and ownership of the Lantern Head ruins

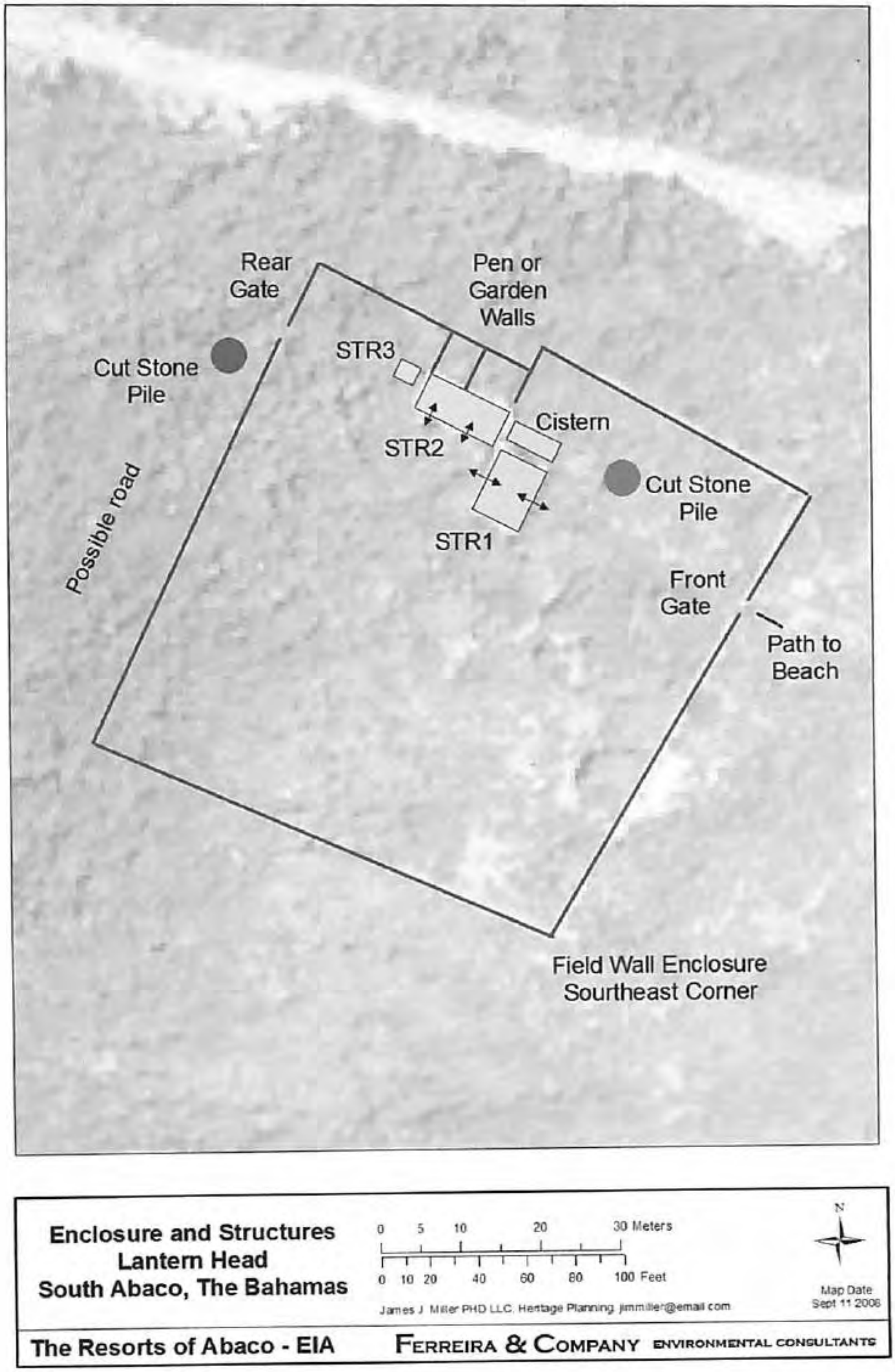
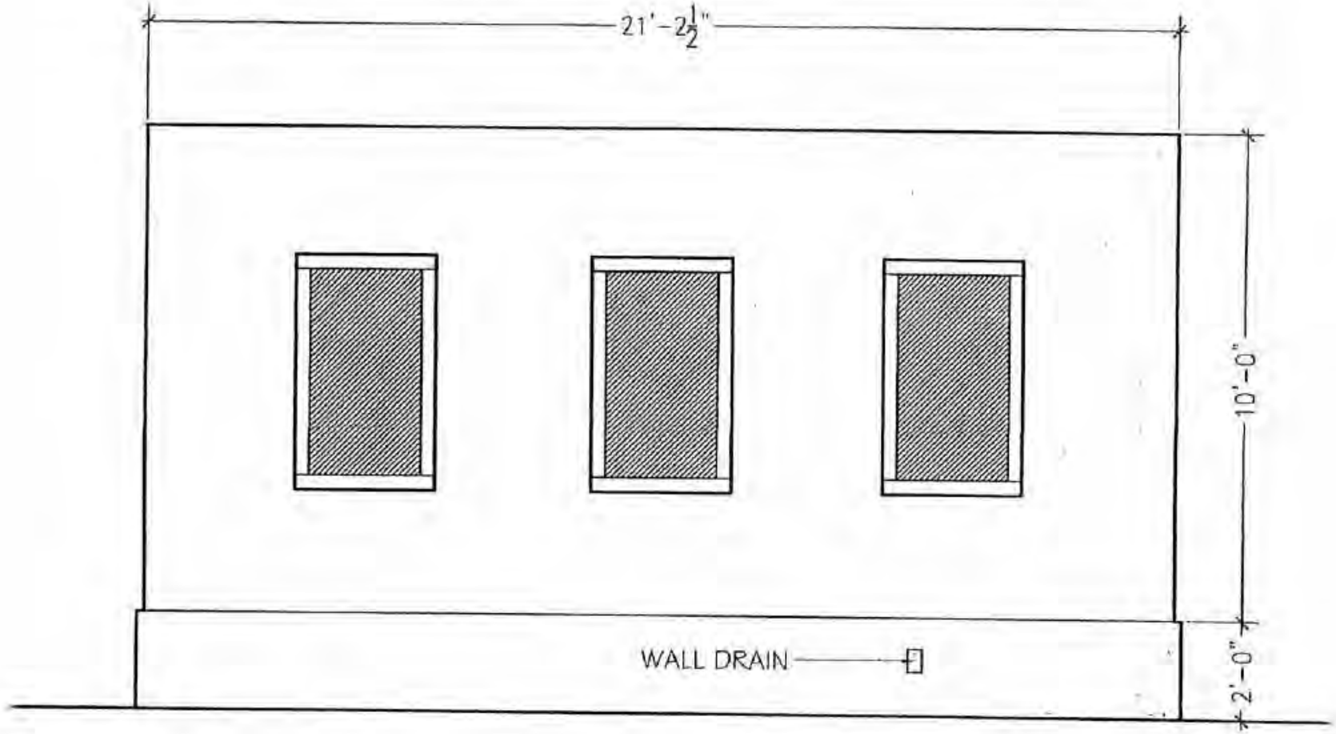


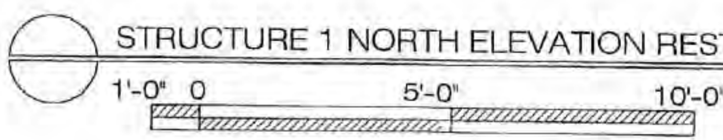
Figure 18. Field wall enclosure and structures at Lantern Head

Figure 19, Lantern Head Structure 1 toward southwest from front yard.
Southeast corner of Structure 2 is visible at far right.

Despite extensive destruction, fragments of first floor framing survive, 4" wide ledges running on interior faces of the two long facades indicating the former presence of timber wall pates installed to receive floor joists (measuring 2 3/4" wide x 3 1/2" deep in section) running east/west. The span across the building was halved by a stone sleeper wall (1'-2" wide) running north/south which presumably received joist ends.

All facades have disassociated, only portions of three corners still standing to a maximum height of 10'-0" above plinth level. Nevertheless, careful examination of wall falls on the interior and fallen timbers derived from wall openings allows at least partial reconstruction, it being likely that north and south elevations each featured three relatively large window openings of equal dimension arranged symmetrically. As already mentioned, east and west facades were each punctured by a central doorway, the doorways being flanked right and left by one or possibly two window openings matching those of north and south facades in size. Loose frames and an intact lintel found inside the building indicate that window openings were 4'-10" high (excluding lintels) x 2'-10 1/2" wide, the frames, set flush with the outer building face, being fabricated from 3 3/8" square timbers. Joints were tenoned and carefully pegged at corners.





STRUCTURE 1 NORTH ELEVATION RESTORED

LANTERN HEAD, GREAT ABACO, THE BAHAMAS

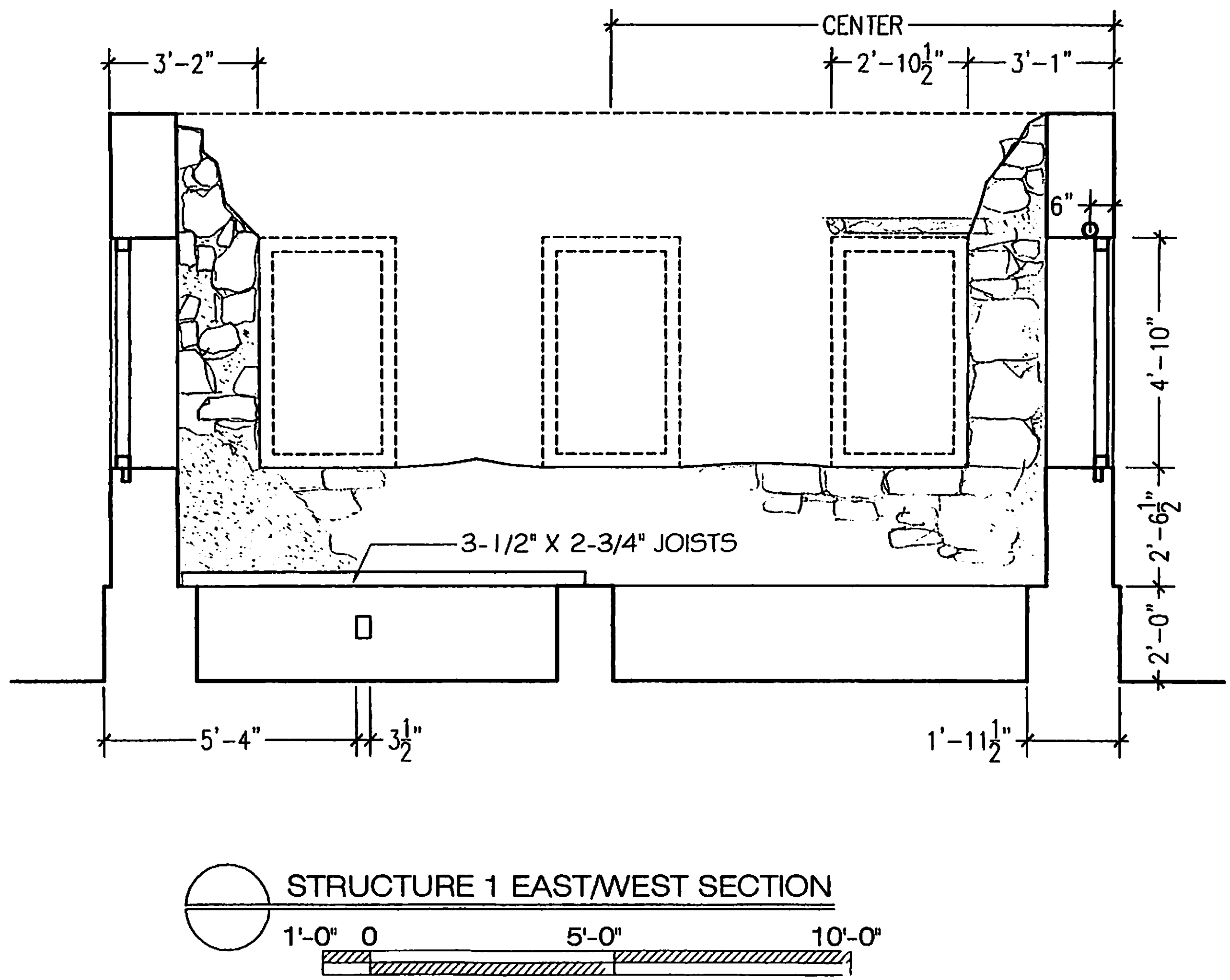
SURVEYED BY COLIN BROOKER MAY 2008

Figure 24, Lantern Head Structure 1, Head of window frame found loose in ruin

It is possible that brick scattered near the building's southwest corner represents a fallen chimney, however it is impossible to be sure about this without excavation since no foundations for such construction are visible above ground.[19]

Separated by a narrow (4'-0" wide) pathway, the main house is flanked on its northern side by a deep rock-cut cistern (measuring about 6'-3" x 20'-0" in plan).

Figure 25, Cistern, Lantern Head Structure 3, showing south and north walls and bottom



LANTERN HEAD, GREAT ABACO, THE BAHAMAS
SURVEYED BY COLIN BROOKER MAY 2008

Immediately west of the cistern stands a long, narrow, single storey building, measuring 36'-3" x 15'-8"overall. Now roofless but otherwise well preserved, this building is enclosed by mortared rubble walls (measuring 1'-6" in width) which, following the sloping ground stand between 7'-0" and 8'-10" high. Inside there are few architectural refinements except at the gabled west end where the enclosed space is dominated by a massive (7'-10" wide) internal fireplace, a bread oven flanking the fireplace on its north side. Here, the hearth is raised about 2'-0 above floor level, a zone of transition between hearth and chimney featuring corbeled construction in cut stone, the large, carefully finished blocks used being supported on a single timber beam measuring 5" x 6" in cross section. Originally, the hearth and fire box were lined in red brick. The same brick was employed to construct an arched opening to the bake oven.

Figure 27, Kitchen, Lantern Head Structure 2 viewed toward northwest from Structure 1.

Elevational treatment is simple, incorporating two doorways (3'-1" and 3'-3" wide) on the long southern side and two windows on the corresponding northern facade, the window openings measuring 2'-10" wide x 4'-7" high. Another, similar window is centered on the eastern facade. Each door and window opening is spanned by an exceptionally thin (1" thick) timber lintel. Some window frames survive. Set flush with facades these are made up from 3" x 3" pine sections, morticed, tenoned and pegged at corners.

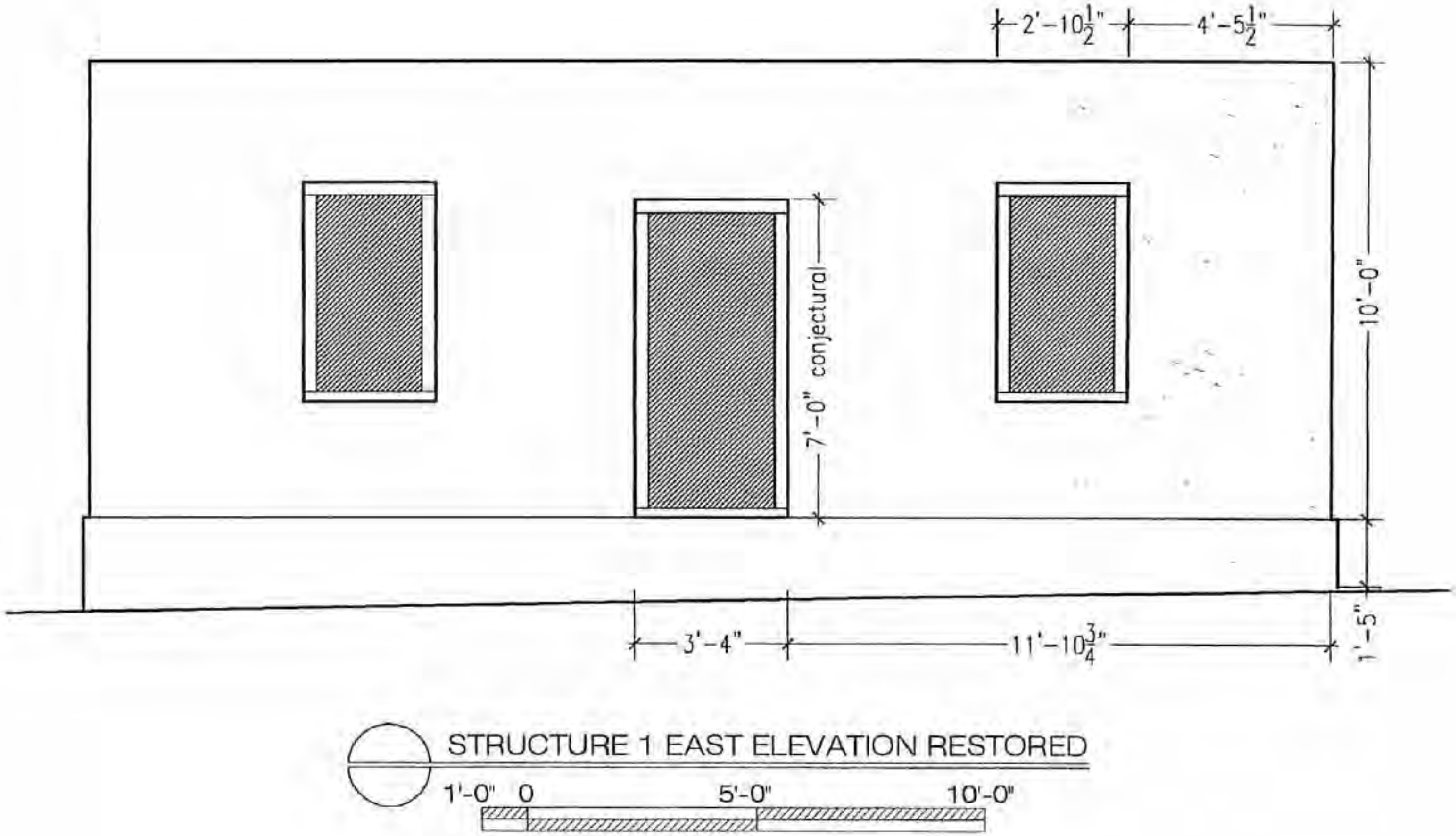
The building appears to have been originally undivided, but a stone partition wall was added to make two spaces during a secondary construction phase (date undetermined).

Figure 28, Hearth and oven, west interior wall of kitchen, Lantern Head Structure 2

Roof timbers are no longer in place. The chimney end of the building is gabled, but lack of a gable at the opposite extremity probably means that the roof here was hipped.

Just west of LH Structure 2 stands a small well-house or well enclosure measuring 7'-10" north/south x 6'-0" east/west. Excavated into bedrock, the well itself is part surrounded by 12" thick rubble walls standing to a maximum height of 6'-3" above grade. Ground north of LH Structure 2 is divided into what appear to be two animal pens defined by dry-stone field walls.

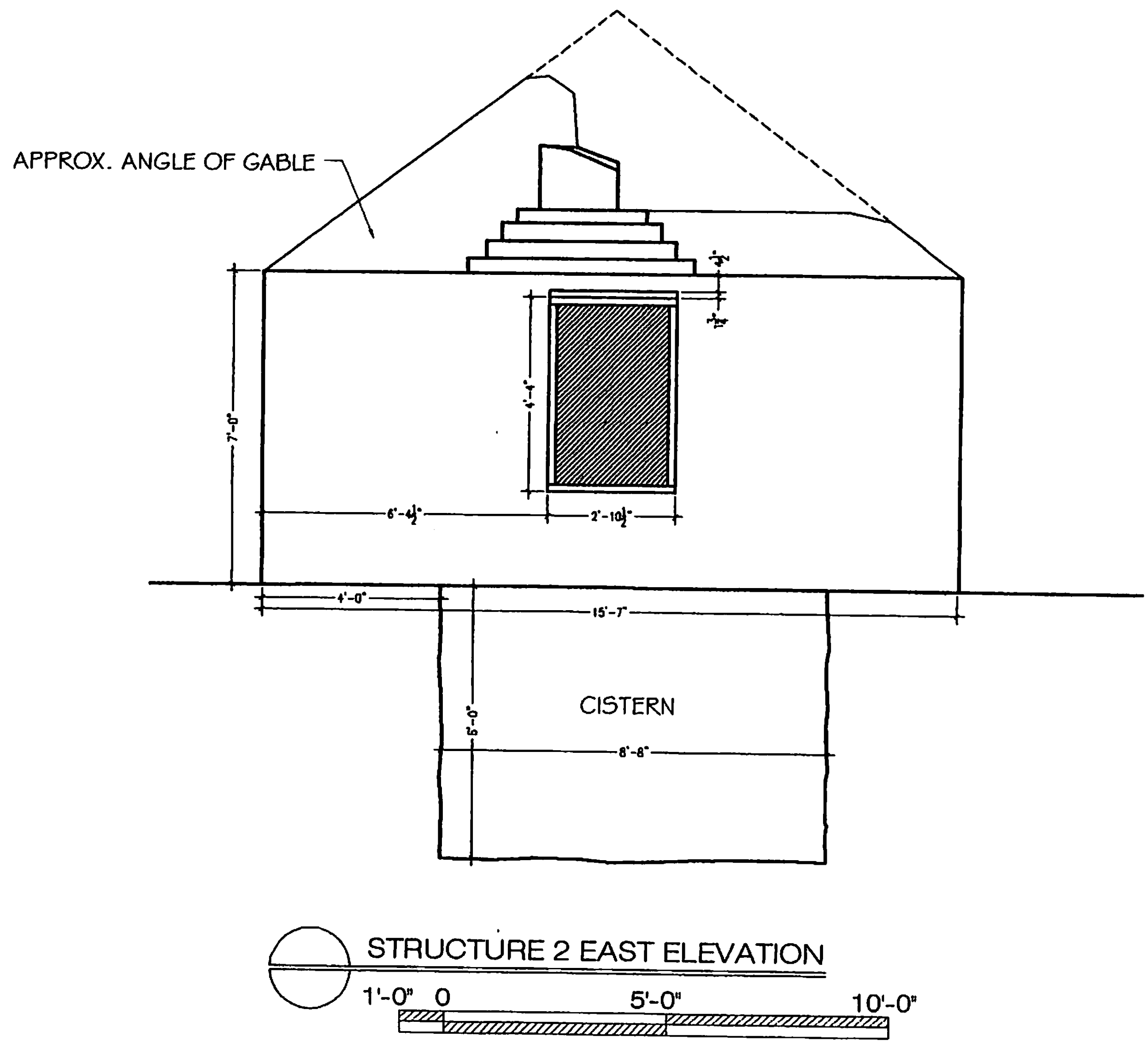
Land ownership
Apart from cartographic notations, the earliest surviving records for Lantern Head go back only as far as 1871 when 210 acres west of the ruins were granted to W. H. Stuart.[20] If this tract had previously been granted is not clear from extant plats, though it can be seen that a strip of land bordering the sea to the east and the headland was Crown property occupied by (or at least let to) an unnamed tenant. Similarly, a tenant held Crown Land located west of Stuart's tract. To the south, 200 acres had earlier been granted to the Hon. Thomas Williams.[21]



STRUCTURE 1 EAST ELEVATION RESTORED

LANTERN HEAD, GREAT ABACO, THE BAHAMAS

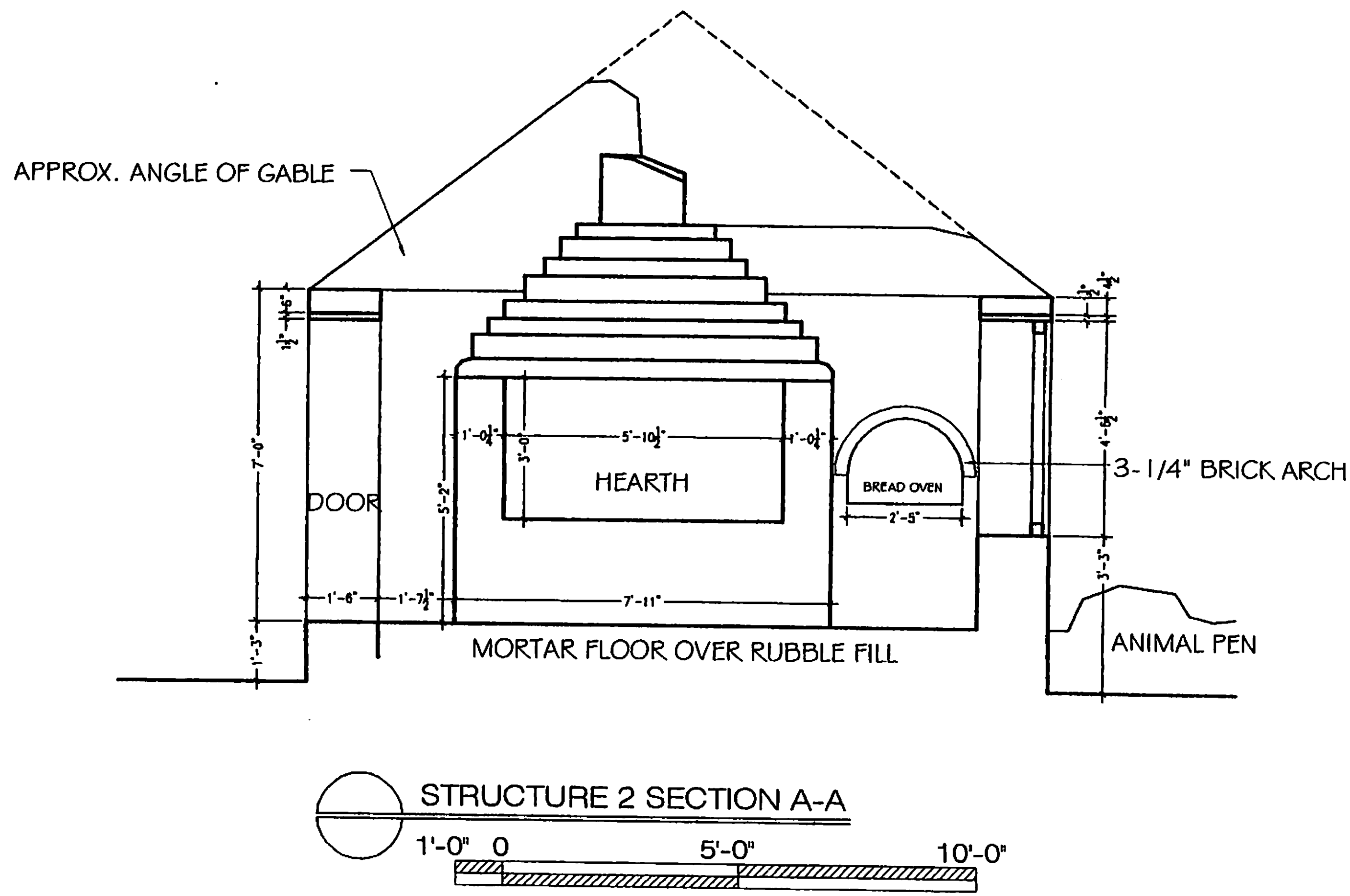
SURVEYED BY COLIN BROOKER MAY 2008



STRUCTURE 2 EAST ELEVATION

LANTERN HEAD, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008



LANTERN HEAD, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008

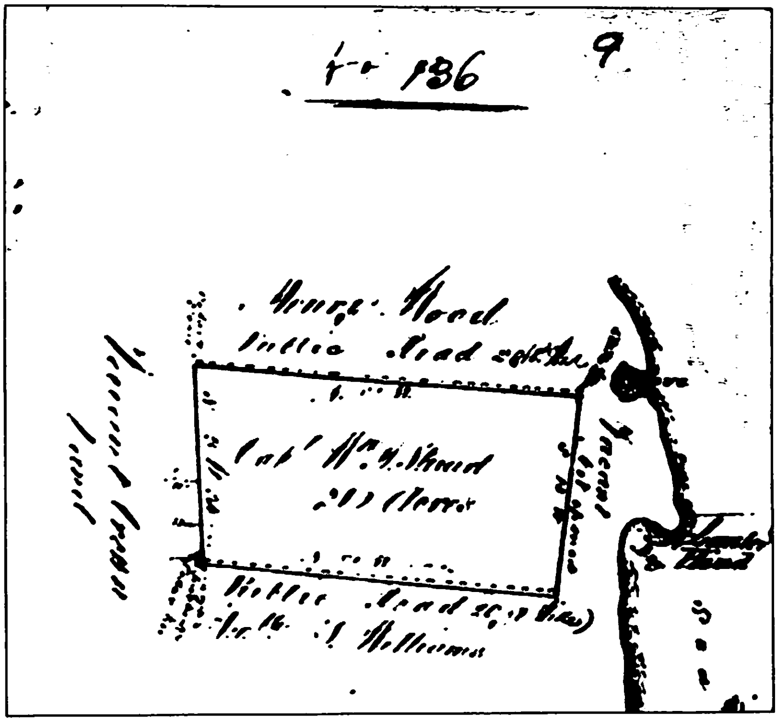


Figure 33, Detail of land near Lantern Head granted to W. H. Stuart, July 1871(?), Department of Lands and Surveys, Nassau.

Little is known about W. H. Stuart's career except that he was probably connected with the Imperial Lighthouse Service. The Nassau *Guardian* for November 18, 1868 reported:

> *The new Lighthouse yacht* Richmond, *W. H. Stuart Commander, arrived from London via Inagua yesterday.*

Nor is it known if Stuart entered into pineapple cultivation like his neighbor to the south or if he ever lived permanently on his Lantern Head holding. Indeed, since they occupy Crown land, it appears probable that the ruins described above have little or nothing to do with Stuart, most likely having been built by the otherwise unknown tenant who is shown in possession of the site in 1871 or conceivably, this person's predecessor. Either way, an abundance of plants still growing here, attest sisal was once cultivated in the immediate vicinity, these plants now being found across an area extending from LH Structure 1 down to the shore, a particularly impressive group growing at the foot of the headland itself.

More significant perhaps is the striking resemblance between structures occupying Lot 1 at Barque Bay and the Lantern Head building group. Barque Bay's Structure 2 and Lantern Head's Structure 1 are almost identical in dimension, plan arrangement, elevational treatment and style, the only real distinction being that neither timber uprights nor wooden sills appear to have been used in wall construction during erection of the main Lantern Head building.

Despite more substantial construction (i.e., rubble rather than tabby walls), Lantern Head's Structure 2 is analogous to Structure 2 at Barque Bay, its massive end chimney suggesting use as a kitchen. If so, it was, like the Barque Bay structure, oversized assuming that the main building (LH Structure 1) saw domestic occupation, a circumstance which seems likely given the numerous ceramics, bottles and other kinds of household refuse found strewn across the site when first seen by ourselves in October 2006.[22] The well, located behind (west of) LH Structure 2, finds close functional and formal parallels in the well house located immediately south of Barque Bay's Structure 2 while both sites feature rock cut cisterns excavated in close proximity to their assumed kitchens. Indeed, these similarities are close enough to indicate a similar construction date sometime during the last quarter of the nineteenth century for the buildings cited at both Lantern Head and Barque Bay.

It should however be observed that no evidence was found at Lantern Head for any subsidiary settlement housing workers, cultivators or sharecroppers. Therefore while it is tempting to assume this building group was directly related to the processing of agricultural products (for example pineapple and or sisal) as suggested for the larger structures at Barque Bay, such a scenario implies workers being recruited from surrounding settlements or seasonal employment of landless squatters. While speculative, this scenario, is not impossible, since late nineteenth century records attest settled and transitory populations (including persons variously described as planter and squatters) in the vicinity of Lantern Head. Moreover, the latter site was not far distanced from a road network radiating outwards from Alexandria Township where locally processed agricultural products were apparently shipped to Nassau, and foodstuffs, supplies and other necessary goods imported.

Whatever the case, agricultural activity must have slowed following the closure of J. S Johnson & Co.'s operations in south Abaco circa 1908. While we would not rule out the possibility that the building group at Lantern Head remained occupied, its is difficult to imagine how its inhabitants survived unless they resorted to fishing, sponging, subsistence farming or alternatively, had ties to the Lighthouse at Hole-in-the-Wall, which then, as now, was a prominent feature in the landscape.[23]

That the main building eventually collapsed, most likely overturned by a massive storm or hurricane blowing from the north or north-east, is attested by wall-falls. Thanks perhaps to long, low profiles, the adjacent kitchen (LH Structure 2) survived the same storm relatively intact, only the roof frame disassociating into a splintered mass of timber, fragments of which still remain where they fell slightly to the south. Looting followed, the building group being quarried for re-usable materials (such as brick and timber) at some undetermined time.

Unfortunately, looting by treasure hunters and bottle collectors continues. Nevertheless, even despoiled, the site along with its ruins retains enough integrity to merit full protection and preservation as an evocative monument to an almost forgotten episode in the history of Great Abaco.

Lantern Head Artifacts

Artifacts were collected from five locations at the Lantern Head ruins, recorded as ART1 through ART5. Since they were all from within the complex of three buildings, no more than a few meters apart, no GPS points were taken. As at Barque Bay, it was obvious that artifacts had been recently moved about, collected in piles and left in prominent places. All artifacts were from the surface, and none of the proveniences should be considered archaeologically reliable. None of the Lantern Head artifacts are dateable to a narrow time range, but all are typical of the second half of the nineteenth century.

ART1, collected from outside the northeast corner of the kitchen, near the cistern, included unglazed earthenware, whiteware and spatterware pottery fragments. Glass was represented by square-shaped case gin and standard cylindrical bottles in green, black and clear. All fragments appeared to be from mold-blown rather than free-blown bottles. One example showed a prominent push-up base with no manual pontil scar. Two lip pieces appear to have a tooled finish and a mineral finish (Figure 34).

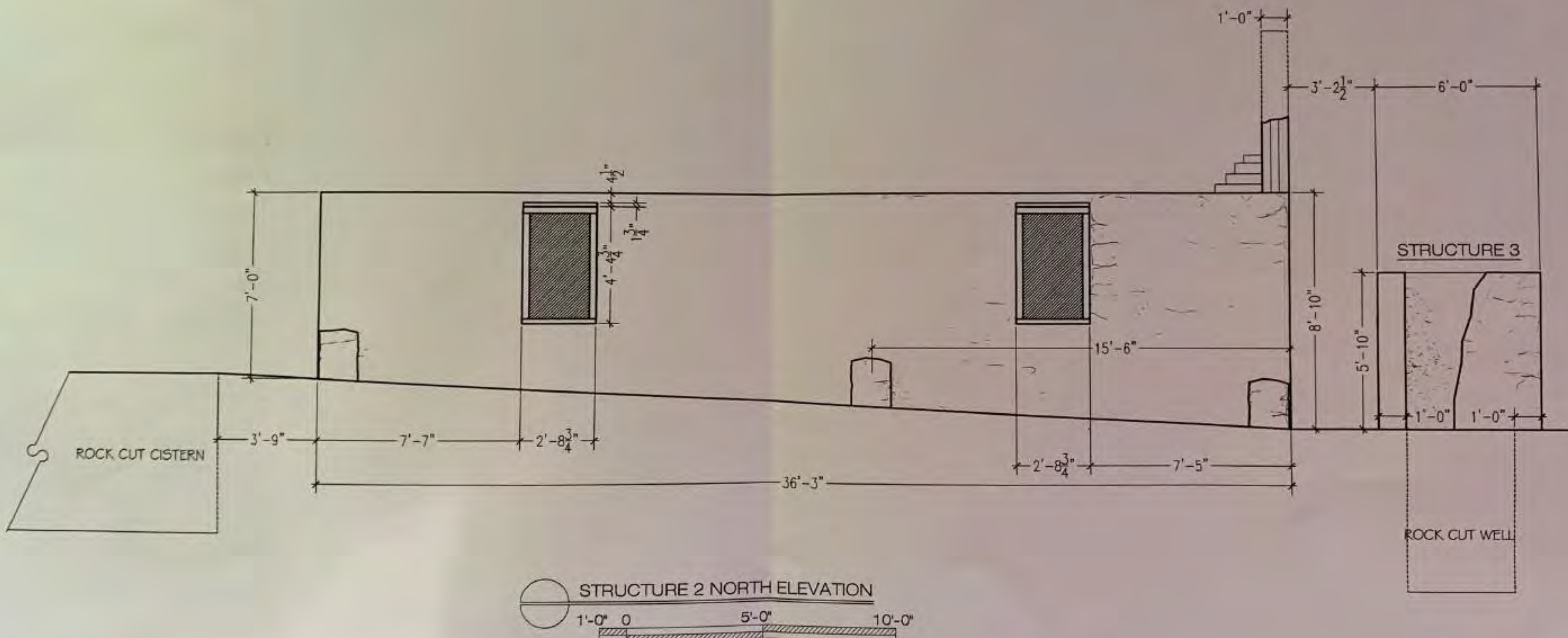
Figure 34, ART1, Lantern Head, Mineral finish and tooled finish bottle necks. Height of specimen on right is 3 inches

ART2 is a brick, collected from a pile of bricks that had been moved to outside the northeast corner of the largest structure. It is typical of bricks in the kitchen oven and fireplace.

ART3 includes artifacts collected from a pile assembled outside the northwest corner of the kitchen, near the well. Three glass fragments, probably from bottles, were light green and blue in color. Ceramics included undiagnostic whiteware and blue spatterware.

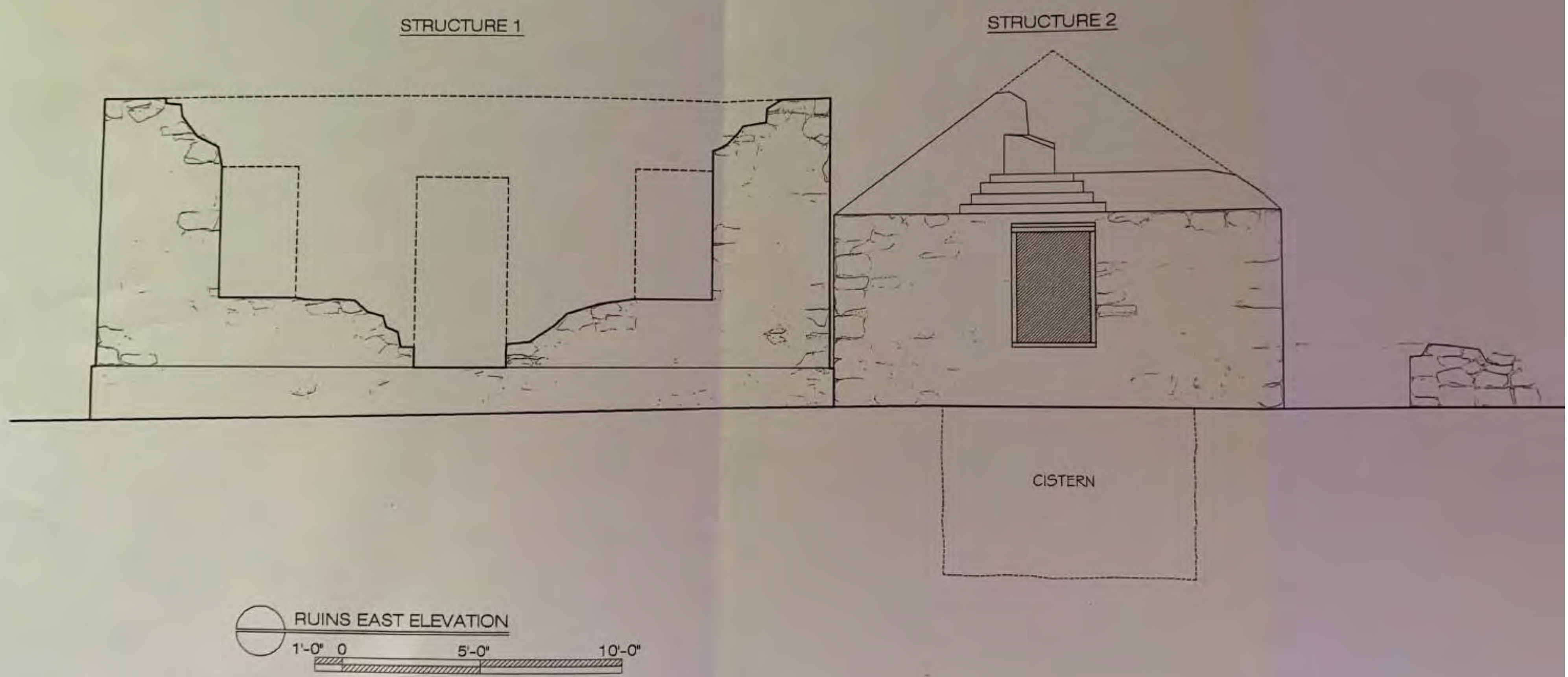
ART4, collected from inside the west kitchen room containing the fireplace and oven, provided two examples of seams on black bottle glass, one with a shoulder seam and one showing the junction of side and shoulder seams.

ART5 from inside the east kitchen room included additional green-black glass, three sherds of a tan glazed earthenware and a fragment of blue spatterware with a handle attachment.



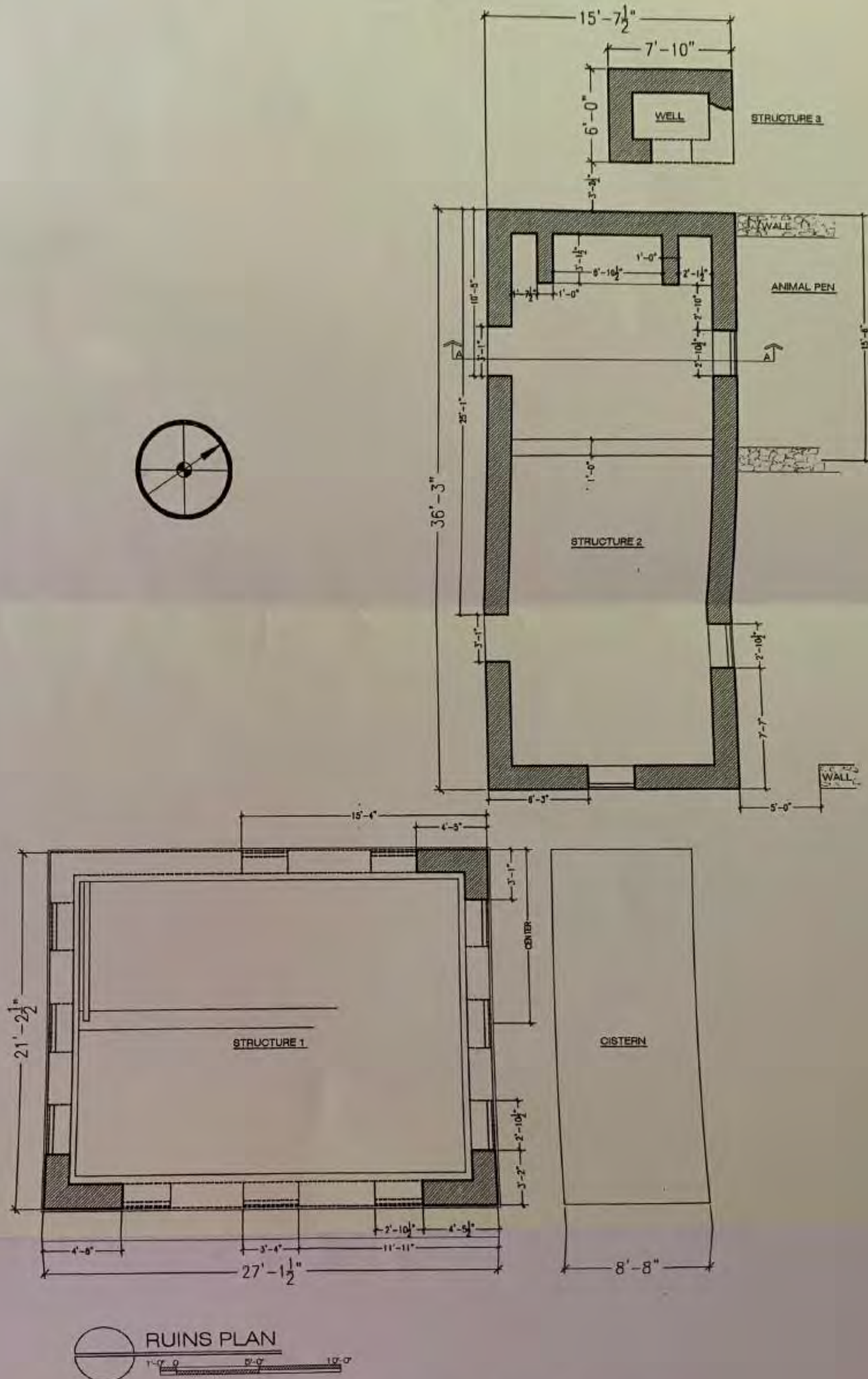
LANTERN HEAD, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008



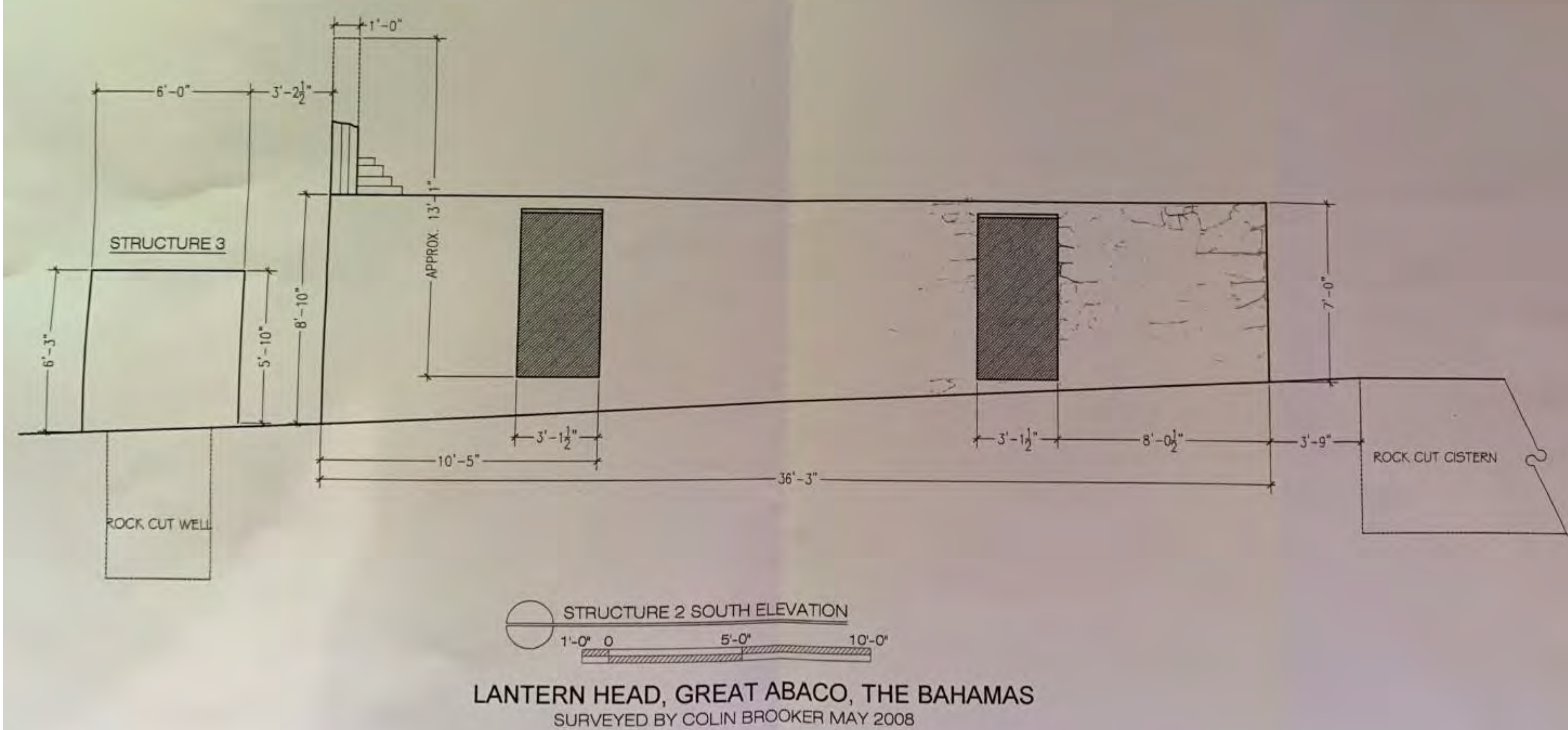
LANTERN HEAD, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008



LANTERN HEAD, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008



1'-0"
6'-0"
3'-2½"
STRUCTURE 3
6'-3"
5'-10"
8'-10"
APPROX. 13'-1"
7'-0"
3'-1½"
10'-5"
36'-3"
3'-1½"
8'-0½"
3'-9"
ROCK CUT WELL
ROCK CUT CISTERN
STRUCTURE 2 SOUTH ELEVATION
1'-0" 0
5'-0"
10'-0"
LANTERN HEAD, GREAT ABACO, THE BAHAMAS
SURVEYED BY COLIN BROOKER MAY 2008

HIGH BANK PROPERTY

Barque Bay Landscape

Setting

Barque Bay is the name long recorded on maps for a geographic feature, and presumably a now abandoned settlement, at the south end of the High Bank property. Like Lantern Head, Barque Bay is a protected stretch of coastline with a sandy beach, in great contrast to the rocks and cliffs that characterize most of the south Abaco Atlantic coast. Like Lantern Head, there is no prominent reef, but the foreshore is beach rock and the consistent breakers would have made access by boat a challenge, although not impossible. The grants, lots and structures at Barque Bay, and presumably any connecting roads, take advantage of the high ridge that borders the Atlantic shore.

This settlement is situated on the limestone ridge at an elevation of about 40 feet above sea level approximately 3 1/4 miles north of Hole-in-the-Wall Lighthouse. Land grants indicate that when first laid out, it was bounded on the east by sand dunes which still form an extensive system running more or less parallel to the ocean along much of Barque Bay and High Bank Bay. These dunes are characterized by a surprisingly rich flora, which includes large clumps of sea lavender (*Tournefortia* sp.) on the foreshore. Sea oats and spider lilies dominate backshore zones, numerous shrub species dwarfed and sheared by winds blowing in from the Atlantic Ocean, occurring further inland.

The settlement itself in now densely wooded, a regenerated Dry Broad-Leaved Evergreen Forest (characterized by its high species diversity and deep humic soil), extending across the site. Among trees used in traditional building construction we noted Red Cedar (*Juniperus bermudiana),* mahogany *(Swietenia mahagoni)* and scattered stands of palm including silver tops (*Coccothrinax argentata),* the leaves of which were once favored for thatching. An introduced species, Sapodilla (*Manilkara zapotilla)* seen in fruit immediately south of the cut line defining the subject property's southern boundary, is probably a relic of former garden cultivation. West, vast stands of Abaco pine (*Pinus caribea)* must have furnished a ubiquitous and seemingly inexhaustible supply of roofing, framing, flooring and finishing materials for local residents and commercial loggers alike.

Ownership

The ownership of the High Bank property is straightforward, consisting of the 500 acre grant to R.H. Sawyer and R. Menendez (Grant Book B1-6). As currently surveyed, the property measures 503.33 acres. The grant is bordered by a Crown Land Reserve to the east along the coast, and by Crown Land (now leased to the Bahamas National Trust) on the west. Joseph Roberts received an adjoining 100 acre grant to the north, and Moreton Roberts was granted 56 acres on the south. Moreton Roberts' grant was inset almost 600 feet farther from the coast than the Sawyer and Menendez tract. As we shall see, this adjustment probably reflects the existence or at least the intent to develop the Barque Bay settlement. Configuration of historic grants is shown in Figure d.

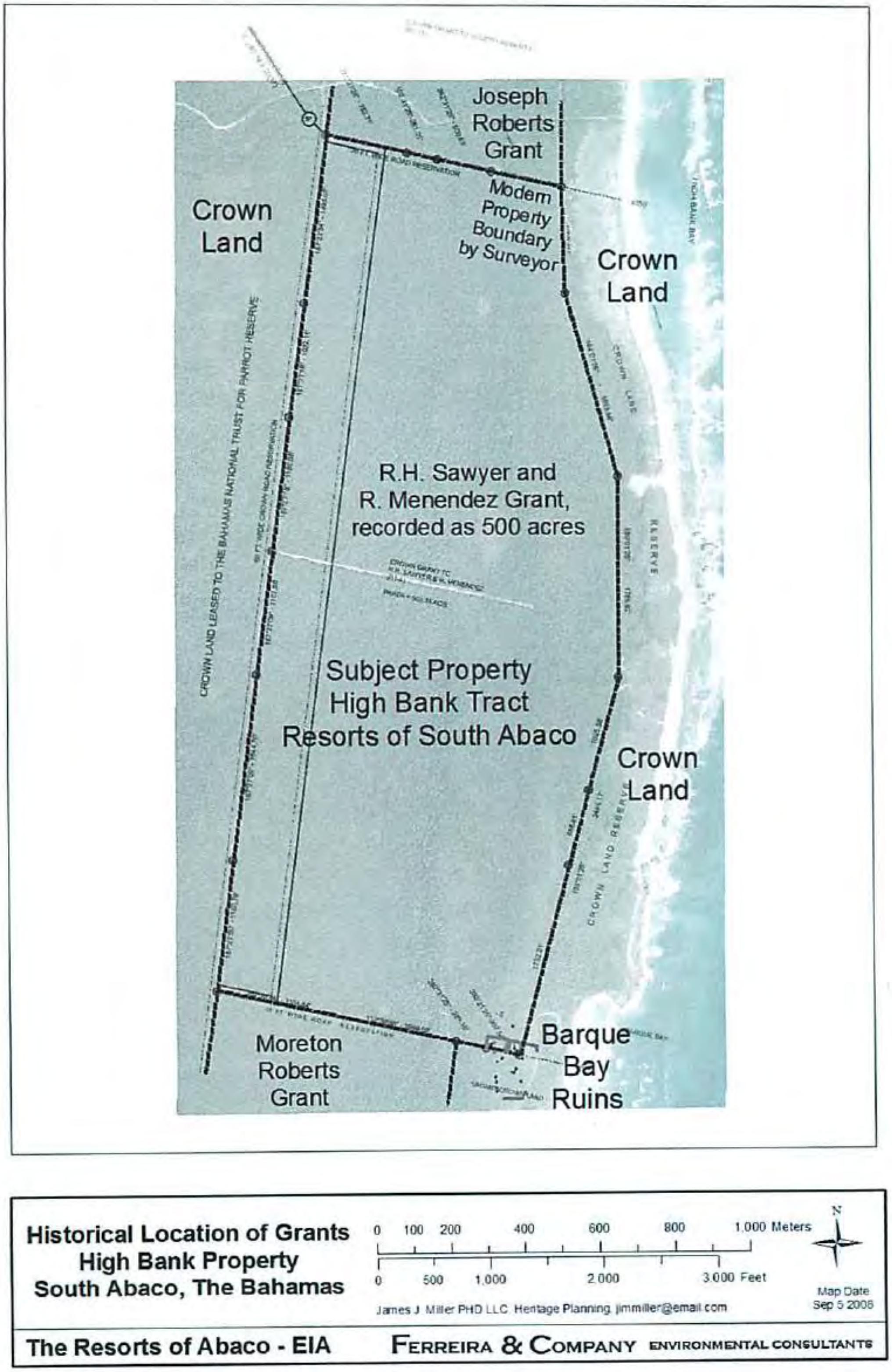


Figure 35, Historical location of grants for High Bank property

Settlement Layout
Ruins at the southeast corner of the High Bank property comprise the settlement we are calling Barque Bay. Here the ownership and development pattern is more complex that at the Lantern Head ruins, which appear to have involved a single owner A thorough search of grant records revealed not only the obvious large tracts, but also a gridded settlement. Its reconstruction from a few lot descriptions and its accurate placement based on field wall remnants revealed a formally platted settlement, previously unknown.

Records of the Department of Lands and Surveys, Nassau indicate the Barque Bay Settlement was laid out on a more or less regular grid plan, some time (probably soon) before 1871. Although referenced in deed descriptions, original drawings illustrating this layout cannot be found. However, judging by the internal evidence of land grants still extant, at least twenty-four lots were designated within the settlement, not all of which were taken up.[24] Typically, individual lots measured 104'-6" east/west x 105' north/south, plats indicating they were each bounded by a public road on either the east or west side. This arrangement is confirmed by field walls standing on the site which allow reconstruction of an almost rectangular enclosure incorporating just over 4 acres, subdivided into a series of small lots arranged in two rows of six (running approximately north/south) separated by a road approximately 20 feet wide (Figure 36).

There are three distinct groups of buildings at Barque Bay, and although two owners had large grants on which to select a building site, it appears that all structures were situated for easy access to the protected bay and its sandy beach. The most obvious feature of the settlement is the field wall enclosure; its north and south walls are obvious on the ground as well as on aerial photographs from the 1940s to the present. The north wall of the enclosure, now situated within the High Bank Property, may have originally marked the southern boundary of the Sawyer and Menendez grant. The modern surveyor's property boundary is at the same bearing as the north wall of the enclosure, but about 100 feet further south.

North of the north enclosure wall about 200 feet is a building complex (Building Group C) that is well within the Sawyer and Menendez grant. It consists of four structures including an oven, a fireplace, a possible well, and a large building we have labeled STR5. It three front entrances suggest some function other than a single-family dwelling. The location of these buildings, and their associated cistern or root cellar about 100 feet east, is clearly within the original ownership of Sawyer and Menendez.

The second building complex (Building Group B), including structures we have labeled STR1 through STR4, is inside the field wall enclosure at its extreme northwest corner. The orientation of the buildings and the field walls is consistent with the bearing of the modern surveyor's property boundary, but the original ownership of this set of buildings, consisting of a well, kitchen, cistern and possibly a house, seems to correspond to the historic location of the Moreton Roberts grant.

The third complex of buildings (Building Group A), mostly but not entirely south of the High Bank Property consists of ruins of vernacular structures, mostly constructed of wattle and mortar, and far less substantial that the larger structures to the north. Although little time was spent on this adjacent property, because it was not part of the proposed development tract, and only GPS locations could be collected, it appeared that these smaller ruins, and their associated ovens and walls, comprised a planned arrangement of some sort. The extent and configuration of this did not become clear until additional research revealed several descriptions of granted lots. These revealed a pattern of twelve lots, measuring approximately 105 feet on a side and arranged in two rows of six lots separated by road, probably 20 feet wide. Once the plat was reconstructed, corresponding walls were finally noticed on aerial photography representing lots 5, 8 and 9 as well as the western side of the enclosure. These aligned very well with the undocumented buildings such that most lots contained one or two structures, and all buildings but one fell within a platted lot.

Most interesting of all, the orientation of the gridded plan did not fit well with the bearings of the large grant boundaries and the north field wall. This is most apparent in the divergence of the north and south enclosure walls by approximately eight degrees. It would appear that the original surveys for the large grants and for the gridded plan were done at different times, and by different surveyors. So far records have not revealed the dates of the surveys, but it is apparent that the platted lots refer to the adjacent ownership of the large grants, while the plats of the large grants do not reflect the existence or knowledge of the small lots. It is probable that the large grants were surveyed first, but it is also possible that some settlement may already have existed at Barque Bay on the lots before the more substantial building complexes associated with the large grants were in place. Whatever the chronology, the contrast between building groups could not be more obvious. It would seem likely that the lots and their insubstantial vernacular structures represent workers' housing, while the larger buildings, not on lots, are associated with the large grant owners, and may have a commercial rather than a residential function.

The location of modern property boundaries and physical features that help place the gridded lots in their proper location is shown in Figure e, and the reconstructed plat with its owners and grant dates is shown in Figure 36.

Individual owners of land within the walled enclosure attested by deeds include Isaac Farrington (Lot 3), J. F. Johnson (Lot 4), Thomas A. Rees (Lot 5), James Farrington (Lot 6), Leadon (London?) Johnson (Lot 8), Joseph Scavella (Lot 9), and Thomas Sands (Lot 1 and Lot 12).

Demographic data concerning these individuals is sparse although an unverified source indicates that James Farrington and his spouse, Charity Johnson recorded the birth (presumably at Barque Bay) of a son (b. October 20, 1874) named Isaac Thomas Farrington.[25] John Frederick Johnson and his spouse Clementina also registered a son (b. 14 January, 1876) named John Frederick after his father. Another child, Joshua Johnson (b. August 4,1886) may have lived at Barque Bay, if his father, a certain London Johnson is the same individual as the Leadon Johnson granted Lot 8 in 1883.[26] Later (June 13, 1888)[27] a daughter named Barbara was born to Leadon Johnson and Mary Dean.

While registers for Alexandria Township provide information about local births and deaths over the period 1878-1911, they are silent about the place from where individuals enumerated originally came. Ethnicity is not always indicated, but two individuals, James Farrington and London Johnson are called "African" which suggests that the majority of inhabitants at Barque Bay were black.[28] The death of James Farrington, planter, at age 38 is registered on April 24, 1880. If this is the James Farrington who was granted Lot 6 at Barque Bay, he would have been approximately 31 years old when he received the land in 1873.

The entry for James Farrington is of particular interest since it give his occupation as "planter" indicating, as might be expected, that he, along with other settlers were engaged in agriculture either on their own account or under some kind of sharecropping arrangement. [29] But, this cannot be the whole story since entries dated 1886 and 1888 mention London Johnson "sponger" suggesting that by that time he, and perhaps others, had fallen back upon sponge fishing for a living, this activity approaching peak profitability between 1883 and 1905.

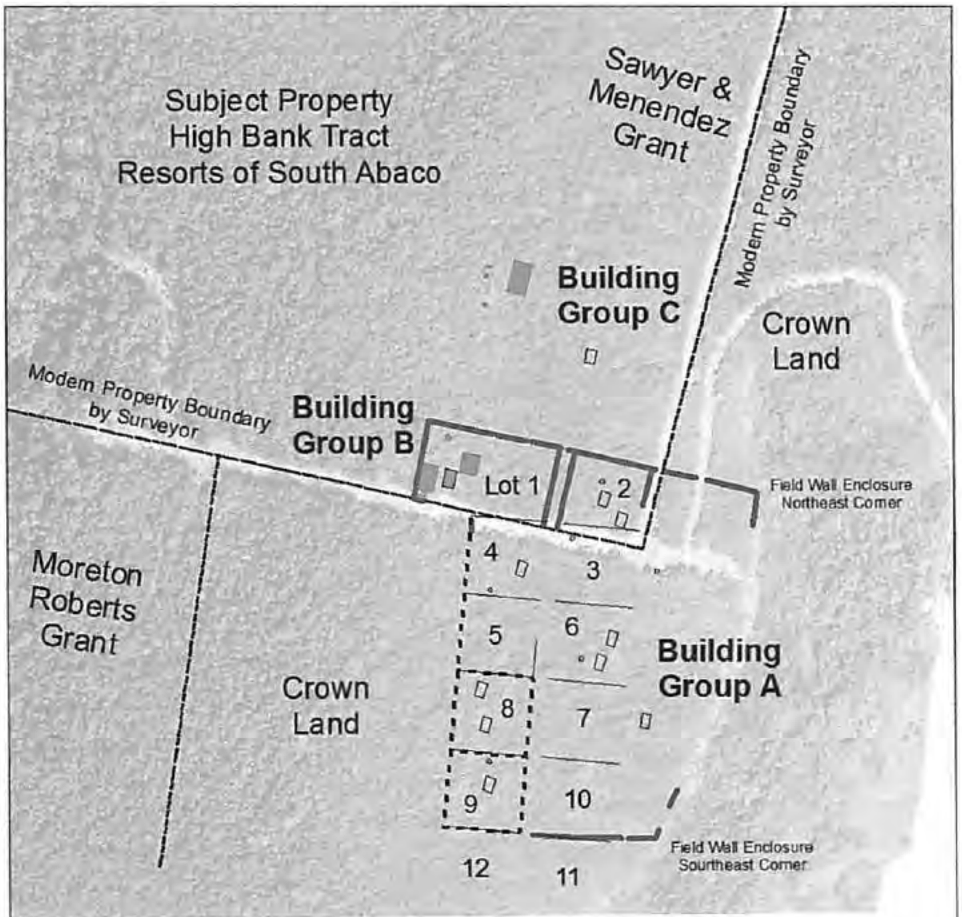
Planning Antecedents

Although his name is not known, the surveyor responsible for laying out Barque Bay settlement obviously shared (like land surveyors elsewhere in the Caribbean Region and Bahamas) a professional preference for regular geometric plans of a kind which had governed layouts of many slave "villages" established during the late eighteenth century and new hamlets established for the reception of freed (liberated) Africans prior to or after Emancipation (1835).[30]

This process is not well documented for The Bahamas but in Jamaica, Higman (1988:281) quotes a contemporary clergyman (James Phillippo) who described freedman settlements as follows:

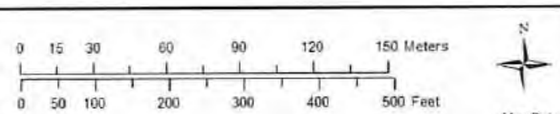
> *The villages are laid out in regular order, being divided into lots more or less intersected by roads or streets. The plots are usually in the form of an oblong square. The cottage is situated at an equal distance from the each side of the allotment and about ten feet, more or less, from the public thoroughfare. The piece of ground in front is, in some instances, cultivated in the style of a European garden . . . while the remainder is covered with all the substantial vegetables and fruits of the country heterogeneously intermixed.*

Settled by liberated Africans as early as 1832, Adelaide, located in the Western District of New Providence when first surveyed in 1839 exhibited very similar characteristics, its somewhat elongated, rectangular lots being arranged in a loose grid about what was probably a pre-existing track which then linked it to another "African" settlement named Carmichael (probably established soon after 1825) located six miles to the east.[31]



Lot 1, Thomas Sands, Date?	Lot 2, William ?, 1871
Lot 4, J.F. Johnson, Aug 1, 1873	Lot 3, Isaac Farrington, Aug 1, 1873
Lot 5, Thomas A. Rees, Date?	Lot 6, James Farrington, Feb 1, 1873
Lot 8, Leadon Johnson, Aug 1, 1873	Lot 7, Vacant?
Lot 9, Joseph Scavella, Aug 1, 1873	Lot 10, Vacant?
Lot 12, Thomas Sands, Date?	Lot 11, Vacant?

Historic Resources and Platted Lots at Barque Bay, South Abaco, The Bahamas



James J Miller PHD LLC Heritage Planning jimmiller@email.com

The Resorts of Abaco - EIA FERREIRA & COMPANY ENVIRONMENTAL CONSULTANTS

Figure 36, Location and ownership of platted lots at Barque Bay settlement on and near the High Bank Property

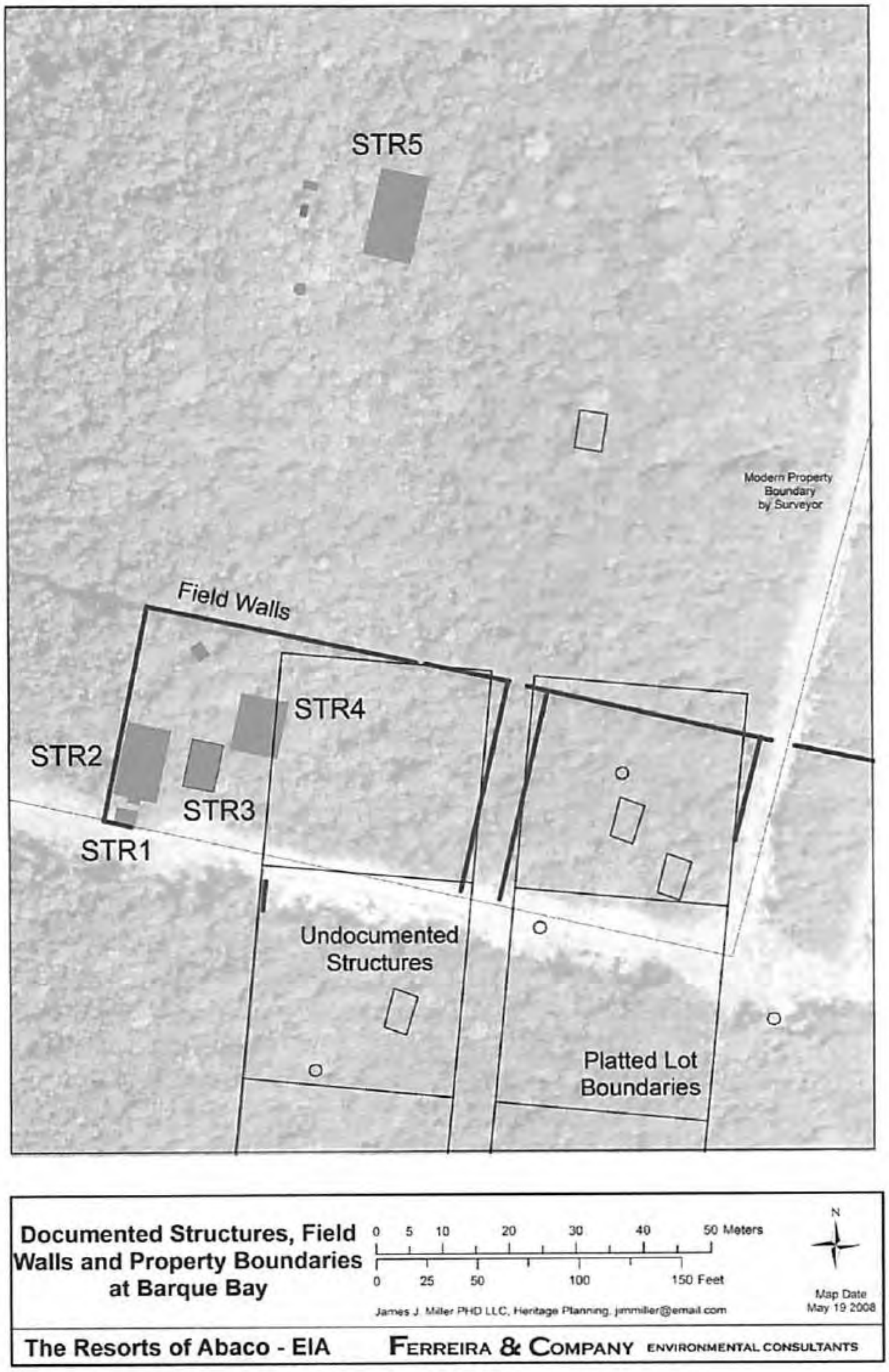


Figure 37, Field walls and structures at Barque Bay settlement in relation to modern property boundaries for High Bank property

Carmichael village was also geometrically planned, though the lot arrangement was linear rather than grid-like, individual holdings being grouped on both sides of the old inland pathway which then linked Adelaide to Nassau. Of particular interest is the fact that Carmichael, like former plantation settlements in the vicinity, had its own provision grounds, these perhaps being held or worked communally.[32]

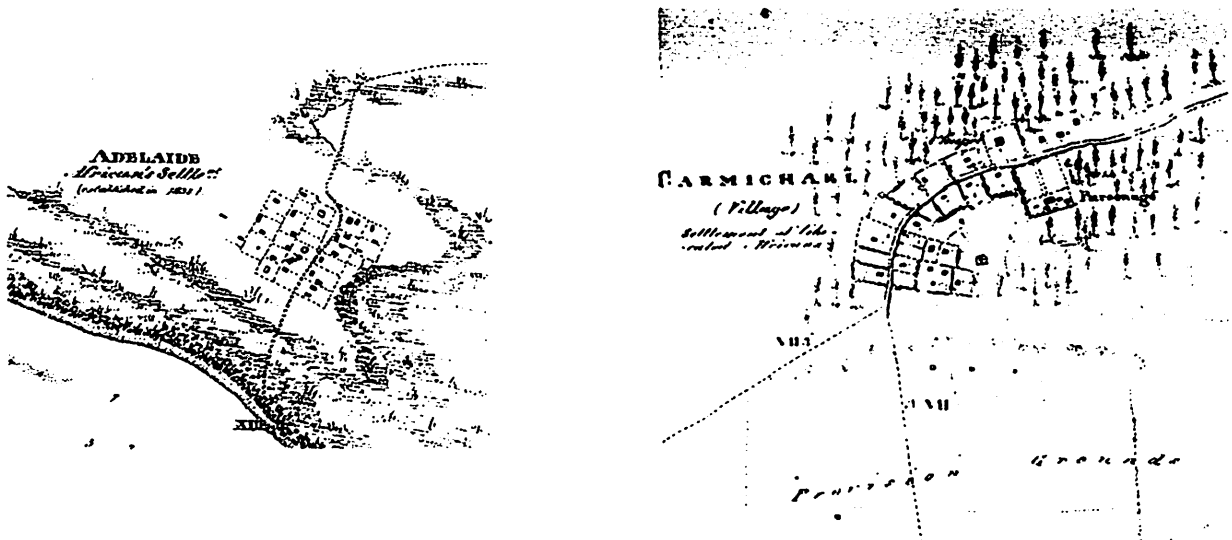


Figure 38, Plan of Adelaide, 1839, and Plan of Carmichael, 1839, Surveys by Commander Edward Barnett, UK Hydrographic Office

Barque Bay presents another variant, being linear in form but more regularly organized than the two settlements cited from New Providence. Conversely, Alexandria Township was laid out on a grid with lots arranged north and south of Soldier Road, but the grid as illustrated on the earliest extant maps is not quite regular, reflecting perhaps earlier land grants or development in the vicinity.[33] Elsewhere across south Abaco, the all pervasive role of land surveyors is evident even in the design of hamlets with a few houses such as the transitory one at Cross Harbor (laid out by James R. Aranha in May 1902) on the south-western coast where plots of different sizes but common orientation were strung out along a public road which seems to have given access to nothing but mangrove swamps.[34]

What is not seen in south Abaco's cadastral records, is evidence for informal, non-geometric settlement patterns indicative of occupation by squatters. That squatters were cultivating coastal areas located slightly west of Hole-in-the-Wall before 1873 is however attested by notes added to an "old survey" held by the Department of Lands and Surveys, Nassau. Additionally, local registers of birth and deaths dating from the turn of the nineteenth century give numerous family names which cannot be associated with grants for any settlement in the area. How large this apparently landless population may have been is impossible to say. Nevertheless, it does seem probable that a hierarchy or hierarchies existed in the black population of planters and cultivators.

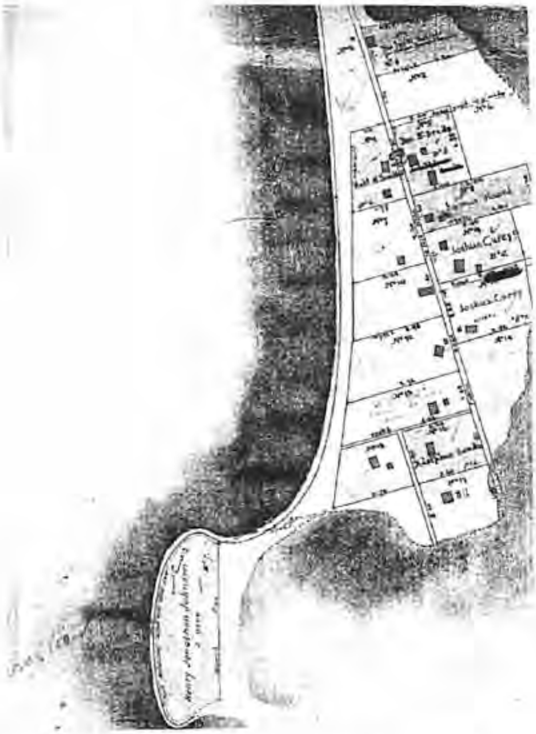


Figure 39, Plan of Cross Harbour, Abaco,
Department of Lands and Surveys, Nassau

Those living in planned settlements had the means to purchase their own building plots plus sufficient income or credit (at least for a while) to allow erection of serviceable structures built using vernacular construction techniques (see discussion below) in an effort perhaps to maximize their resources. These individuals were also willing to accept a communal landscape ordered on geometric principle regardless of how reminiscent this may have been of villages and slave settlements dating back to plantation times.

Conversely, although by no means negligible in size, the non-landed population has left no visible trace on the landscape, its buildings perhaps being too scattered and insubstantial to survive the economic collapse which overwhelmed south Abaco during the early years of the twentieth century.

Barque Bay Buildings

General
We have distinguished three distinct building groups at Barque Bay. Two are situated within the same enclosure wall, another being centered about 200 feet north of the enclosure's north boundary.

In the following section, structures standing within the enclosure located south of the cut line defining the subject property's southern boundary are designated Building Group A. It should be understood that since we lacked permission from the owners to investigate this area, inspection was cursory and far from complete, though sufficient to establish a pattern of largely domestic building which despite imperfect preservation, appears relatively coherent.

Structures standing within the enclosure located north of the cut line already mentioned are here designated Building Group B, a group distinguished by relatively large-scale construction apparently related to industrial, commercial or collective activities rather than simple domestic routines.

Standing on the former Menendez and Sawyer tract north of the enclosure, Building Group C is difficult to categorize since it includes both the largest building known from Barque Bay (which appears collective in character) and much smaller structures such as a kitchen and oven.

Descriptions are based on field measurement and notes taken on site. For comparative purposes we have drawn upon an earlier survey conducted by ourselves at Alexandria Township besides other studies of historic sites undertaken elsewhere in The Bahamas.

Building Group A, Description

Structures located south of the High Bank property south boundary are mostly (though not exclusively) residential in character, including dwellings and outbuilding related to dwellings such as ovens and animal pens. Generally, it appears that each house and its dependencies stood in a compound or garden defined by dry stone walls which originally followed the boundaries of individual lots. The dwellings themselves are now heavily damaged having, it appears, been deliberately broken up, most likely by local relic hunters who have also disturbed (and robbed) associated artifact scatters while searching for artifacts like bottles, tools and ceramics.

Nevertheless, remnants of exterior house walls are distinctive, including numerous chunks of lime mortar finished smooth on one face and bearing impressions of interwoven timber strips on the other. These fragments attest walls fabricated using wattle and daub, a vernacular construction technique which in variant forms has been used in The Bahamas since at least the early Loyalist Period. In the present instance, it seems likely that construction involved erection of woven hurdles (wattles), the hurdles being secured to timber uprights which besides strengthening walls, supported roofing materials such as palm thatch. The hurdles themselves were stuccoed with lime mortar on the outer face, this technique producing more or less weather-proof surfaces.

Figure 40, Wall fragments with smooth mortar on exterior face and wattle impressions inside

We were unable to determine if individual houses were defined by a stone or rubble building platform (as often the case elsewhere) nor did it prove possible to recover any overall building dimensions. However, given their spatial distribution, it may reasonably be assumed that dwellings were approached either east or west from the roadway bisecting the settlement north/south. A traditional through-hall or central passageway with front and back entrances would have provided good ventilation and access to the owner's compound, where, in most cases stood a beehive-shaped oven (one relatively well preserved example measuring approximately 5'-6" in diameter) roughly built of limestone rubble stuccoed smooth on the exterior. Additionally, most, if not all compounds, had an animal shelter built of stacked, un-mortared stone (typically standing 4'-0" high) in a "L" shaped configuration.

Figure 41, Oven of limestone rubble with stucco exterior

The structure occupying Lot 4 is different, its size and construction providing firm links to buildings standing on Lot 1. Despite poor preservation, we were able to determine it originally measured 17'-10" east/west x 21'-0" north/south in plan, with a least one entrance centered on the east facade. External walls measure 16" at base, this dimension being reduced by an external chamfer to 8" approximately 18" above grade.

Figure 42, Detail showing impression of corner post at building occupying Lot 4

Upper wall levels are lost but it can be seen from impressions that these were most likely of lime mortar cast in place about a series of rounded vertical timber posts placed 4'-0" on center, building corners being defined by 5 1/2" x 5 1/2" uprights of wrought timber. This technique is similar if not identical to techniques used to fabricate exterior walls of Structure 2 standing on Lot #1.

Without archaeological excavation, it would be premature to assign any function to this building. However it should be noted that a ruined structure of near identical size (measuring 21'-0" east/west x 17'-4" north/south) and similar organization stands at Alexandria on Lot 15 or Lot 16.[35]

Building Group A, Commentary

Fragmented remnants of wattle and daub walling found at Barque Bay are almost indistinguishable from materials seen in the context of earlier settlements. Indeed, this material (more accurately described as "wattle and plaster") being cheaper than stone, was frequently used for construction of slave houses during the Plantation Period, documented examples being widely distributed throughout The Bahamas.[36]

It is impossible to say if the Barque Bay dwellings resembled slave houses in size and interior plan organization. Nevertheless, wall scatters suggest they were relatively small and it is certain that (like many slave houses) their cooking facilities were separated from living areas, most probably set in gardens cultivated for the sake of fruit and vegetables. Similarly, the settlement's layout appears closely related to the formalized schemes adopted for both late eighteenth century slave quarters by ameliorating landowners (cf. William Wylly's so-called slave village at Clifton, New Providence) and by missionaries or civil servants for the settlement of Liberated Africans (later freedmen) around the time of Emancipation (see discussion above).

If correctly dated, the Barque Bay Settlement attests then the persistence into the late nineteenth century of traditional construction modes and planning principles in what was almost certainly a largely black community. Furthermore, comparison between Barque Bay and Alexandria reveals that a similar persistence operated within the latter Township where we have observed a fragmented wattle and daub dwelling associated with (as at Barque Bay) a freestanding beehive shaped oven and "L" shaped animal pen.

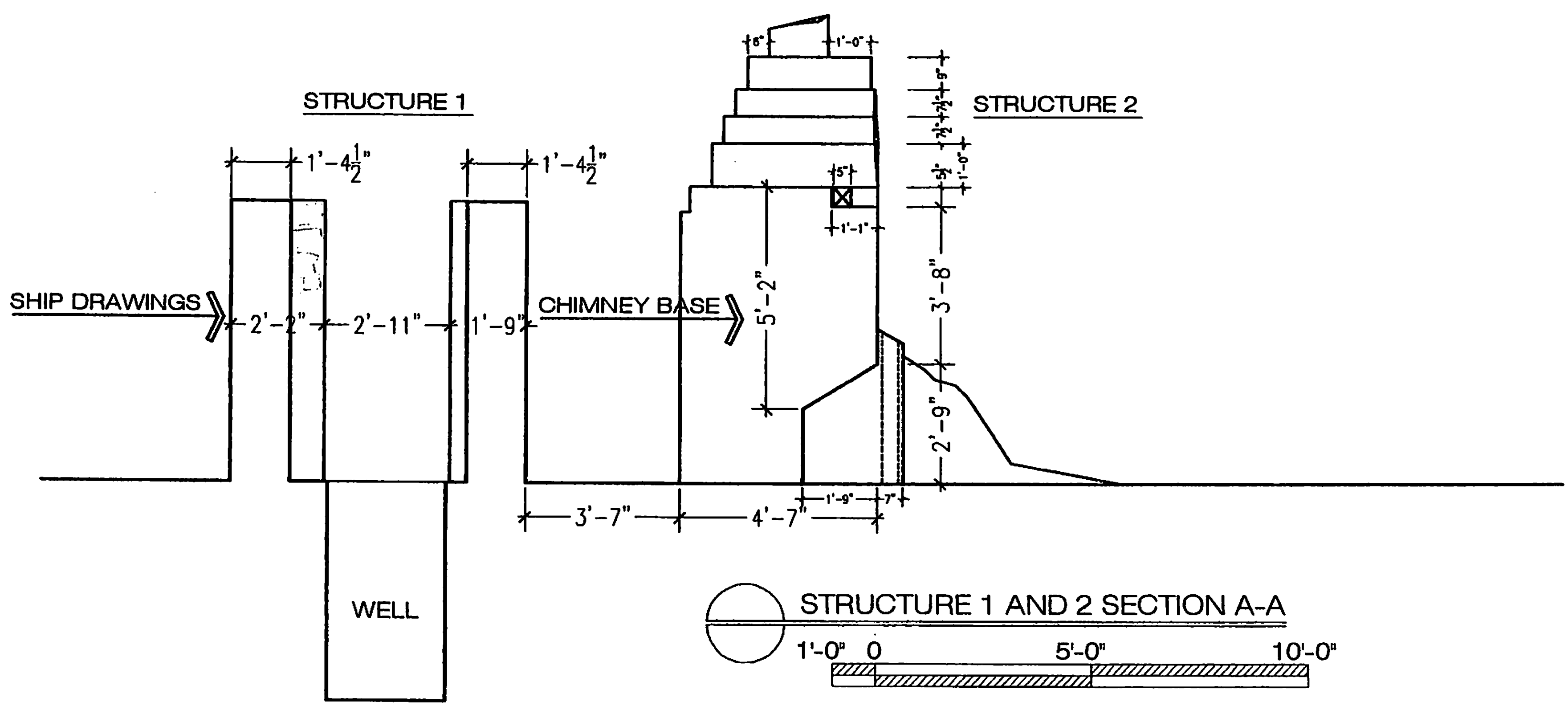
Building Group B, Description

Land within the enclosure west of Lot 1 is occupied by a cluster of relatively large masonry structures which although differing in size and construction appear to have been conceived as a single functional assemblage. All are now more or less ruined but standing elements indicate that components of the group were orientated in similar fashion about cardinal compass points. As a whole the assemblage was enclosed within an area (now heavily overgrown but doubtless once cleared) defined by Field Wall 3 to the west, Field Wall 5 to the north, and on the east by the boundary of Lot 1. It appears that another field wall defined this area to the south, but mechanical clearing along the subject property's southern boundary has largely destroyed evidence for building here.

Measuring 36'-0" north/south x 21'-3" east/west, Structure 2 (located at the southwestern corner of the building group) has the largest footprint of any Group B building. Aside from its wall construction (see below) this structure is distinguished by a substantial fireplace (the base of which still stands to full original height) centered on the south facade. Elsewhere, exterior walls are poorly preserved, now standing at most only 3 feet above ground level. Consequently, evidence for all window openings is lost. However, the remains of three symmetrically arranged doorways survive on the east side, these almost certainly giving sole access to the building when it stood intact. Inside, we found no trace of any spatial division, existing conditions suggesting an undivided interior space measuring 16'-5" east-west x 31'-1" north-south.

Measuring 6'-1" x 4'-7" in plan, the fireplace is fabricated of stone, rubble and lime mortar. Spanned by a 4 1/2" x 5" timber lintel, the fireplace opening (measuring 4'-0" wide x 3'-10" high including the lintel) appears to have incorporated a hearth slightly raised above floor level. The chimney is lost, except for a small stump, but corbeled stonework above the opening, which served to support it, remains in excellent condition.

Figure 43, Barque Bay Structure 2, detail of chimney and hearth, from interior of building toward southeast



BARQUE BAY, GREAT ABACO, THE BAHAMAS
SURVEYED BY COLIN BROOKER MAY 2008

Figure 47, Barque Bay Structure 2, wide base with chamfer on exterior faces, toward southwest

How exactly mortar constituting the relatively thin upper walls was supported or applied is uncertain. Possibly, thin horizontal timber strips were fixed between the timber uprights, mortar then being daubed over posts and strips until the required wall thickness was achieved. More likely, mortar was cast between form boards fixed to or positioned around the vertical posts, using techniques familiar in tabby construction.[38] Either way, the resulting walls lacked strength, ratios between length and thickness being such as to almost guarantee early cracking or disassociation especially as timber posts buried in the fabric (but otherwise barely protected from penetrating moisture) decayed.

Nothing definite is know about roof construction, flooring, window or door frames although door openings (measuring 3'-4" in width on the inner wall face) are unusual, being broadly splayed in plan.

Located immediately behind (south of) Structure 2, Structure 1 is a rock-cut well (excavated to a depth in excess of 5'-0"), enclosed within rubble walls (typically 1'-4 1/2" wide) standing to a height of 6'-6". The well proper is accessed by openings (each 2'-11" wide) positioned opposite one another east and west. Overall the structure measures 10'-0" east/west x 6'-10" north/south. No evidence survives for roofing or other structural details but the south wall is of considerable interest since it is incised with at least two ship drawings and what may be a monogram or Masonic emblem. The better preserved ship drawing represents a schooner under sail (Figure 49).

Figure 48, Barque Bay Structure 1 behind disturbed section of south wall of enclosure, toward northwest.

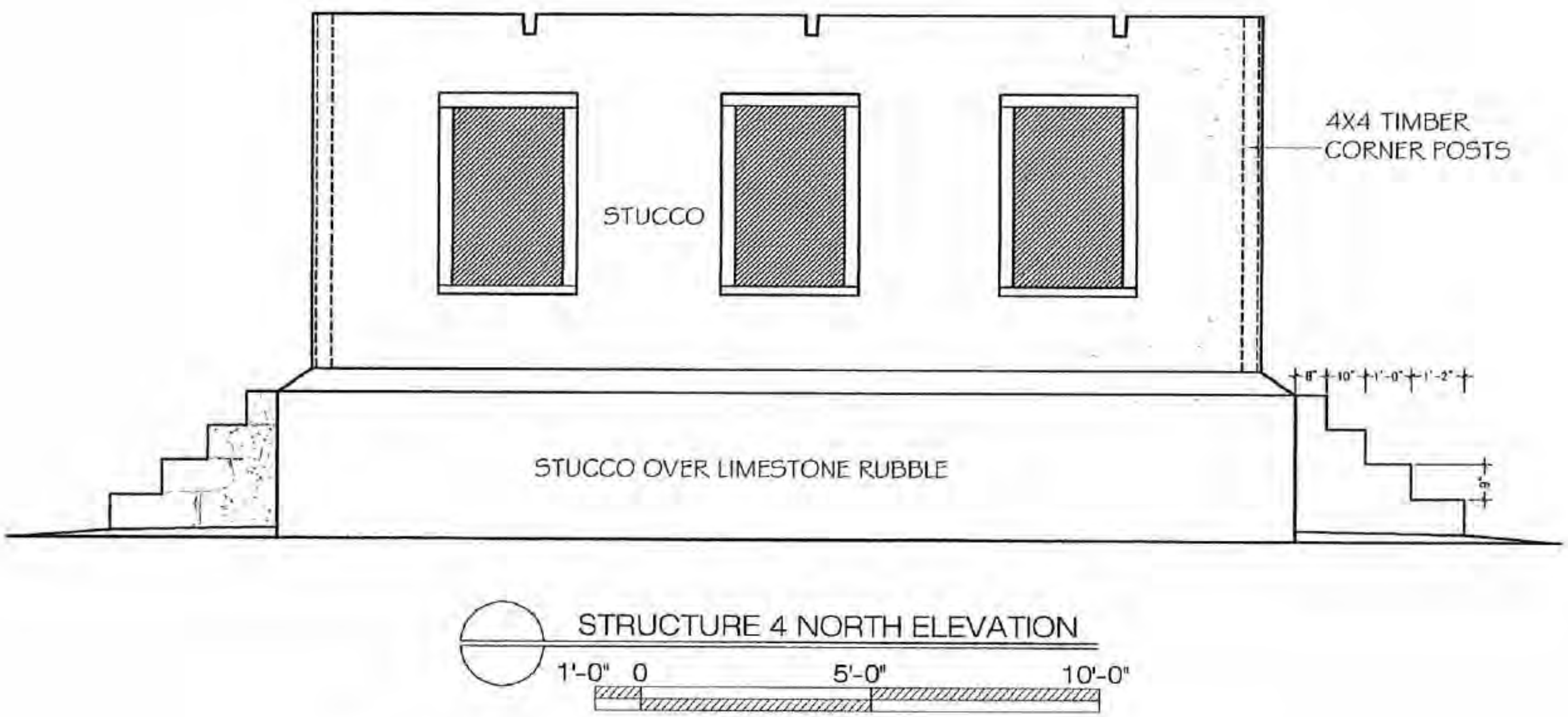
Figure 49, Better preserved ship drawing on south wall of Barque Bay Structure 1

Aligned parallel to Structure 2 on its east side, Structure 3 is a rectangular rock-cut cistern excavated to a depth of at least 5'-0" below present grade. The feature is enclosed by a 2'-10" wide curb or dwarf wall standing 2 feet high and measures (including curbs) 23'-7" north/south x 15'-5" east/west. Originally, this cistern was roofed, closely spaced 4" to 6" diameter logs spanning east/west supporting a 5" thick slab cast in lime mortar, of which only fragments survive.

Figure 50, Barque Bay Structure 3, cistern, toward north

Positioned slightly north-east of the cistern, Structure 4 is a rectangular, masonry building measuring at ground level 27'-10" x 23'-2". Three of its four exterior walls have disassociated and collapsed but the north facade still stands more or less intact to a height of 9'-2" above present grade. This facade shows that the building originally incorporated one storey raised over an elevated crawl space, access steps centered on each long elevation indicating the plan was organized about a through-hall or central passageway running east/west. Another set of external steps attest a third entrance positioned slightly west of the structure's southeast corner, these steps (measuring 3'-5" in width) like other external steps being constructed of limestone blocks.

We found no certain evidence for any internal division, however it should be noted that if not supported by independent foundations, all traces of any timber framed or boarded partition would have been lost when exterior walls collapsed.



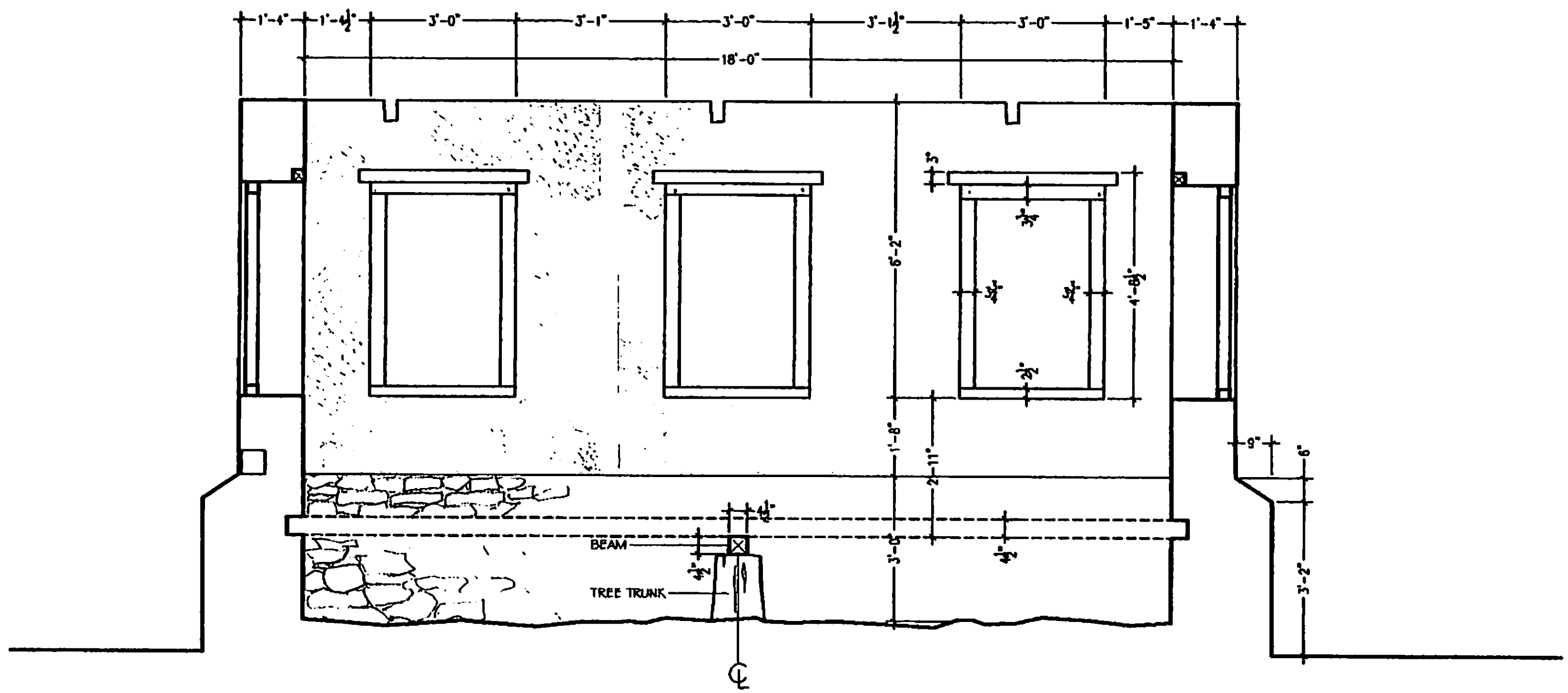
BARQUE BAY, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008

Figure 54, Barque Bay Structure 4, interior view showing beam for joists supported by cedar posts and slots at top of north wall for rafters, toward northwest

Elevational treatment is imperfectly known. The north facade featured three symmetrically spaced windows, each window opening measuring 3'-2" wide x 4'-8" high including a 3" deep timber lintel spanning across the opening. Frames (typically measuring 3 1/2" x 3 3/4" in section) still extant are set flush with exterior building faces. Enough remains of the south facade to indicate its organization was similar except that the most easterly opening here was a door rather than a window. East and west facades are too far gone for any certain reconstruction although it is evident that each featured a central doorway flanked right and left by one, or possibly two, windows.

At ground level, exterior walls are approximately 2'-0" thick, this dimension being reduced by means of an external chamfer to 1'-4" about 3'-0" above ground level. Construction is predominately of limestone rubble set in lime mortar, stuccoed smooth on exterior faces and plastered on the interior, however breaks in wall finishes reveal that the surviving north facade incorporates structural timbers including horizontal cills (now decayed), two 4" x 4" corner posts and perhaps other vertical posts, these timbers being concealed by exterior stucco. Such features suggest that building operations included first laying up a limestone rubble plinth, which supported timber sills and uprights at the point where the exterior wall thickness was reduced in width. What function these timbers performed is difficult to determine though it seems possible they acted as supports during erection of upper wall levels if the latter were cast using a rubble and lime mortar mix poured into timber forms.



STRUCTURE 4 SECTION B-B

1'-0" 0 5'-0" 10'-0"

BARQUE BAY, GREAT ABACO, THE BAHAMAS

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Figure 56, Barque Bay Structure 4, detail of north facade, toward southwest

It is certain that floor joists measuring 5" x 5 1/2" distanced about 3'-4" on center were set in place as the plinth neared completion, the joists, running east/west being supported half way across the building by an intermediate cross beam of pine, measuring 4 1/2" x 4" in section. The beam itself was supported on untrimmed cedar posts, these (like the cross beam) still remaining *in situ.*

Conversely, all roof timbers have disappeared but slots spaced unequally along the top of the north facade indicate the former presence of rafters measuring at least 6" in depth. Other ghost impressions at the junction of north, west and east facades confirm (as rafter slots suggest) that the roof frame was hipped, however, nothing survives of its covering.

Building Group B, Interpretation
Given their common orientation and close proximity, there can be little doubt that the four structures standing on Lot 1 described above are closely related in terms of date and function. Structure 1 (here identified as a well) and Structure 3 (a cistern) were obviously installed to ensure an ample water supply for whatever activities took place on the site. Structure 2 is less easily recognized, however the relatively large chimney centered on its

south facade provides typological links to a series of kitchen buildings known from elsewhere in The Bahamas.

Kitchens built detached from, but in relatively close proximity to, dwellings were commonplace during the late eighteenth century in both urban and plantation settings, this pattern persisting among outlying islands well into the twentieth century. Such popularity is explained by the need to isolate functions which always generated heat and often caused destructive fires.

Examples dating back to the Plantation Period show a surprising degree of uniformity with respect to size and organization. William Walker's kitchen (built circa 1785) on Crab Cay near George Town (Exuma), for instance, measured 22'-7" x 16'-2". At Marine Farm, Crooked Island, a property once owned by James Moss, the freestanding kitchen (early 19th century) located downslope from the main house is very similar in overall form and size measuring 24'-2" x 17'-3" excluding the projecting end chimney. Another plantation kitchen at South Ocean (New Providence) measures 22'-0" x 16'-9" north/south x east/west excluding the chimney base. Of shouldered form, the base in this case extends 3'-0" proud of the west facade and measures 9'-5" in width at grade, dimensions which almost match those of the chimney of Structure 2 at Barque Bay. But the latter is a much larger building (measuring as already noted 36'-0" north/south x 21'-3" east/west) which suggests either communal, institutional or industrial usage, if, as seems likely, it functioned as a kitchen.

Seen in isolation, Structure 4 with its apparent through or central hall plan and ample fenestration appears to reflect domestic occupation, the relatively large floor area and carefully applied finishes pointing to occupants of higher economic and/or social status than those inhabiting the wattle and daub house once standing elsewhere on the site. By what must surely be more than coincidence, Structure 4 almost exactly matches the main building at Lantern Head in orientation, dimension, plan organization and (insofar as can be determined from the present ruins) facade treatment, the two buildings being uncannily alike with respect to style and typology. Moreover, another very similar building (measuring 21'-9" east/west x 30'-2" north/south) stands in the vicinity of Lots 14 and 15 at Alexandria Township.[39] Such resemblances are difficult to explain unless they reflect use of a common model by a group of individuals or a corporate/institutional entity. If the latter, it seems reasonable to conclude that Structure 1 through Structure 4 were erected by, or perhaps for, one of the companies which, during the late nineteenth century, began planting south Abaco, first in pineapples and later in sisal. Indeed, the oversized kitchen at Barque Bay (Structure 2) with its adjacent well (Structure 1) and large cistern (Structure 3) appear consistent with agricultural processing on a commercial scale rather than conventional residential activities.

Since Sawyer and Menendez (owners of adjacent land to the north) are recorded growing sugarloaf and scarlet pineapples on an extensive scale at the "*south end of Abaco*" (including High Bank Bay)[40] in 1871, we believe it likely that the Settlement at Barque Bay was founded to facilitate pineapple production, Structure 4 providing accommodation for a local manager perhaps and Structure 2 containing processing facilities for the harvested fruit prior to shipping.[41] If, in addition to, say, sorting and grading, canning of pineapples took place here is impossible to say in the absence of corporate records. It is recorded that "Sawyer and Co." were operating a sisal plant on Abaco in 1909 but the location of this facility is not given, leaving open the possibility that buildings at Barque Bay were adapted for sisal production some time after 1900.[42]

One striking characteristic of this building group is the fact that it bridges the gap between vernacular and what may be termed "polite" or conventional construction modes. For instance, before falling into ruin, Structure 2 must have seemed almost monumental in scale, exterior walls, giving the impression of expensive stone construction when they actually consisted of cheap mortar applied over slender timber uprights. Consciously or otherwise, such illusion was achieved by resorting to traditional vernacular methods involving either use of wattle and daub or tabby concealed under finish coats of smooth plaster.

At first sight, Structure 4 also appears to be a conventional masonry structure constructed using cut limestone blocks and stone rubble. But, inspection of the ruined exterior walls reveals that they incorporate substantial timbers including vertical posts at building corners and horizontal sills. As already noted this may well mean that walls were laid up between timber form boards, this technique being akin to but not identical with tabby construction seen elsewhere in the context of Bahamian folk building.

Another kind of vernacular or folk expression merits special mention, namely the ship drawings seen incised on the south face of Structure 1. Similar graffiti are widely distributed, early examples being recorded from public buildings such as the Nassau Public Library (formerly Jail) and Fort Charlotte (Nassau) besides a variety of plantation structures.[43] Numerous examples at Alexandria which illustrate sloops and schooners of types once common in Bahamian waters suggest that drawings of this kind continued to be made decades after Emancipation.[44]

Generally, it is accepted that ship drawings were mostly created by individuals of African descent although why this should have been the case has not been explained.[45] Neither is it certain exactly what such drawings signify. Are they for instance tallies of ships seen by residents of a particular site or merely generalized and imaginary pictures? Drawings at Barque Bay do not answer these questions but further attest the impulse for making such representations persisted (at least in south Abaco) into the closing decades of the nineteenth century among predominantly black communities.

Building Group C, Description

About 200 feet north of the Barque Bay enclosure stands another cluster of buildings, this group including an oven, well, fireplace and larger masonry structure here designated Structure 5. Now densely overgrown and ruined, it measures approximately 41'-2" north/south x 24'-4" east/west. Although substantial portions of the two long facades have

Figure 57, Second ship drawing on south wall of Barque Bay Structure 1

Figure 58, Monogram or Masonic emblem on south wall of Barque Bay Structure 1 collapsed and upper portions of north and south facades are heavily damaged, enough fabric remains to attest a single story masonry building defined by 1'-10" thick exterior walls with perhaps end gables carried up in stone. It can also be determined that east and west elevations each featured three door openings (typically measuring 3'-4 1/2" wide x 7'-0") disposed more or less symmetrically, these doorways giving access to the interior space or spaces via exterior stone steps. Window openings were probably positioned between each doorway, one surviving example measuring 2'-9 1/2" wide x 4'-5 1/2"high. Three similar window openings puncture the north facade. The south facade was probably similar but now stands incomplete and heavily overgrown.

Figure 59, Barque Bay Structure 5, detail of north façade

Inside, we found no evidence for interior partition making it impossible to be sure if doorways gave onto three separate units or one large space. However remnants in situ show the principal floor was raised about 2'-9" above grade and designed for heavy loads. Stone sleeper walls (distanced 5'-9" off the interior face of both east and west exterior wall) which originally received floor joists, extended along the building's entire length. Floor joists themselves appear to have been untrimmed timbers of varying dimension.

Enigmatic wall fragments suggest that some kind of porch probably ran along at least part of the west facade but no details could be recovered.

It is likely that a small group of structures located just east of Structure 5 is related functionally to the latter. A well built stone chimney, closely resembling the chimney of

Figure 60, Barque Bay Structure 5, interior of north wall toward northeast

Figure 61, Barque Bay Structure 5, detail of floor joists

Structure 2, suggests one of these buildings was a kitchen, but if so, an oven of traditional beehive form, rather roughly fabricated of stone rubble located nearby seems out of place. A depression just north of the chimney is also enigmatic, suggesting either a cistern or some kind of cellar. Either way, it remains to be determined if Building Group C is a coherent one, or indeed what kind of purpose it was built to serve.

Figure 64, Fireplace west of Barque Bay Structure 5

Figure 65, Oven of limestone rubble with stucco exterior west of Barque Bay Structure 5

Barque Bay Artifacts

At the Barque Bay settlement, four artifact samples were collected from the settlement south of the High Bank property, all associated with building ruins. GPS positions were recorded for each sample along with a short description of the location.

The first sample, labeled ART1 (Figure 66), was collected from a building ruin believed to represent a wattle and plaster structure. Its location corresponds to Lot 3 at Barque Bay, granted to Isaac Farrington on August 1, 1873.

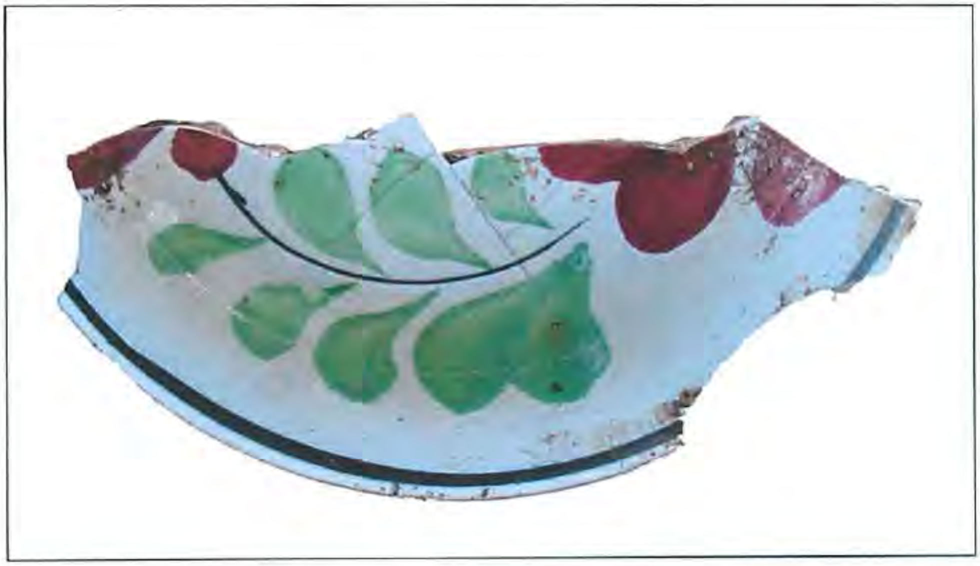


Figure 66, ART1 Barque Bay, Gaudy Dutch hand-painted lid, width 6 inches

The single artifact is a large piece of hand-painted whiteware, probably a lid to a covered serving bowl. The decoration is stylized and simple, green leaves, blue stems and red flowers on a white ground, and there is a thin dark band near the edge. There are no identifying marks. The piece is consistent with Guady Dutch or Gaudy Welch pottery, an inexpensive ware popular from 1810 to 1930. The piece falls within the range of the pattern known as Queens Rose.

The second sample, ART2, is another, smaller, fragment of the same pattern, found at the remains of a small stone structure on adjacent Lot 6. This property, next door to Lot 3 on the south side, was granted to James Farrington, presumably a close relative of Isaac Farrington, on February 1, 1873. The piece shows only a portion of one of the distinctive red painted flowers.

ART3 is a rim sherd from a whiteware dinner plate, featuring an intricate black decorative band with an intertwined floral design bordered by double black bands (Figure 67). The piece is marked "Renaissance H&C" in a circle with crown above and fleur-de-lis below surrounded by branches. The pattern is believed to have been produced at

Staffordshire around the middle of the nineteenth century. It was recovered near the ruins of a structure on Lot 8, granted to Leadon Johnson on August 1, 1873.

Figure 67, ART3 Barque Bay, dinner plate sherd, Renaissance pattern, H&C Mark, width 3.25 inches

ART4, recovered from the ruins of a stone building on Lot 4, granted to J.F. Johnson on August 1, 1873, includes another sherd from a Renaissance pattern dinner plate as well as a pressed glass or sandwich glass saucer fragment. The saucer pattern has a center circle of equal length rays surrounded by a circular diamond pattern terminating in a beaded edge.

The location of artifact recoveries ART1 through ART4 from Barque Bay in relation to ruins, walls and lots is shown in Figure 68).

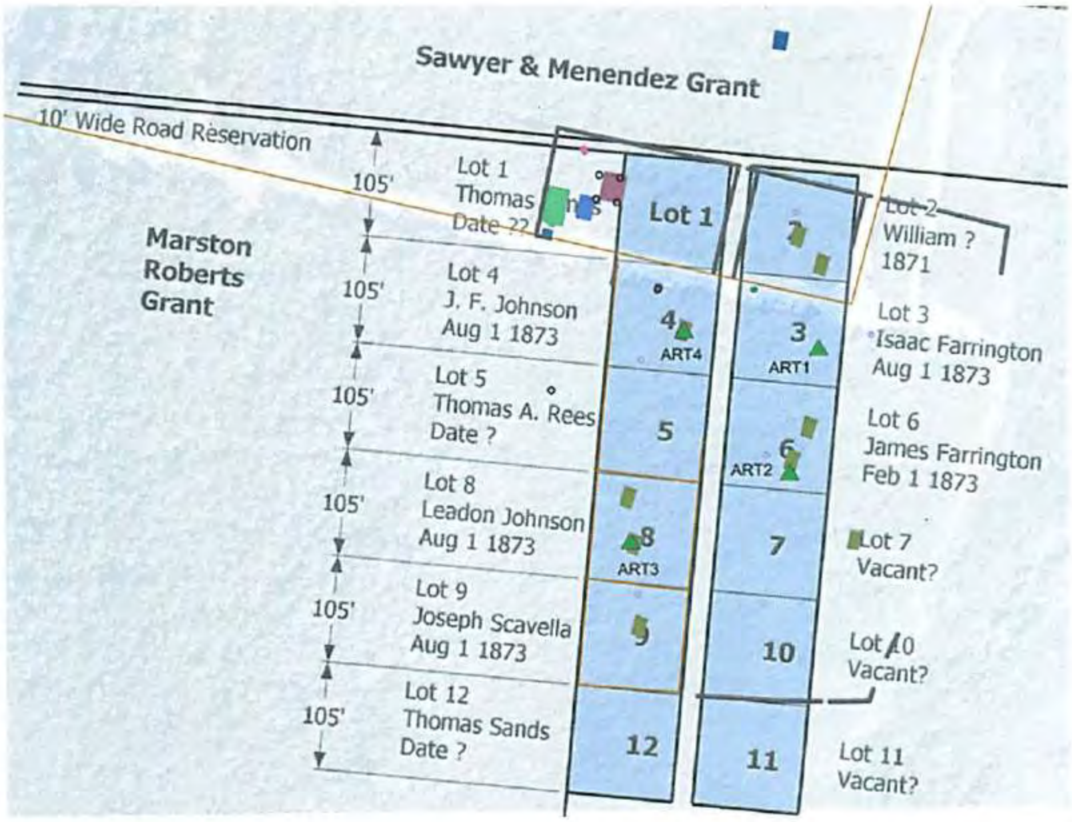
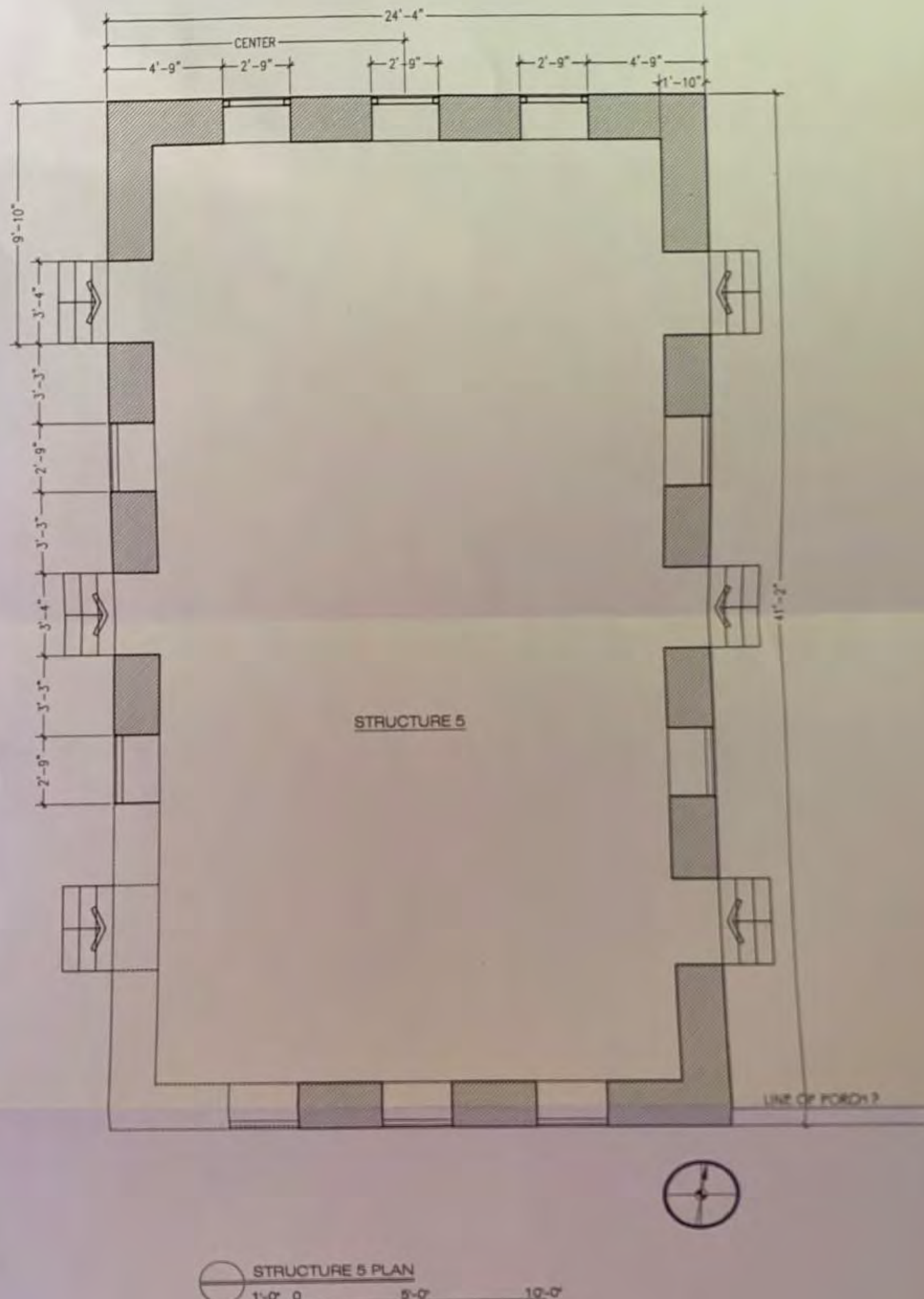


Figure 68. Location of artifacts collected at Barque Bay settlement adjacent to High Bank property



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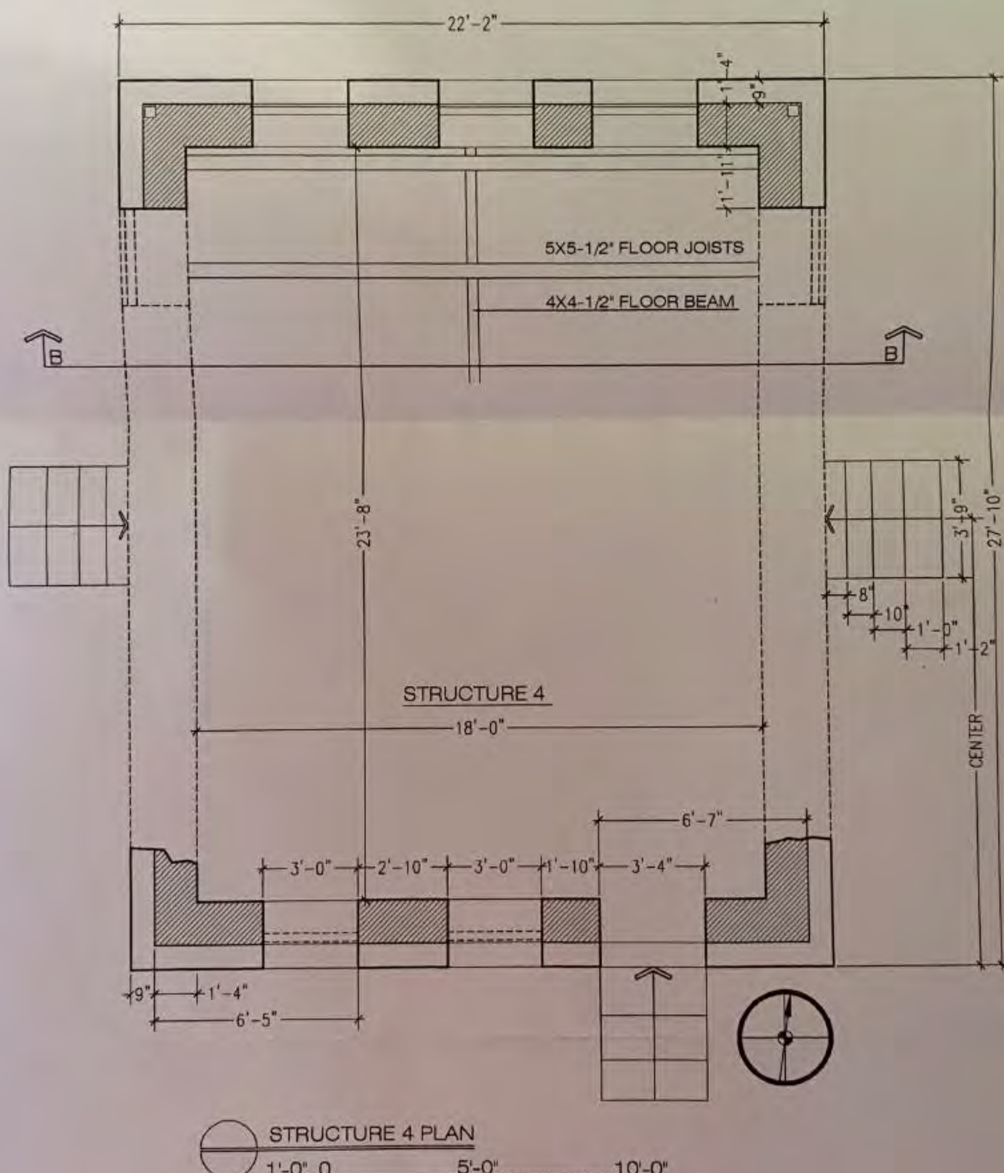

BARQUE BAY, GREAT ABACO, THE BAHAMAS

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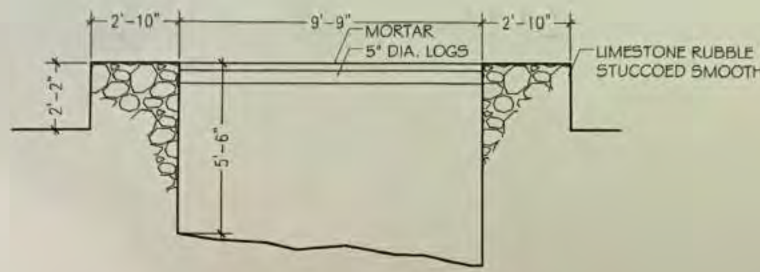

STRUCTURE 3 CISTERN SECTION A-A

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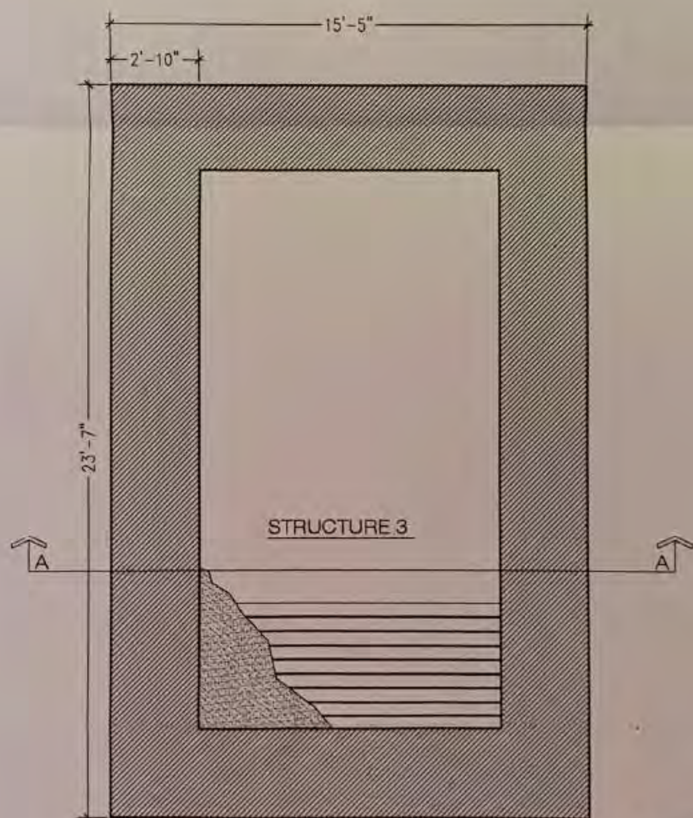

STRUCTURE 3 CISTERN PLAN

1'-0" 0 5'-0" 10'-0"

BARQUE BAY, GREAT ABACO, THE BAHAMAS

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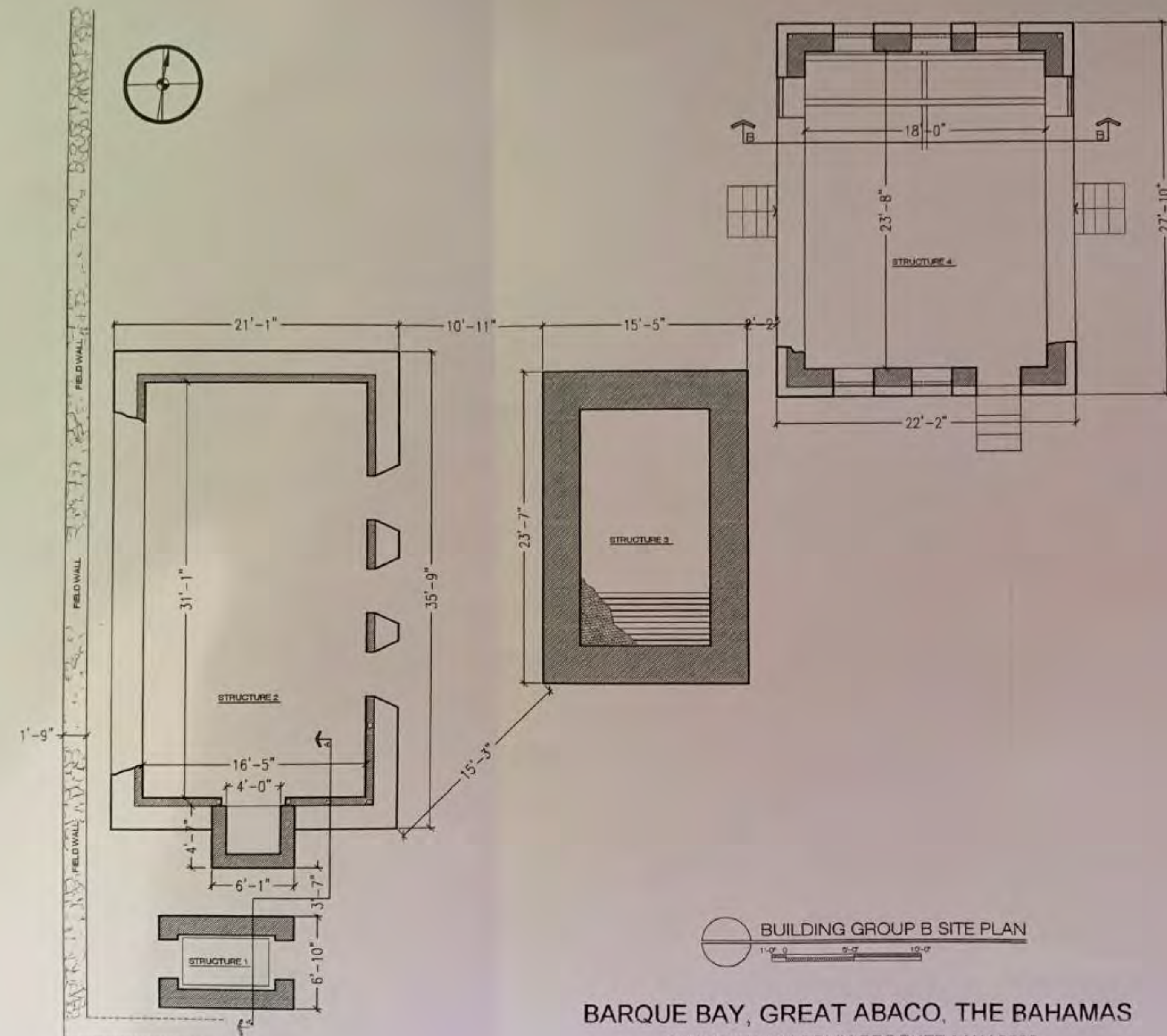

BARQUE BAY, GREAT ABACO, THE BAHAMAS

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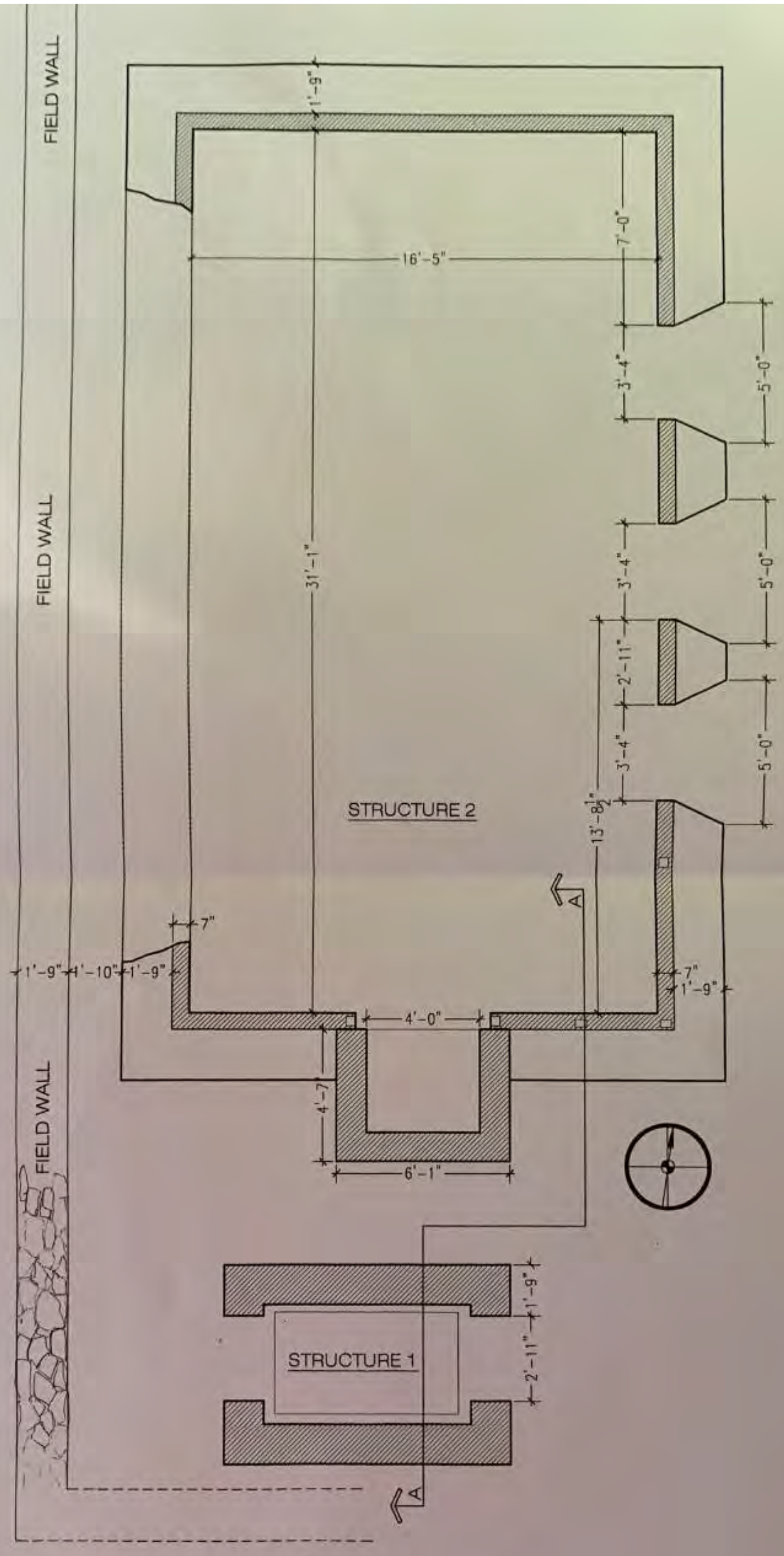
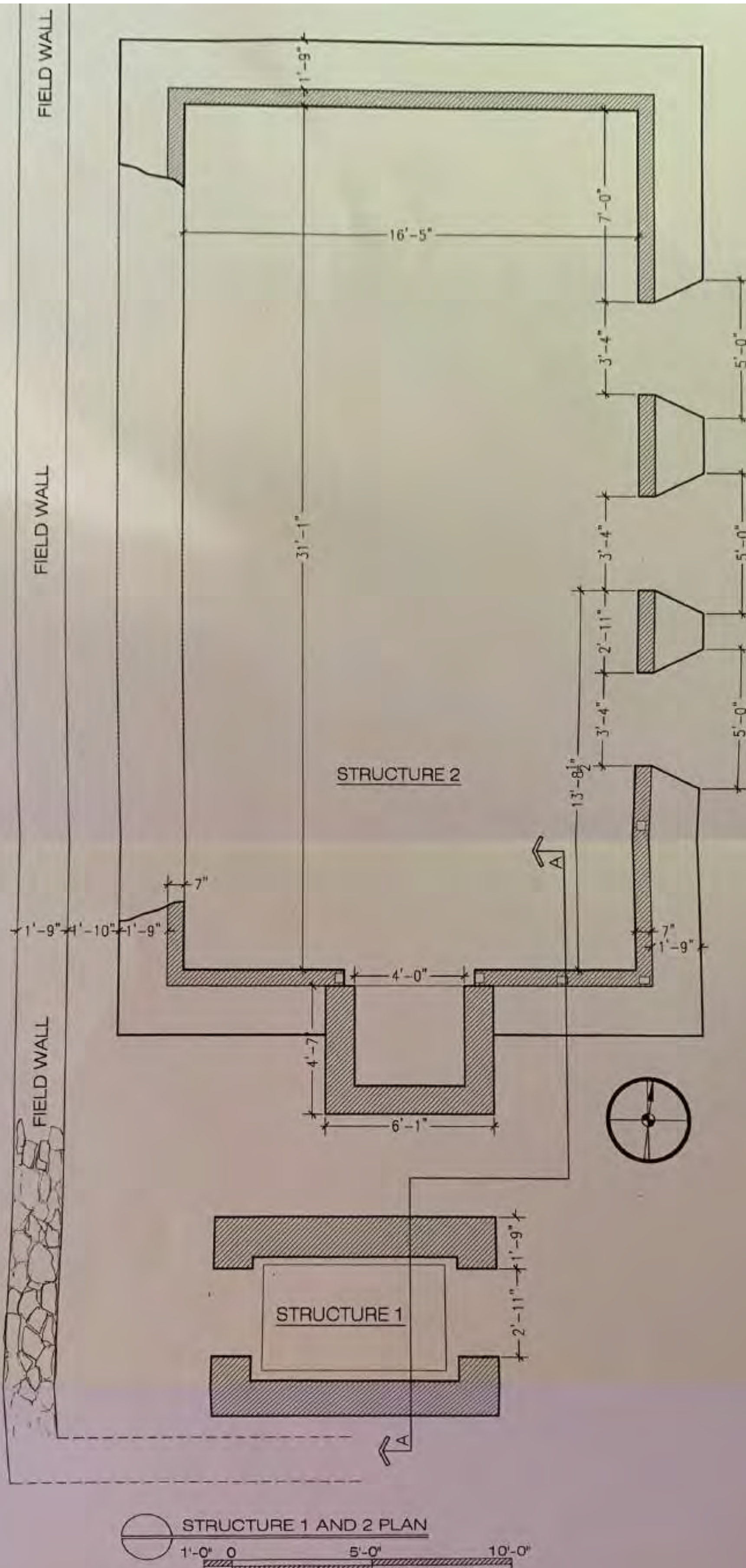


STRUCTURE 1 AND 2 PLAN

1'-0" 0 5'-0" 10'-0"

BARQUE BAY, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008



BARQUE BAY, GREAT ABACO, THE BAHAMAS

SURVEYED BY COLIN BROOKER MAY 2008

Summary and Conclusions

Current investigation has produced a picture of south Abaco at variance with the conventional one, the ruins here described demonstrating that, starting in the 1870's international commerce fueled local development on a previously unprecedented scale. This development included extensive cultivation of pineapples and sisal on previously unproductive lands, investment in buildings, (some substantial, others not), the setting up of machinery for the cleaning of sisal together with establishment of new residential settlements such as Alexandria and Barque Bay.

Architectural survey at the latter site shows that despite an apparent infusion of capital from companies based in Nassau, traditional or vernacular building modes prevailed throughout the settlement, ranging between somewhat rudimentary wattle and daub dwellings erected by individual (predominately black) settlers to larger, "company" buildings most likely fabricated from tabby and an otherwise unrecorded method (which is perhaps a variant of tabby construction) combining mass masonry with relatively lightweight timber framing. The settlement's layout falls into a pattern which perpetuated the kind of formalized grid and linear planning first developed in the context of slave "villages" during the later plantation period and continued among Liberated African settlements during Emancipation and early post-Emancipation times.

Unfortunately, nothing has emerged to indicate exactly when the Barque Bay settlement was abandoned or how prosperous it was during its heyday although casual examination of sherds scattered across the site's southern portion suggest that the inhabitants had access to urban markets, either directly through travel or indirectly through local traders, where they acquired European (predominately English) ceramics of middling quality.

Questions of ownership and patronage invite speculation, obvious architectural similarities at three different settlements (Lantern Head, Barque Bay and Alexandria) suggesting a common model governed erection of their larger structures, though differences in construction indicate execution most likely involved more than one workforce. Were commercial relationships between local companies with a stake in south Abaco's agricultural development (i.e., Johnson & Co, Sawyer & Menendez, Thomas Williams & Co.) close enough during the late 19th/early 20th century then to allow collaboration on building projects realized by different landholders? Or alternatively, did different owners borrow one another's plans? Unfortunately, at the present stage of investigation it is impossible to say. Nor is it known if granting of Crown leases to Johnson for land in the vicinity of Lantern Head has any bearing on these questions, both the historic record and oral tradition being deficient in this regard.

Archival sources do confirm agricultural overproduction, lack of quality control, foreign competition and consequent withdrawal of mercantile activity ultimately led to widespread dislocation of the local population which, during the early 1900's gradually melted away. High infant mortality rates suggest the latter had become impoverished, black freeholders being forced, it seems, to abandon dwellings erected on lands they had managed to purchase from the Crown.[46]

If south Abaco saw out-migration of settlers to other islands or the United States is undetermined.[47] Clearly however, without labour, agricultural establishments at Lantern Head or anywhere else in the vicinity ceased to be viable, depopulation becoming near total some time before 1925 when records of Birth and Deaths from Alexandria Township were returned blank. Subsequently, formerly cultivated lands reverted to 'bush' or open heath, memory of once flourishing pineapple plantations, sisal fields and the settlements they supported, such as Barque Bay, all but disappearing from collective memory.

MANAGEMENT RECOMMENDATIONS

Our project has recorded and evaluated two significant complexes of heritage resources, the Lantern Head Ruins and the Barque Bay Settlement, and placed them in a regional historic context. In itself, that is a comparatively important contribution, especially since the documentary record is so sparse, and since the past human settlement of south Abaco has received so little attention by anyone. Equally important, however, is the opportunity to advance the wise management and long-term preservation of these resources which have been amazingly preserved considering they were abandoned more than a century ago. The abundant remains of buildings, stone field walls, gates, ovens, cisterns, wells and other features that represent the historic landscape have escaped serious disturbance or destruction, mostly because they are inaccessible. However, if future generations are to appreciate and understand these unique remains of a past way of life in The Bahamas, active management is essential.

All indications are that government, the public and many of those who are planning and developing future communities in The Bahamas are already committed to heritage preservation. In this context, it is possible to focus on planning and implementation of reasonable solutions that protect resources from further loss while facilitating public access and public appreciation. In the near future we want to find ways to protect the heritage resources from threats imposed by construction and uncontrolled access. In the mid-range we can prepare for the eventual public use of the property by planning and installing a trail and sign system, stabilizing fragile ruins, and eliminating dangerous conditions for visitors. Over the long term, a reasonable goal is a passive historical park that is open during daylight hours, where visitors and ruins will not pose a threat to each other, and where people can learn first-hand who came before and how they lived. A preserved heritage site is a community amenity that can be used to advantage in many different ways.

During the early phases of development already underway, principals, planners, regulators, contractors and other key people should be made fully aware of the location, nature and potential of the historical resources. This will not only let decision-makers begin to plan for responsible management, it will also disseminate information about the location and nature of the sites to prevent accidents caused by lack of knowledge. The Heritage Preservation Areas recommended at the beginning of this report should be marked clearly on all development maps now to avoid future land use conflicts. The present report should be distributed to appropriate staff and consultants, and, if helpful, one or more presentations can be arranged. The successful preservation and use of the heritage resources will depend on a thorough understanding of how they are at risk, but more important, how they can be put to advantage. As other development team members become aware of the resources, it is appropriate to begin to plan possible routes and means of public access, and generally to determine how the properties will be integrated into the planned community in the future.

The entire Heritage Preservation Area at Lantern Head, and about three-quarters of the Area at Barque Bay (High Bank Tract), are on Crown Land and must be thoroughly incorporated in any permits or agreements with Government. Although two building groups at Barque Bay are on private development property, the ruins themselves as well as the associated artifacts are owned by Government with title assigned to Antiquities, Monuments and Museums Corporation. Regardless of land ownership, treatment and disposition of heritage resources are under the control of Government, and should be addressed explicitly by specific agreements to delineate rights and responsibilities of each party. A desirable outcome would be a public-private partnership that would ensure preservation and public access in ways that ensure long term preservation and benefit the planned community as well as Bahamian residents and visitors.

Before the property is opened to construction activities and public access, whether authorized or not, the Heritage Preservation Areas should be fenced and posted as detailed in the Summary and Management Recommendations section. Presently, the areas are dangerous with open wells and cisterns, fragile building walls and other hazards that pose a risk to people as well as the resources themselves. Artifacts that are exposed on the ground and around the buildings are at risk of being looted. These objects are property of the Antiquities, Monuments and Museums Corporation in the public trust, and should eventually be collected and properly curated, but only under the terms of a permit from that agency.

After the Heritage Preservation Areas are fenced, an historic architect approved by AMMC should be consulted to advise on ruins stabilization and public access. Some ruins may be made safe for visitation; others may be best kept off limits. Stabilization goals, and responsibility for costs should be addressed in agreements between Government and the developer in the context of permits and potential access to Crown Land. A heritage planner approved by AMMC should be consulted to plan a path system, any appropriate infrastructure within the Heritage Preservation Area, and an interpretive program featuring outdoor signs and exhibits. The goal is to design a passive, self-directed interpretation of the heritage resources in a park setting that will require minimum staffing and maintenance over the long term and that will ensure the protection of the ruins as well as the safety of the visitors. Maintenance of heritage resources, as well as natural resources, has continuing costs, and consideration should be given to the establishment of a preservation trust. A property transfer tax that will involve resales as well as initial sales has been shown to be an effective funding mechanism for such long-term conservation efforts.

As planned improvements are implemented, such as stabilization of buildings, creation of public use and restricted zones, installation of paths and facilities and installation of a signage system, the heritage planner should maintain a close working relationship among AMMC, the development company and local community representatives. Efforts should be directed toward creating heritage parks that are responsible to the resources, the public who may well have descendant or ethnic interests in the historic remains, and the new community being created.

NOTES

1 Survey of Abaco Island, Great Bahama, the Mantilla Reef etc. Anthony DeMayne, Surveyor, HM Surveying Cutter *Landrail,* 1817, 1818. UK Hydrographic Office, Taunton, Somerset, Ag.6 D803.

2. The name is said to be derived from a fancied resemblance to an 18th century lantern given by caves in its cliffs but we would not rule out a more sinister interpretation considering that this headland would have provided an ideal lookout for wreckers.

3. See Bahama *Gazette*, January 1, 1789.

4. Reported by *Royal Gazette*, May 27, 1826.

5. We have been unable to find any documentary materials relating to construction of the lighthouse or Soldier Road in archives of Trinity House or the Royal Engineers, the consensus being that these records were destroyed by bombing during World War II.

6. During our survey at Barque Bay, workers employed to cut vegetation traveled by foot along coastal tracks to the site from Crossing Rocks.

7. Pencil note on Map of Land Grants, south Abaco, Department of Land and Surveys, Nassau.

8. In 1963, the then Commissioner wrote: *"it is commonly believed that Sandy Point was settled by the Deans, Dames and Burrows [families) . . . this belief is supported by the common existence of the surnames at Sandy Point and Moores Island. Later settlers migrated from other islands . . . particularly Long Island and Grand Bahama. Today the population is entirely of African descent with a small segment of mulattoes."* (Commissioners's Report, Abaco, 1963, Department of Archives, Nassau). Earlier, it had been noted that the populations of Sandy Point and Moores Island were *"very law abiding"* owing to their *"superstitious ideas of obeah."* (Commissioners's Report, Abaco, 1913, Department of Archives, Nassau)

9. This information is taken from a booklet published to accompany an exhibition called the <u>Pineapple Industry of the Bahamas</u> by the Department of Archives, Nassau, 1977.

10. See Dalleo, nd.:18-19.

11. This method is well illustrated by photographs held at the Department of Archives, Nassau. We observed the same technique being used for the cultivation of fruit and vegetables by Haitian squatters settled near South Ocean, New Providence in 2006.

12. Following his death, the Nassau *Guardian* for 17 April, 1875 reported: *"Mr. Williams arrived at Nassau from England in May 1847. He was engaged as a clerk in the Mercantile firm of Messrs Claypole & Son in Liverpool, which office he left for their branch establishment here. He afterwards conducted Messrs. R. W. Bethel & Co's business in this city, in which firm he was a partner and was also senior member of the firm of Messrs. T. Williams & Co."*

13 Nassau *Guardian*, 24 June 1871

14. Nassau *Guardian*, 12 August, 1871

15. Archives Exhibition booklet, 1977: 26

16. Originals of J. S. Johnson & Co's. Journals were consulted at the Department of Archives, Nassau. Vol. 1 of the series is missing, information given here being extracted from Volume 2.

17. Modern sailing guides state shelter from westerly and northwesterly winds can be found immediately west of the rocky tongue which gave Hole-in-the-Rocks (Hole-in-the-Wall_ its name. Pathways down from the lighthouse above suggest a landing stage was installed here to facilitate transfer of supplies to the Keeper and his family. It should be observed that relatively large stands of sisal still grow on Johnson's former property to the west, suggesting that cultivation, if not processing, of sisal took place here.

18. In 1963, the then Commissioner wrote: *"it is commonly believed that Sandy Point was settled by the Deans, Dames and Burrows [families) . . . this belief is supported by the common existence of the surnames at Sandy Point and Moores Island. Later settlers migrated from other islands . . . particularly Long Island and Grand Bahama. Today the population is entirely of African descent with a small segment of mulattoes."* (Commissioners's Report, Abaco, 1963, Department of Archives, Nassau). Informants at Sandy Point relate how in more recent times they worked in sugar fields (now abandoned) established near Marsh Harbour. Today, tourism promises future employment, as resort development is attracted by south Abaco's near pristine natural environments (part incorporated into the Abaco National Park) and unrivalled sports fishing.

19. Bricks are hand made, relatively soft and match brick used for construction of the bread oven and hearth in Lantern Head Structure II.

20. The 1870 settlement plan shows Capt . W. H. Stuart then owned a small parcel of land just north of Alexandria. For reasons unknown, the reference map at the Department of Lands and Surveys, Nassau does not show this parcel.

21. Following his death, the Nassau *Guardian* for 17 April, 1875 reported: *"Mr. Williams arrived at Nassau from England in May 1847. He was engaged as a clerk in the Mercantile firm of Messrs Claypole & Son in Liverpool, which office he left for their*

branch establishment here. He afterwards conducted Messrs. R. W. Bethel & Co's business in this city, in which firm he was a partner and was also senior member of the firm of Messrs. T. Williams & Co." In addition to lands near Lantern Head, Williams was granted Alexandria Township Plot nos.1; 4; 5; 12; 13; 23; 29; 31; 36 in 1870.

22. Ground surrounding the building group was then strewn with artifacts including glass bottles, fragments of iron cooking pots and ceramics. The ceramics included both glazed and unglazed wares, the majority seen (including numerous transfer wares) dating to the latter half of the nineteenth and early part of the twentieth centuries, with late nineteenth century patterns predominating.

23. The Lighthouse is clearly visible from inside the main building, where relatively large windows once framed panoramic views south to the light, east to Lantern Head and the Atlantic Ocean making it an ideal lookout for observing ships passing into or out of the New Providence Channel and whales migrating with the seasons. It is also positioned close to a sandy beach where small boats might be launched. Although larger sailing vessels could never have found safe haven here except for brief periods, longboats were another matter, these perhaps allowing supplies to be landed or taken off. Continued occupation might explain why the kitchen was sub-divided into two spaces during a secondary building phase.

24. This information is taken from Lands and Surveys Books, B; B1 and K. It should be noted that generally these records are in very poor condition and seem incomplete, copies on microfilm at the Dept of Archives, Nassau not being capable of legible reproduction.

25. According to the Register of Birth and Deaths, Alexandra Township (Registrar General records, microfilm Dept. of Archives, Nassau) James Farrington died of a "rupture" in April 1880. He was aged 38. Locally, "consumption" seems to have been the commonest cause of death, preliminary examination of the records cited indicating that infant mortality was high.

26. Ms. June Maura informs me (Personal Communication, 2009) that the names Loundon Johnson and London Johnson are used interchangeably in local records. The name of Joshua Johnson's mother is given as Josephine Sands.

27. Register of Births and Deaths, Alexandria Township, Abaco. (Registrar General records, microfilm, Dept. of Archives, Nassau). These records apparently include individuals resident not only in the township itself but other settlements scattered across south Abaco. Returns were made as late as 1922 but the latter include no entries.

28. Registers describe individuals as African, European, Mixed or Mulatto, the term African not necessarily, it appears, denoting a Liberated African as designated in earlier Slave Registers.

29. Besides planters (the majority), occupations listed in the Alexandria Registers include ship's carpenters, seaman and a printer.

30. The crucial role played by land surveyors in post emancipation settlement planning is emphasized by Higman (1988: 279) who notes (for Jamaica but equally applicable to The Bahamas): *"when planters decided to subdivide their properties for sale they gave general instructions to the size of the lots but the surveyors interjected their on notions of spatial organization and exercised judgment in the face of circumstances on the ground. Planters, missionaries and surveyors shared a common view of the ideal human landscape, seeking generally to impose order wherever they saw disorder. Thus the geometric organizing principles which emerged in the planning of slave villages by the end of the nineteenth century were carried into the post-emancipation landscape through the layout of townships "*

31. See Saunders, (2000: 196). Little is known about early dwellings at either settlement but, palm thatched "huts" are mentioned in Adelaide, along with a well (shown on the1839 survey), primitive hospital and school. Barque Bay was perhaps too small and short lived to enjoy similar communal facilities, though it is difficult to be sure in the absence of documentation. Land records do show that one lot at Coss Harbor (another abandoned settlement laid out in May 1902, see below) was occupied by the Rev. Jos . W. Roberts "for the Native Baptist Society."

32. Adelaide and Carmichael are both illustrated by the survey of New Providence conducted by Commander Edward Barnett (HMS Thunder) in November 1839. For this submission I have consulted original charts held by the UK Hydrographic Office, Taunton, Somerset (Ref. L1985; L1986 Shelf 718).

33. Little is recorded about Alexandria's history, the earliest land record so far discovered being a plan of the township dated August 4, 1870. This depicts plots aligned approximately north and south of Soldier Road at its western extremity, the plots (numbered 1 through 38) laid out in an irregular grid-like pattern. Newspaper advertisements attest that parcels hereabouts had escheated before 1834 and were then offered for public sale, but no specific details are given.

34. According to a pencil notation on a map held by Dept. Of Lands and Surveys, cross Harbour had been almost abandoned by 1925 when only "Jas. Brown and family" were living there.

35. The Alexandria building incorporates one storey raised on a plinth, the plinth standing about 3 feet above grade, Exterior walls (measuring 1'-4" in width above plinth level) of rubble are heavily damaged making it impossible to gauge their original height, although much exterior stucco and interior plaster survives. North and south facades each feature a central doorway reached by stone steps. Each of these doorways is flanked right and left by a window measuring 3'-0" wide x perhaps 3'-6' high. The east facade presents two symmetrically disposed windows of similar if not identical size. The west facade incorporates one window and (to the north) another, slightly narrower (2'-4 1/2" wide) exterior doorway.

36. For discussion see Farnsworth (2001). On New Providence, specific examples include clusters of dwellings at Belle Vista (now South Ocean), the neighboring Promised Land plantation and site of Louis Johnson's holding at Clifton Point. We have described others from William Walker's Plantation on Crab Cay, Exuma. Similar construction was commonplace throughout the Caribbean region, especially in slave settlements, Handler and Lange (1978: 48) illustrating typical dwellings of the type from Ashford Estate, Barbados.

37. At the lower level exterior walls appear to incorporate quantities of broken limestone rubble, the rubble being cemented together by liberal amounts of lime mortar. Conversely, upper wall levels contain little or no stone.

38. As late as 1950 the local Commissioner wrote: *"The coloured and labouring class on Harbour Island* [Eleuthera] *build their houses of 'Tabby' - rocks of uneven sizes and shapes poured into forms and then plastered this is much cheaper than block construction."* Commissioner's Annual Report, 1950, Harbour Island District. (Bahamas Department of Archives, Nassau). Elsewhere (at an abandoned settlement at Richmond Hill, Great Exuma for instance) we have seen small houses (probably late 19th century) built with lime mortar cast around timber uprights, exterior surfaces giving clear evidence for use of horizontal form boards. Describing early 18th century practice in St. Augustine, Florida, Manucy (1978: 69) describes analogous tabby construction as follows: *lime mortar hardened very slowly . . . one means of reinforcing the green mortar and hastening construction was to insert vertical wooden posts into the wall at about 5-foot intervals. The Spanish term for this technique was* ostion y postes. *The posts not only stiffened the wall, but carried the weight of the roof, thus relieving the new tabby of premature strain."* Visiting St. Augustine in 1765/1766 the botanist John Bartram noted how tabby walls built *"by common soldiers and poor people"* in the city were apt to *"wind and crack."*

39. Reference maps of Alexandria (Department Lands and Surveys, Nassau), show Plot 14 to have been granted to J. S. Johnson and Lot 15 granted to Edwin Carey (described as an "African" planter in Alexandria Register, 1893). Sawyer and Menendez(who as tenants in common were granted land adjacent to the Barque Bay settlement in August, 1870), also owned a plot in Alexandria (No. 19) located overlooking the ocean behind the Lighthouse Store.

40. Nassau *Guardian*, June 24, 1871; August 12, 1871.

41. Few records have been found regarding shipment of pineapples from south Abaco. Where roads were passable it appears probable that the fruit was transported to Alexandria and then shipped to Nassau. Pineapples from High Bank Bay were perhaps taken to Crossing Rocks, or alternatively transferred by lighter to sailing vessels anchored off shore. Similar conditions prevailed on Rum Cay, the Resident Justice recording in 1904: *"The roads are so very poor that no cart or wagon can possibly be utilized. The fruit is consequently conveyed in large baskets either slung across horses' backs or placed on the heads of carriers, The cost of conveyance averages two and a half pence per dozen considerably more than the freight rate at Nassau."* (Cited Archives Exhibition *The*

Pineapple Industry of the Bahamas, 1977 which also notes a large schooner could carry 7,500 to 150,000 pineapples.

42. Colonial Annual Reports, 1907-1911.

43. We have seen other ship drawings on New Providence (Clifton; Bahamas Historical Society Museum, salvaged from Tusculum); Eleuthera (Millers); Andros (Big Pine Cay); Crooked Island (Marine Farm; Great Hope).

44. In many instances at Alexandria, rigging and sails are shown by means of carefully incised lines drawn using a straight edge. Of particular note are drawings depicting steam ships, one of which looks very much like an ironclad vessel of the Confederate era. Additionally, a pennant shown flying from the mast of another otherwise indistinct vessel bears the initials "*N P*" presumably for New Providence. Typically, pictorial graffiti are about 6" to 8" high, there being indications that a few, presumably later drawings, are superimposed on top of earlier ones.

45. For discussion see Turner (2004).

46. Registers for Alexandria Township record that Elizah Roberts, aged 3, died of hunger on February 15, 1911. During the same year (1911) 7 children died of fever, 4 others "born sick" succumbed after a few days.

47. Craton (1962: 256) notes that *"in the decade after 1911 . . . many of the islands lost 10 per cent of their inhabitants to the United States, especially Florida."*

APPENDIX I

List of Grantees of Tracts and Lots from Available Records

NAME	TYPE	DESCRIPTION	GRANT BOOK	ACRES
Albury	Lot	Alexandria, Lot 24		
Armbrister, W.E.	Lot	Alexandria, Lots 8,9		
Carey, Edwin	Lot	Alexandria, Lot 15		
Cooper, T.	Tract	Ordinance Map	B1-113	
Dean, W.M.	Tract	Ordinance Map	B1-36	25
Farrington, James	Lot	Barque Bay, Lot 6		
Fisher, I.	Tract	Ordinance Map	B1-19	55
Johnson, J.F.	Tract	Ordinance Map	B1-20	64
Johnson, J.R.	Lot	Alexandria, Lots 32, 38	RG 6?	
Johnson, John P.	Lot	Alexandria, Lots 33, 37		
Johnson, Joseph S.	Tract	Ordinance Map	B1-2	200
Johnson, Joseph S.	Tract	Ordinance Map	B1-3	123
Johnson, Joseph S.	Tract	Ordinance Map	B1-1	93
Johnson, Joseph S.	Tract	Ordinance Map		74
Johnson, Joseph S.	Tract	Ordinance Map	B1-65	70
Johnson, Joseph S.	Tract	Ordinance Map	B1-1	18
Johnson, Joseph S.	Tract	Ordinance Map	B1-80	12
Johnson, Joseph S.	Tract	Ordinance Map	B-3	12
Johnson, Joseph S.	Lot	Alexandria, Lots 2, 3, 10,	RG 6?	
Johnson, Leadon	Lot	Barque Bay, Lot 8		
Johnson, Samuel	Lot	Alexandria, Lot 17		
Johnson, Thomas	Lot	Alexandria, Lots 27, 28, 35		
Jones, E.A.	Tract	Ordinance Map	B1-36	100
Knowles	Lot	Alexandria, Lots 22, 30		
Knowles, L.P.	Tract	Ordinance Map	B1-5	128
Knowles, L.P.	Tract	Ordinance Map	B1-5	68
Knowles, M.	Tract	Ordinance Map	B1-38	20
Knowles, M.C.	Tract	Ordinance Map	B1-39	20
Knowles, Michael	Tract	Ordinance Map	B1-67	20
Knowles, S.D.	Tract	Ordinance Map	B1-78	10
Knowles, T.	Tract	Ordinance Map	B1-8	20
Knowles, Thomas	Lot	Alexandria, Lot 25		
Laroda, Joseph	Tract	Ordinance Map	B1-88	40
Laroda, Joseph	Tract	Ordinance Map	B1-88	28
Laroda, Joseph	Tract	Ordinance Map	B1-	20
Laroda, Joseph	Tract	Ordinance Map	B1-44	
Laroda, Joseph	Tract	Ordinance Map	B1-44	
Menendez, R.	Tract	Ordinance Map	B1-13	500
Murray, W.M.	Tract	Ordinance Map	B1-32	
Murray, William	Lot	Alexandria, Lot 6		
Newbold, Joshua	Tract	Ordinance Map	B1-37	200
Rattray, W.G.	Tract	Ordinance Map	B1-4	100

Rattray, W.G.	Tract	Ordinance Map	B1-12	22
Rattray, W.G.	Tract	Ordinance Map	B1-35?	20
Rattray, W.G.	Lot	Alexandria, Lot 18		
Rees, T.A.	Tract	Ordinance Map	B1-72	20
Robert, J.	Tract	Ordinance Map	B1-13	100
Roberts, Moreton	Tract	Ordinance Map	B1-19	56
Russell, Duintus	Tract	Ordinance Map	B1-33	100
Sands, Thomas	Lot	Barque Bay, Lot 12		
Sands, Thomas	Lot	Barque Bay, Lot 1		
Sawyer, Robert H.	Tract	Ordinance Map	B1-83	250
Sawyer, Robert H.	Tract	Ordinance Map	B1-72	50
Sawyer, Robert H. & Menendez, R.	Lot	Alexandria, Lot 19		
Scavella, Joseph	Lot	Barque Bay, Lot 9		
Stuart, Capt. W.H.	Tract	Ordinance Map	B1-11	210
Stuart, Capt. W.H.	Tract	Ordinance Map	B1-76	20
Stuart, Capt. W.H.	Lot	Alexandria, no lot number		
Thurston, Arthur	Tract	Ordinance Map	B1-3	123
Thurston, Arthur, & Strachan, S.	Tract	Ordinance Map	B1-7	110
Walker, Tob	Tract	Ordinance Map	B1-92	
Williams, Thomas	Tract	Ordinance Map	B1-9	445
Williams, Thomas	Tract	Ordinance Map	B1-10	20
Williams, Thomas	Lot	Alexandria, Lots 23, 29, 36	B1-25	
Williams, Thomas	Lot	Alexandria, Lots 4, 5		
Williams, Thomas	Lot	Alexandria, Lots 21, 31	B1-32	
Williams, Thomas	Lot	Alexandria, Lots 1, 12, 13	B1-30	
Wood, Henry	Tract	Ordinance Map	B1-8	217
Young & Higgs	Lot	Alexandria, Lot 7		

APPENDIX II

Alexandria Township Register of Births, 1866-1901

Date of Birth	Name	Father's Name	Occupation	Mother's Name
September 20, 1866	Theopelus	Stuart, Alexander	Planter	Davis, Mary
July 15, 1875	Norman Alexander	Dames, Richard	Planter	Dixon, Bella
September 20, 1875	John	Moss,	Planter	Russel, Caroline
July 16, 1886	Isaac	Swain, Zacheus	Sponger	Sims, Frizutella
July 16, 1886	Rebecca	Swain, Zacheus	Sponger	Sims, Frizutella
August 4, 1886	Joshua	Johnson, London	Sponger	Sands, Josephine
August 12, 1886	Diana	Davis, Anthony	Sponger	Davis, Melia
September 20, 1886	George	Swain, Albert	Sponger	Davis, Phebe
September 26, 1886	Felix	Gardiner, Joseph	Sponger	Sands, Eliza
October 8, 1886	Elizabeth	Davis, Isaac	Planter	Swain, Caroline
October 26, 1886	Diana	Carey, Alexander	Sponger	Pinder, Diana
November 16, 1886	Johnathan	McBride, Theophilus	Planter	Mitchell, Margaret
December 2, 1886	Matthias	Davis, Joshua	Sponger	Feaster, Victoria
December 20, 1886	Still Born	Davis, John	Sponger	Swain, Christina
December 23, 1886	Solomon	Davis, Nathan	Planter	Davis, Caroline
December 27, 1886	Edmond	Davis, Jacob	Sponger	Green, Grace
February 5, 1888	Mahalah Ann	Lockhart, Bristol	Seaman	Sims, Cutipre
March 2, 1888	Hezoria Arridain	Sims, John	Planter	Mitchell, Eliza
March 16, 1888	Ishmael	Wilmore, Nathaniel	Sponger	Jane Mitchell, Matilda
March 28, 1888	Edward	Wilmore, Joseph	Sponger	Rolle, Henrietta
April 14, 1888	Edwin Stuart	Stuart, Alexander	Farmer	Davis, Mary
April 18, 1888	Hopful ?	Swain, Joseph	Farmer	Mitchell, Christina
May 6, 1888	Still Born (Setitia)	Davis, Jacob	Farmer	Green, Grace
May 20, 1888	Sutifred	McHenry, Samuel	Farmer	Davis, Rebecca
June 13, 1888	Barbara	Johnson, London	Sponger	Dean, Mary
June 26, 1888	Still Born	Carey, Joshua	Sponger	Russell, Sarah
July 5, 1888	Mahalah Ann	Lockwood, Brister	Planter	Symms?, Eutispy
August 8, 1888	Ishmail	Willmore, Nathanel	Planter	Mitchell, Mathilda
August 16, 1888	Drusilla	Davis, Thomas	Planter	Mitchell, Margaret
September 14, 1888	Isadora	Symms, John	Planter	Mitchell, Eliza
September 18, 1888	Nathaniel	Willmore, Joseph	Planter	Rolle, Henrietta
October 15, 1888	Victoria	Stout, Benjamin	Planter	Corry, Susana
October 16, 1888	No Name	Dorkins, David	Planter	Amfield, Rina
November 12, 1888	No Name	Green, Samuel	Planter	Davis, Letia
November 14, 1888	Manuel	Davis, Aaron	Planter	Mitchell, Alvira
November 22, 1888	Moyanna?	Davis, Solomon	Planter	Davis, Caroline

December 9, 1888	Letetia	Davis, John	Planter	McBride, Louisa
April 25, 1892	Joseph	Green, Joseph	Planter	Davis, Hanna
May 23, 1892	Peter	Russell, Richard	Planter	Willmore, Baby
June 1, 1892	Still Born	Davis, Charles	Planter	Archey, Mary
June 12, 1892	Rebecca	Dames, Thomas	Seaman	Johnson, Caroline
June 24, 1892	No Name	Swain, Albert		Davis, Phoebe
June 26, 1892	Francina	Coolbrook, Obediah	Seaman	Lightbourn, Frances
August 4, 1892	Henry	Lockwood, Brister	Planter	Sims, ?
September 5, 1892	Elina	Davis, Exellous	Seaman	McBride, Francesca
September 24, 1892	Georgeanna	McKensie, Edward	Planter	Swain, Emmaly
September 30, 1892	Still Born Twins	Davis, Aaron		Mitchell, Advera
September 30, 1892	Still Born Twins	Davis, Aaron		Mitchell, Advera
October 28, 1892	John	Sands, Horatio	Planter	Dames, Martha
December 21, 1892	No Name	Saunders, Napolion	Planter	Willmore, Elianor
January 5, 1893	Silvenia	Green, Samuel	Planter	Davis, Letia
January 7, 1893	James	Mitchell, Rufus	Planter	Davis, Sarah
January 14, 1893	John	Williams, George	Planter	Evans, Josephine
February 16, 1893	No Name	Carey, Matthew	Planter	Cayes, Advelda
February 27, 1893	James	Willmore, Elijah	Planter	Sands, Olevia
March 1, 1893	No Name	Barr, David	Planter	Walker, Ramelda
March 13, 1893	Florance	Nil,		Dean, Mary
March 17, 1893	No Name	Sims, Felix	Planter	Swain, Dorothia
March 31, 1893	No Name	Swain, ?	Planter	Sims, Frizzapella
April 1, 1893	Sophenia	Davis, Solomon	Planter	Davis, Caraline
April 2, 1893	Still Born	Stout, Benjamin	Planter	Curry, Lasana
April 15, 1893	Still Born	Davis, Isaac	Planter	Swain, Caroline
April 15, 1893	Still Born	Davis, Isaac	Planter	Swain, Caroline
April 18, 1893	Estell	McKensie, Beleah		Mitchell, Mattilda
April 29, 1893	Still Born	Unknown		Carey, Drucella
May 28, 1893	No Name	Sims, John	Planter	Mitchell, Eliza
June 7, 1893	Saverteter	Swain, Samuel	Planter	McBride, Louisa
June 11, 1893	Emma Jane	Williams, George		Evans, Josephine
July 17, 1893	Elianor	Brown, James	Seaman	Unknown, Unknown
August 4, 1893	Still Born	Stuart, Horatio	Seaman	Foster, Allice
August 5, 1893	Fransener	Johnson, Robert	Planter	Carey, Arabella
September 6, 1893	Alfonzo	Carey, Edwin	Planter	Carey, Advilda
October 0, 1893	No Name	Dames, Sam	Seaman	Dean, Julia
November 11, 1893	Willfred	Williams, Austin	Seaman	Davis, ?
November 18, 1893	Still Born	McKenzie, Belfo	Planter	Davis, Eliza
December 2, 1893	Elizabeth	Smith, Joseph	Seaman	Davis, ?
January 5, 1894	Eufemea	McKinney, Samuel	Planter	Davis, Rebecca

January 15, 1894	Joshuea	Swain, Joseph	Planter	Mitchell, Christiana
February 4, 1894	Rozillia	Coldbrook, Obediah	Seaman	Lightbourn, Francis
February 8, 1894	Mahalea	Dorkins, Jeremiah	Planter	Willmore, Victoria
February 12, 1894	Veleria	Davis, Isaac	Planter	Swain, Caroline
February 25, 1894	Filbert	Mitchell, William	Seaman	Botler, Lovenia
February 26, 1894	Acey	Davis, Aaron	Planter	Mitchell, Advia
February 27, 1894	Elidian	Davis, Thomas	Planter	Mitchell, Margaret
March 10, 1894	Edam	Willmore, John	Planter	Sims, Luda
March 12, 1894	No Name	Dames, George	Seaman	Sike, Baby
March 27, 1894	Cathlena	Stuart, Alexander	Planter	Davis, Mary
March 27, 1894	Isaac	Davis, Zelous	Seaman	McBride, Leadis
October 4, 1901	No Name	Davis, Benjamin	Seaman	Davis, Letia
October 27, 1901	No Name	Swain, John	Planter	Swain, Elina
December 20, 1901	No Name	Stuart, Horatio	Seaman	Stuart, Alice
December 25, 1901	No Name	Williams, Phillip		Williams, Clemantina
Record Damaged	Advilda	Davis, ?	Planter	Fiester, Victoria

APPENDIX III

Alexandria Township Register of Deaths, 1875-1926

Date of Death	Name	Age	Occupation	Cause of Death
January 1, 1875	Rolle, Eleanor	34	Unlisted	Consumption
January 8, 1875	Bethel, Otis	6	Unlisted	Consumption
February 24, 1875	Kemp, George	23	Unlisted	Overstrains
May 28, 1875	Samuel, Robert	65	Planter	Fever and Other Infermities
January 21, 1876	Johnson, Agnes	18	Unlisted	Consumption
April 4, 1876	Johnson, Mary	24	Unlisted	Consumption
January 30, 1877	Russel, Julian	26	Unlisted	Consumption
August 12, 1877	Hamilton, Eliza	60	Unlisted	Fever
September 20, 1877	F., ? Colebrook	3	Unlisted	Fever
October 20, 1877	Crookson, George	16	Printers Apprentice	Consumption
April 7, 1878	No Name	3 Days	Unlisted	Convulsions
April 15, 1878	No Name	11 Days	Unlisted	Convulsions
May 11, 1878	Johnson, John	98	Planter	Fever & Dability
August 6, 1878	No Name	14 Days	Unlisted	Locked Jaw
August 14, 1878	Watkins, Enoch	20	Planter	Consumption
September 3, 1878	No Name	26 Days	Unlisted	Fits
September 17, 1878	Brown, Timothy Wm.	3	Unlisted	Fever
April 24, 1880	Farrington, James	38	Planter	Rupture
September 24, 1880	No Name	3 Days	Unlisted	Spasm
November 12, 1880	Carey, Joseph	68	Planter	?
May 20, 1882	Farrington, Abraham	4	Unlisted	Fever
1883	No Listing		Unlisted	
1884	No Listing		Unlisted	
April 26, 1885	Mitchel, James	56	Planter	Consumption
May 5, 1885	Swain, Rebecca	10 Months	Unlisted	Fever
May 24, 1885	Brown, Phebe	75	Unlisted	Informities of Age
June 5, 1885	Davis, Hezekial	48	Planter	Consumption
June 18, 1885	Gardner, James	70	Planter	Informities of Age
May 2, 1886	Johnson, Jane	54	Planter	Consumption
July 10, 1886	Stuart, Lorrain	8	Unlisted	Fever
August 16, 1886	Swain, Thomas	60	Planter	Consumption
August 21, 1886	Knowles, John B.	5	Unlisted	Fever
August 28, 1886	Swain, Rebecca	3 Months	Unlisted	Fever
September 12, 1886	Johnson, Silowrel ?	2	Unlisted	Consumption
September 12, 1886	Johnson, Cecilin	12	Unlisted	Consumption
September 14, 1886	Brown, Phebe	59	Unlisted	Fever
September 26, 1886	Mitchel, James	48	Unlisted	Consumption

March 14, 1887	Mackey, Matilda	52	Planter	Sudden & unknown
March 30, 1887	Williams, George	2 Days	Unlisted	Locked Jaw
May 1, 1887	Williams, George	1 Month	Unlisted	Fever
June 2, 1887	Sands, James	6	Unlisted	Drowned
June 9, 1887	Sweeeting, Charles	12 Days	Unlisted	Locked Jaw
August 13, 1887	Sands, Mary	54	Planter	Heart Disease
March 24, 1888	Swain, James	4	Unlisted	Spasm
April 21, 1888	Stuart, Jonathan	3	Unlisted	Fever
June 18, 1888	Larimore, James	65	Planter	Fever
June 28, 1888	Symms, Isadore	30 Days	Unlisted	Cough
June 29, 1888	Kemp, Joseph A.	53	Shop Carpenter	Burnt
September 10, 1888	Stoul, Victoria	25 Days	Unlisted	Born Sick
September 12, 1888	Davis, Rachel	60	Planter	Paralyzed
September 15, 1888	No Name	0	Unlisted	Still Born
April 16, 1889	Boodle, Roseanna	24	Planter	Consumption
May 4, 1889	No Name	0	Unlisted	Still Born
May 19, 1889	Davis, Esau	43	Planter	Stomach Complaint
August 4, 1889	Smith, Richard	65	Planter	Paralyzed
August 11, 1889	Sands, Eliza	33	Planter	Consumption
August 31, 1889	Mitchell, Martha	1 Day	Unlisted	Born Sick
August 31, 1889	Mitchell, Mary	1 Day	Unlisted	Born Sick
February 18, 1890	?, Euphelia	6 Months	Unlisted	Fever
April 28, 1890	Farrington, Charlotte	Unknown	Planter	Consumption
June 18, 1890	Sands, Martha	30	Planter	Consumption
July 13, 1890	No Name	1 Day	Unlisted	Born Sick
July 21, 1890	No Name	1 Day	Unlisted	Born Sick
August 2, 1890	Gardiner, Laoharias	19	Planter	Consumption
August 7, 1890	No Name	1 Day	Unlisted	Born Sick
August 28, 1890	No Name	1 Day	Unlisted	Born Sick
August 31, 1890	Carey, Ruth	6 Months	Unlisted	Fell Down
November 8, 1890	Evans, Roseanna	59	Planter	Consumption
November 17, 1890	Stuart, ?	11 Months	Unlisted	Born Sick
January 24, 1891	Green, Perliwe/Perline?	16 Months	Unlisted	Consumption
March 15, 1891	No Name	12 Days	Unlisted	Born Sick
April 6, 1891	Stuart, Lydian	5	Unlisted	Deaformed-Swelling
April 6, 1891	Swain, Jenkins	1 Month	Unlisted	Born Sick
July 4, 1891	Ambruster, Elizabeth	35	Wash Woman	Asama (Asthma?)
January 12, 1892	Ambrister, Elizabeth	35	Planter	Fever
January 20, 1892	McKensie, Beatrice	15 Months	Unlisted	Measels
February 6, 1892	No Name	3 Weeks	Unlisted	Cough
February 13, 1892	Davis, Jessey	18 Months	Unlisted	Fever

April 23, 1892	Saunders, Sarah	22	Planter	Consumption
May 27, 1892	Sands, Clothilda	15 Months	Unlisted	Consumption
June 1, 1892	No Name	0	Unlisted	Still Born
September 30, 1892	Mitchell, Inf.	0	Unlisted	Still Born
September 30, 1892	Mitchell, Inf.	0	Unlisted	Still Born
November 4, 1892	Johnson, William	6	Unlisted	Consumption
April 2, 1893	No Name	0	Unlisted	Still Born
April 15, 1893	No Name	0	Unlisted	Still Born
April 15, 1893	No Name	0	Unlisted	Still Born
April 22, 1893	Russell, Chatham	78	Planter	Fever
April 29, 1893	No Name	0	Unlisted	Still Born
August 4, 1893	Heastie, Stuart	0	Unlisted	Still Born
November 18, 1893	No Name	0	Unlisted	Still Born
November 28, 1893	Willmore, Victoria	4	Unlisted	Crippled from Birth
December 28, 1893	Stout, Benjamin	50	Planter	Consumption
April 3, 1894	Burrows, John C.	39	Seaman	Lost (loss) of Blood
April 6, 1894	Willmore, James	14 Months	Unlisted	Diarehoea (diarrhea)
June 17, 1894	Sims, John	75	Planter	Stopage of Water
July 13, 1894	Sands, Amis	60	Planter	Drowned
July 25, 1894	Davis, Emily	5 Months	Unlisted	Cough
July 31, 1894	Williams, Wednesday	95	Planter	Old Age
August 12, 1894	?, Bruce	6 Months	Unlisted	Cough
August 26, 1894	Swain, Joseph	5	Unlisted	Cough
November 29, 1894	Williams, John	1	Unlisted	Bowles Complaint
December 19, 1894	Lightbourn, Ella	3	Unlisted	Cough
December 23, 1894	Cooper, Timothy	70	Planter	Lost (loss) of Strength
December 27, 1894	Lightbourn, Annie	6 Months	Unlisted	Cough
1895	Mitchell, Enoch	6 Months	Unlisted	Fever
January 28, 1895	Wallace, Louvenia	25	Planter	Consumption
February 16, 1895	Green, Charles	24	Planter	Poison
March 10, 1895	davis, Exellous	24	Planter	Poison
April 23, 1895	Green, Randal	21	Planter	Fever
August 28, 1895	Boodle, James	2 Months	Unlisted	Fever
September 10, 1895	No Name	2 Days	Unlisted	Born Sick
December 15, 1895	Green, Sarah	15	Planter	Fever
April 28, 1897	Willmore, Joseph	75	Planter	Sick Bowels
July 10, 1897	No Name	0	Unlisted	Still Born
February 12, 1908	Willmore, Theophillus	3	Unlisted	Fever
March 23, 1908	Williams, Samuel	3	Unlisted	Drowned
July 25, 1908	Sawyer, Mary	60	Farmer	Fever
August 1, 1908	Boodle, Inf.	0	Unlisted	Still Born

August 8, 1908	Booth, Bartholomew	3	Unlisted	Sickly from Birth
October 3, 1908	James, George	30	Seaman	Bowles Complaint
October 6, 1908	Kemp, Herman	39	Ships Carpenter	Hemourage
October 10, 1908	Albury, Elizabeth	86	Farmer	Fever
October 10, 1908	Raumea, John	1	Unlisted	Fever
October 12, 1908	McBride, Joseph	60	Farmer	Stopage of Water
October 12, 1908	Swain, Inf.	0	Unlisted	Still Born
December 4, 1908	Stuart, Ethel	2	Unlisted	Fits
December 23, 1908	Curry, Inf.	3 Days	Unlisted	Born Sick
January 10, 1909	Dorkins, Charles	6	Unlisted	Fever
January 16, 1909	Nebold, Henary	18	Seaman	Swelling Rumatism
January 25, 1909	Saunders, Sarah	5 Months	Unlisted	Born Sick
February 22, 1909	Mitchell, Samuel	65	Farmer	Insanity
March 31, 1909	Reumea, Reginal	8 Months	Unlisted	Itchin
April 27, 1909	Green, Amos	30	Seaman	Drowned
April 27, 1909	Green, Joseph	9	Unlisted	Drowned
May 8, 1909	Pinder, John	30	Seaman	Paralyzed
June 11, 1909	Brown, Sarah	36	Farmer	Consumption
June 11, 1909	Colebrook, Bradford	11	Unlisted	Bowles Complaint
June 18, 1909	Carey, Ammeta	16	Farmer	Fever
June 24, 1909	Davis, Inf.	0	Unlisted	Still Born
July 11, 1909	Curry, Hilton	2	Unlisted	Fever
July 19, 1909	Carey, Vergenia	15	Planter	Consumption
July 31, 1909	Barr, Edward	21	Seaman	Drowned
August 10, 1909	Fester, Elianor	73	Planter	Sun Struck
August 19, 1909	Roberts, Inf.	0	Unlisted	Still Born
August 19, 1909	Smith, Ellen	59	Wash Woman	Consumption
November 5, 1909	Davis, Caroline	49	Farmer	Consumption
December 6, 1909	Davis, Norman	24	Seaman	Consumption
December 11, 1909	Swain, Sarah	79	Farmer	Fever
December 13, 1909	Smith, Joseph	38	Seaman	Consumption
December 28, 1909	Smith, Lalia	16	Farmer	Heart Failour
December 29, 1909	Symmet, Abram	74	Farmer	Heart Failour
January 7, 1911	Stuart, Alice	36	Farmer	Heart Failure
January 9, 1911	Gipson, Inf.	1 Day	Unlisted	Born Sick
January 16, 1911	Davis, Jacob	66	Farmer	Fever
January 17, 1911	Colebrook, John	4 Months	Unlisted	Fever
January 20, 1911	Johnson, John	3 Months	Unlisted	Fever
February 15, 1911	Roberts, Elizah	3	Unlisted	Hunger
March 10, 1911	James, Mittras	Unknown	Unlisted	Cough
March 12, 1911	Stuart, Alexander	66	Farmer	Rupeted (ruptured?)

March 31, 1911	Belfore, Inf.	2 Days	Unlisted	Born Sick
May 8, 1911	Swain, Inf.	9 Days	Unlisted	Born Sick
July 2, 1911	Sims, Inf.	4 Days	Unlisted	Born Sick
July 17, 1911	Johnson, Lilian	3 Months	Unlisted	Fever
July 28, 1911	Dorkins, Bernice	6 Months	Unlisted	Fever
July 29, 1911	McKenzie, Mary	2 Months	Unlisted	Fever
September 18, 1911	Swain, Hilton	1 Month	Unlisted	Fever
October 18, 1911	Williams, Jamima	25	Farmer	Consumption
1920	Pages, no names		Unlisted	
1921	Pages, no names		Unlisted	
1922	Pages, no names		Unlisted	
1926	Pages, no names		Unlisted	
unknown	Russel, Harriet	18	Unlisted	Measales
unknown	Bain, Jeremia	6 Months	Unlisted	Fever

BIBLIOGRAPHY

Maps and Manuscripts

1817/1818
A Survey of Abaco Islands, Great Bahama, the Mantila Reef with part of the coast of East Florida. Anthony DeMayne, Surveyor, HM Surveying Cutter *Landrail*. (UK Hydrographic Office, Taunton, Somerset: E972 Ag.6 D803).

c 1820
West end of New Providence and Anchorage. Surveyed by Anthony De Mayne, RN, drawn by Edward Barnett.(UK Hydrographic Office, Taunton, Somerset: E972 8 Folio 25).

1839
Island of New Providence, N.W. Part, Sheet No. III. George B. Lawrance, Asst. Surveyor under direction of Commander Edward Barnett, HMS *Thunder*. (UK Hydrographic Office, Taunton, Somerset: L 1986).

J. S. Johnson and Company, Journals. Department of Lands and Surveys, Nassau.

Register of Births and Deaths, Alexandria Township, Abaco. (Registrar General records, microfilm, Department of Archives, Nassau).

Published Sources

Buisseret, David, 1980
Historic Architecture of the Caribbean. Heinemann, London, Kingston, Port of Spain.

Baxter, Jane E. and John D. Burton 2006
Building meaning into the Landscape . Building Design and use at Polly Hill plantation, San Salvador. *Journal of the Bahamas Historical Society*, Vol. 28, 56-61

Craton, Michael, 1962
A History of the Bahamas. London, Collins.

Craton, Michael and Gail Saunders 1992.
Islanders in the Stream, a History of the Bahamian People. Two volumes. Athens and London. University of Georgia Press

Department of Archives, Nassau, 1977
Exhibition, the Pineapple Industry of the Bahamas. Archives Section, Ministry of Education and Culture, Nassau, Bahamas.

Farnsworth, Paul, 1994.

Archaeological Excavation at Promised Land Plantation, New Providence. *Journal of Bahamas Historical Society*, Vol 16 No 1 pp 21-30.

Farnsworth, Paul [editor] 2001
Island Lives, Historical Archaeologies of the Caribbean. Tuscaloosa and London, University of Alabama Press.

Higman B.W., 1988
Jamaica Surveyed. Plantation maps and plans of the eighteenth and nineteenth centuries. Institute of Jamaica.

Joyner, Charles, 1984
Down by the Riverside, a South Carolina Slave Community. Urbana and Chicago, University of Illinois Press.

Manucy, Albert, 1978
The Houses of St. Augustine , 1565-1821. St. Augustine, Florida. St. Augustine Historical Society.

Moss, Valeria Moseley, 2001
Reminiscing, Memories of Old Nassau. Nassau, Media Publishing.

Patterson, Jack, 2002
Native Trees of the Bahamas. Nassau, Bahamas National Trust.

Powles, L.D. [1888]
The Land of the Pink Pearl. Reprint Edition, 1996, Nassau, Media Publishing Ltd.

Riley, Sandra, 1983
Homeward Bound. A History of the Bahama Islands to 1850. Miami,Florida. Island Research.

Sealey, Neil E. 2006
Bahamian Landscapes. (Third Edition). Macmillan Caribbean.

Saunders, Gail. 2000
Slavery in the Bahamas 1648-1838. Nassau Guardian

Saunders, Gail. 2003
Bahamian Society after Emancipation. Kingston, Ian Randle

Turner, Grace, 1994
Plantation Slavery in the Bahamas: An Overview. *Journal of Bahamas Historical Society,* Vol. 16 No. 1, pp. 2 1-30, October 1994

Turner, Grace, 2004

Bahamian Ship Grafitti. Thesis presented to Texas A&M University, on-line version.

Vlach, John Michael, 1993
Back of the Big House, the Architecture of Plantation Slavery. Chapel Hill, University of North Carolina Press.

West Indies Pilot, 1927
Vol.1 (Fifth Edition), Hydrographic Office No. 128. Washington, DC. US Government Printing Office

Appendix K - Project Density

SUMMARY:
PROGRAM DENSITY

THE SETAI
KAKONA

THE SETAI			
SALDCO - Owned Parcel	700.00 AC	43,560 SF/AC	30,492,000 SF
SALDCO - Contract Parcel	281.06 AC	43,560 SF/AC	12,242,974 SF
TOTAL DEVELOPMENT AREA	**981.06 AC**		**42,734,974 SF**
DEVELOPMENT PROGRAM			
Conch Sound Point	55.41 AC		2,413,660 SF
High Bank Bay	58.26 AC		2,537,830 SF
Leeward Harbor	64.17 AC		2,795,460 SF
DEVELOPED AREA	**177.85 AC**		**7,746,950 SF**
DISTURBED AREA DURING CONSTRUCTION			
Conch Sound Point	133.57 AC		5,818,120 SF
High Bank Bay	325.81 AC		14,192,375 SF
Leeward Harbor	90.17 AC		3,927,960 SF
TOTAL DISTURBED AREA	**549.55 AC**		**23,938,455 SF**
DISTURBED AREAS REPLANTED			
Conch Sound Point	66.90 AC		2,914,060 SF
High Bank Bay	276.52 AC		12,045,045 SF
Leeward Harbor	32.11 AC		1,398,760 SF
TOTAL AREA REPLANTED	**375.52 AC**		**16,357,865 SF**
EST. PERCENTAGES			
Disturbed Area during Construction	56.02%	549.55 AC	

SUMMARY:
PROGRAM DENSITY

THE SETAI
KAKONA

Final Constructed Area	18.13%	177.85 AC	
TOTAL DEVELOPMENT PERCENTAGE - COMMERCIAL & RESIDNETIAL			**18.13%**

RESIDENTIAL DENSITY	
The Setai Residence Club - Conch Sound Point	125.00 ea
The Setai Sporting Club - High Bank Bay	171.00 ea
The Setai Harbor Club - Leeward Harbor	106.00 ea
TOTAL	**402.00 ea**
DENSITY UPON COMPLETION	**.41 UNITS/AC**

SUMMARY:
PROGRAM DENSITY

THE SETAI

KAKONA

THE RESIDENCE CLUB							CONCH SOUND POINT
SALDCO - Owned Parcel	300.00 ac	43,560 sf/ac		13,068,000 sf			
SALDCO - Contract Parcel	75.00 ac	43,560 sf/ac		3,267,000 sf			
TOTAL CSP PARCEL AREA	**375.00 ac**			**16,335,000 sf**			

DEVELOPMENT PROGRAM	QTY	CONDITIONED AREA		UNCONDITIONED AREA		
The Residence Club						
Entry & Reception	1.00 ea	1,000 sf	1,000 sf	sf	sf	
Hotel Restaurant / Boutique / Lounge / Library	1.00 ea	12,500 sf	12,500 sf	5,000 sf	5,000 sf	
Pool & Pool Bar	1.00 ea	4,500 sf	4,500 sf	5,000 sf	5,000 sf	
Spa & Wellness	1.00 ea	26,000 sf	26,000 sf	8,000 sf	8,000 sf	
Beach Bar & Grill (Palapa)	1.00 ea	5,000 sf	5,000 sf	5,000 sf	5,000 sf	
Cottages	25.00 ea	2,800 sf	70,000 sf	1,000 sf	25,000 sf	
Staff Housing	25.00 ea	400 sf	10,000 sf	200 sf	5,000 sf	
Back of House	1.00 ea	10,000 sf	10,000 sf	5,000 sf	5,000 sf	
Landscape / Hardscape	1.00 ea			139,000 sf	139,000 sf	
Total Setai Residence Club			**139,000 sf**		**197,000 sf**	
Residence Club Private Villas	58.00 ea	5,000 sf	290,000 sf	1,500 sf	87,000 sf	
Infrastructure						
Exterior Access Road	4,605 lf	20 lf			92,100 sf	
Interior Roads	36,868 lf	20 lf			737,360 sf	
Waterway	10.00 ac	43,560 sf/ac			435,600 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
DEVELOPED AREA					**2,413,660 sf**	**55.41 ac**
DISTURBED AREA DURING CONSTRUCTION						
The Residence Club	1.00 ea	788,000 sf			788,000 sf	
Residence Club Private Villas	100.00 ea	25,000 sf			2,500,000 sf	
Exterior Access Road	4,605 lf	40 lf			184,200 sf	
Interior Roads	36,868 lf	40 lf			1,474,720 sf	
Waterway	10.00 ac	43,560 sf/ac			435,600 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
TOTAL DISTURBED AREA					**5,818,120 SF**	**133.57 ac**
DISTURBED AREAS REPLANTED						
The Residence Club	1.00 ea	649,000 sf			649,000 sf	
Residence Club Private Villas	100.00 ea	10,000 sf			1,000,000 sf	
Exterior Access Road	4,605 lf	20 lf			92,100 sf	
Interior Roads	36,868 lf	20 lf			737,360 sf	
Waterway	10.00 ac	43,560 sf/ac			435,600 sf	
Utility Area	.00 ac	43,560 sf/ac			sf	
TOTAL AREA REPLANTED					**2,914,060 sf**	**66.90 ac**
DISTURBANCE						
Disturbed Area during Construction	35.62%					
Finished Constructed Area	14.78%					
TOTAL DEVELOPMENT PERCENTAGE - COMMERCIAL & RESIDNETIAL				**14.78%**		
RESIDENTIAL DENSITY						
Residence Club Cottages				25.00 ea		
Residence Club Private Villas				100.00 ea		
TOTAL RESIDENTIAL UNITS				**125.00 ea**		
RESIDENTIAL DENSITY UPON COMPLETION				**0.33 Units/ac**		

THE SETAI

KAKONA

THE SPORTING CLUB				HIGH BANK BAY
SALDCO - Owned Parcel	400.00 ac	43,560 sf/ac	17,424,000 sf	
SALDCO - Contract Parcel	103.00 ac	43,560 sf/ac	4,486,680 sf	
TOTAL CSP PARCEL AREA	**503.00 ac**		**21,910,680 sf**	

DEVELOPMENT PROGRAM	QTY	CONDITIONED AREA		UNCONDITIONED AREA		
THE SPORTING CLUB						
Entry & Reception	1.00 ea	1,000 sf	1,000 sf	sf	sf	
Hotel Restaurant / Boutique / Lounge / Library	1.00 ea	12,500 sf	12,500 sf	5,000 sf	5,000 sf	
Pool & Pool Bar	1.00 ea	4,500 sf	4,500 sf	5,000 sf	5,000 sf	
Spa & Wellness	1.00 ea	26,000 sf	26,000 sf	8,000 sf	8,000 sf	
Beach Bar & Grill (Palapa)	1.00 ea	5,000 sf	5,000 sf	5,000 sf	5,000 sf	
Hotel Suites	30.00 ea	1,000 sf	30,000 sf	250 sf	7,500 sf	
Cottages	25.00 ea	2,800 sf	70,000 sf	1,000 sf	25,000 sf	
Staff Housing	25.00 ea	400 sf	10,000 sf	200 sf	5,000 sf	
Back of House	1.00 ea	10,000 sf	10,000 sf	5,000 sf	5,000 sf	
Landscape / Hardscape	1.00 ea			169,000 sf	169,000 sf	
Total Setai Sporting Club			**169,000 sf**		**234,500 sf**	
Sporting Club Private Villas						
Private Estate Home Model	1.00 ea	7,500 sf	7,500 sf	2,500 sf	2,500 sf	
Preserve Lots	58.00 ea	3,500 sf	203,000 sf	1,000 sf	58,000 sf	
Tier 1 - Beachfront	10.00 ea	6,500 sf	65,000 sf	2,500 sf	25,000 sf	
Tier 2 - Hillside	12.00 ea	5,000 sf	60,000 sf	1,500 sf	18,000 sf	
Tier 3 - Hilltop	25.00 ea	5,000 sf	125,000 sf	1,500 sf	37,500 sf	
Private Enclave Beachfront	10.00 ea	5,000 sf	50,000 sf	1,500 sf	15,000 sf	
Infrastructure						
Exterior Access Road	4,605 lf	20 lf			92,100 sf	
Interior Roads	41,725 lf	20 lf			834,500 sf	
Pedestrian Paths & Cart Paths	9,563 lf	10 lf			95,630 sf	
Golf Course	.00 ac	43,560 sf/ac			sf	
Golf Course Maintenance	1.00 ea	10,000 sf			10,000 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
DEVELOPED AREA					**2,537,830 sf**	**58.26 ac**
DISTURBED AREA DURING CONSTRUCTION						
The Sporting Club	1.00 ea	938,000 sf			938,000 sf	
Sporting Club Private Villas						
Private Estate Home Model	1.00 ea	30,000 sf			30,000 sf	
Preserve Lots	58.00 ea	13,500 sf			783,000 sf	
Tier 1 - Beachfront	10.00 ea	27,000 sf			270,000 sf	
Tier 2 - Hillside	12.00 ea	19,500 sf			234,000 sf	
Tier 3 - Hilltop	25.00 ea	19,500 sf			487,500 sf	
Private Enclave Beachfront	10.00 ea	19,500 sf			195,000 sf	
Exterior Access Road	4,605 lf	40 lf			184,200 sf	
Interior Roads	41,725 lf	40 lf			1,669,000 sf	
Pedestrian Paths & Cart Paths	9,563 lf	25 lf			239,075 sf	
Golf Course	200.00 ac	43,560 sf/ac			8,712,000 sf	
Golf Course Maintenance	1.00 ea	15,000 sf			15,000 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
TOTAL DISTURBED AREA					**14,192,375 SF**	**325.81 ac**
DISTURBED AREAS REPLANTED						
The Sporting Club	1.00 ea	769,000 sf			769,000 sf	
Sporting Club Private Villas						
Private Estate Home Model	1.00 ea	22,500 sf			22,500 sf	
Preserve Lots	58.00 ea	10,000 sf			580,000 sf	
Tier 1 - Beachfront	10.00 ea	20,500 sf			205,000 sf	
Tier 2 - Hillside	12.00 ea	14,500 sf			174,000 sf	
Tier 3 - Hilltop	25.00 ea	14,500 sf			362,500 sf	
Private Enclave Beachfront	10.00 ea	14,500 sf			145,000 sf	
Exterior Access Road	4,605 lf	20 lf			92,100 sf	
Interior Roads	41,725 lf	20 lf			834,500 sf	
Pedestrian Paths & Cart Paths	9,563 lf	15 lf			143,445 sf	

THE SETAI

KAKONA

Golf Course	200.00 ac	43,560 sf/ac	8,712,000 sf	
Golf Course Maintenance	1.00 ea	5,000 sf	5,000 sf	
Utility Area	.00 ac	43,560 sf/ac	sf	
TOTAL AREA REPLANTED			**12,045,045 sf**	**276.52 ac**

DISTURBANCE		
Disturbed Area during Construction	64.77%	
Finished Constructed Area	11.58%	
TOTAL DEVELOPMENT PERCENTAGE - COMMERCIAL & RESIDNETIAL		**11.58%**

RESIDENTIAL DENSITY	
Hotel Suites	30.00 ea
Residence Club Cottages	25.00 ea
Sporting Club Private Villas	116.00 ea
TOTAL RESIDENTIAL UNITS	**171.00 ea**
RESIDENTIAL DENSITY UPON COMPLETION	**0.34 Units/ac**

THE SETAI

KAKONA

THE HARBOUR CLUB			LEEWARD HARBOUR
SALDCO - Owned Parcel	.00 ac	43,560 sf/ac	sf
SALDCO - Contract Parcel	103.06 ac	43,560 sf/ac	4,489,294 sf
TOTAL CSP PARCEL AREA	**103.06 ac**		**4,489,294 sf**

DEVELOPMENT PROGRAM	QTY	CONDITIONED AREA		UNCONDITIONED AREA		
THE HARBOUR CLUB						
Entry & Reception	1.00 ea	1,000 sf	1,000 sf	sf	sf	
Club Restaurant / Boutique / Lounge / Library	1.00 ea	8,000 sf	8,000 sf	5,000 sf	5,000 sf	
Pool & Pool Bar	1.00 ea	4,500 sf	4,500 sf	5,000 sf	5,000 sf	
Spa & Wellness	1.00 ea	5,000 sf	5,000 sf	2,000 sf	2,000 sf	
Beach Bar & Grill (Palapa)	1.00 ea	6,500 sf	6,500 sf	5,000 sf	5,000 sf	
Club Rooms	20.00 ea	500 sf	10,000 sf	250 sf	5,000 sf	
Branded Villas	5.00 ea	1,800 sf	9,000 sf	500 sf	2,500 sf	
Staff Housing	10.00 ea	400 sf	4,000 sf	200 sf	2,000 sf	
Back of House	1.00 ea	2,000 sf	2,000 sf	2,000 sf	2,000 sf	
Landscape / Hardscape	1.00 ea			8,500 sf	8,500 sf	
Total Setai Harbour Club			**50,000 sf**		**37,000 sf**	
Harbour Club Private Villas						
Harbor Front Home	75.00 ea	2,000 sf	150,000 sf	1,000 sf	75,000 sf	
Loft Residences	6.00 ea	1,000 sf	6,000 sf	300 sf	1,800 sf	
Infrastructure						
Exterior Access Road	5,280 lf	20 lf			105,600 sf	
Interior Roads	8,580 lf	20 lf			171,600 sf	
Pedestrian Paths & Cart Paths	8,580 lf	10 lf			85,800 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
Harbor Basin	35.00 ac	43,560 sf/ac			1,524,600 sf	
Harbor Walk - Retail / Boutiques / Restaurants	3.50 ac	43,560 sf/ac			152,460 sf	
DEVELOPED AREA					**2,795,460 sf**	**64.17 ac**
DISTURBED AREA DURING CONSTRUCTION						
The Harbour Club	1.00 ea	348,000 sf			348,000 sf	
Harbour Club Private Villas						
Harbor Front Home	75.00 ea	9,000 sf			675,000 sf	
Loft Residences	6.00 ea	3,900 sf			23,400 sf	
Exterior Access Road	5,280 lf	40 lf			211,200 sf	
Interior Roads	8,580 lf	40 lf			343,200 sf	
Pedestrian Paths & Cart Paths	8,580 lf	25 lf			214,500 sf	
Utility Area	10.00 ac	43,560 sf/ac			435,600 sf	
Harbor Basin	35.00 ac	43,560 sf/ac			1,524,600 sf	
Harbor Walk - Retail / Boutiques / Restaurants	3.50 ac	43,560 sf/ac			152,460 sf	
TOTAL DISTURBED AREA					**3,927,960 SF**	**90.17 ac**
DISTURBED AREAS REPLANTED						
The Harbour Club	1.00 ea	298,000 sf			298,000 sf	
Harbour Club Private Villas						
Harbor Front Home	75.00 ea	7,000 sf			525,000 sf	
Loft Residences	6.00 ea	2,900 sf			17,400 sf	
Exterior Access Road	5,280 lf	20 lf			105,600 sf	
Interior Roads	8,580 lf	20 lf			171,600 sf	
Pedestrian Paths & Cart Paths	8,580 lf	15 lf			128,700 sf	
Utility Area	.00 ac	43,560 sf/ac			sf	
Harbor Basin	.00 ac	43,560 sf/ac			sf	
Harbor Walk - Retail / Boutiques / Restaurants	3.50 ea	43,560 sf/ac			152,460 sf	
TOTAL AREA REPLANTED					**1,398,760 sf**	**32.11 ac**
DISTURBANCE						
Disturbed Area during Construction	87.50%					
Finished Constructed Area	62.27%					
TOTAL DEVELOPMENT PERCENTAGE - COMMERCIAL & RESIDENTIAL				**62.27%**		

THE SETAI

KAKONA

RESIDENTIAL DENSITY	
Club Rooms	20.00 ea
Branded Villas	5.00 ea
Harbour Club Private Villas	75.00 ea
Loft Residences	6.00 ea
TOTAL RESIDENTIAL UNITS	**106.00 ea**
RESIDENTIAL DENSITY UPON COMPLETION	**1.03 Units/ac**

APPENDIX L - COST BENEFIT ANALYSIS

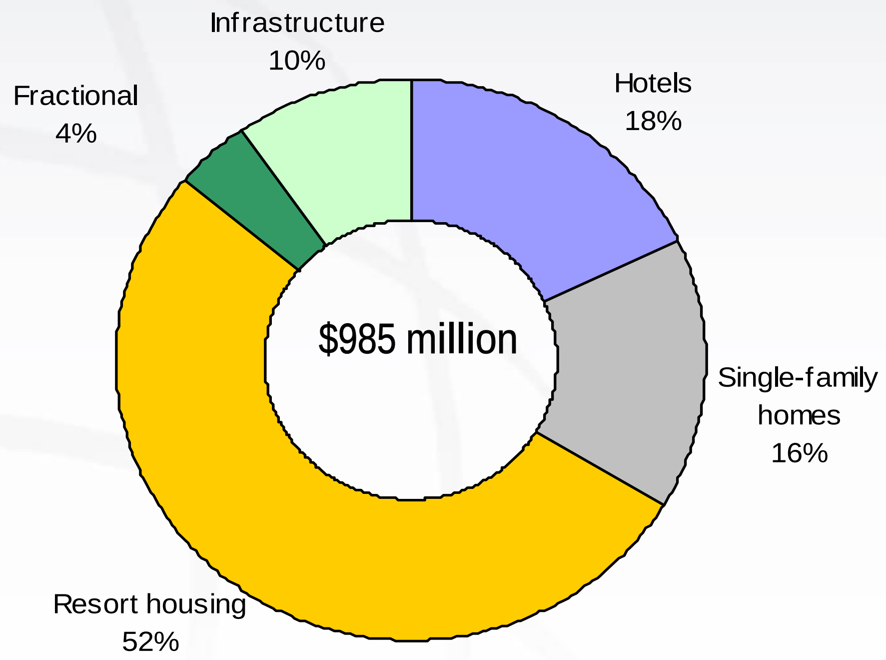
Overview

NOTE: THE INFORMATION PROVIED HEREIN IS NOT CORRECT BASED ON THE UPDATED PROJECT PROGRAM AND CURRENT APPROVALS FROM THE GOVERNMENT OF THE BAHAMAS.

- Valencia Capital and its partners seek to develop over 400 acres on South Abaco on Conch Sound Point, High Bank Bay, and Lantern Head.
- The project includes mixed-use development of the following:
    - Three hotels with a total of 524 keys
    - 1,220 single family homes
    - 164 fractional units
- Total capital costs tally $985 million.
- Another 846-unit development, along with a 262-slip marina is planned for Eagle Bay. This has not been included in this analysis pending discussions between the government of The Bahamas and Valencia Capital.
- This study quantifies the economic impact of the development in terms of GDP, employment, wages and taxes. The study also quantifies various concessions which are sought by the developer.
- The economic model is based on the latest release of Department of Statistics national accounts industry data, the developer’s financial accounts, the tax code of The Bahamas, and the concession parameters sought by the developer.

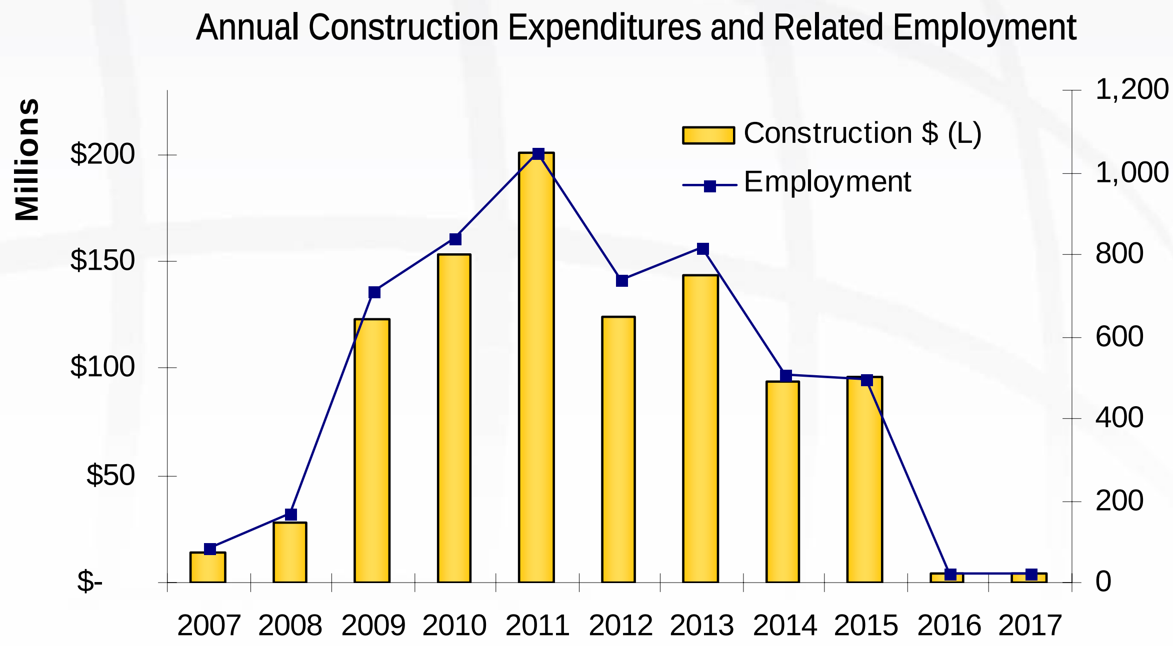
Capital investment

- Total hard construction expenditures will reach $985 million by the end of 2017.
- Infrastructure development of $95 million represents 10% of the total budget.
- Resort housing, which is built to specifications as part of the overall development, represents just over half of construction expenditures.
- Single family homes to be custom developed by lot buyers comprises 16% of construction.
- Hotel development tallies 18% of total construction expenditures.



Construction schedule

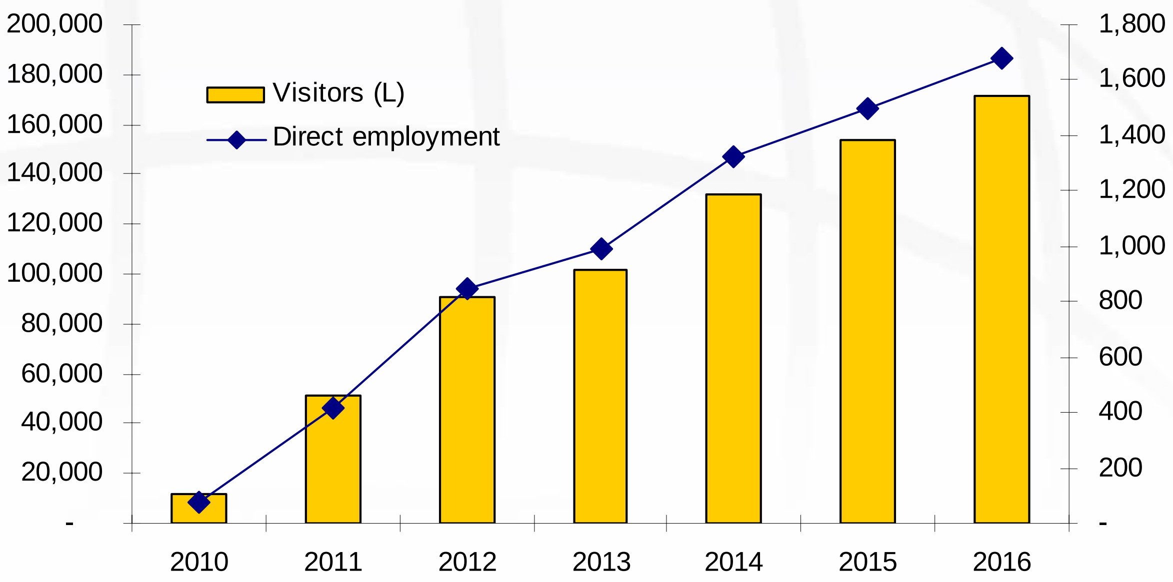
- A construction plan of $985 million will begin in 2007.
- The majority of construction is completed between 2009 and 2015 as hotel and real estate development occurs together.
- Direct construction employment averages over 736 during this period, peaking at 1,000 jobs in 2011.



Visitation and employment

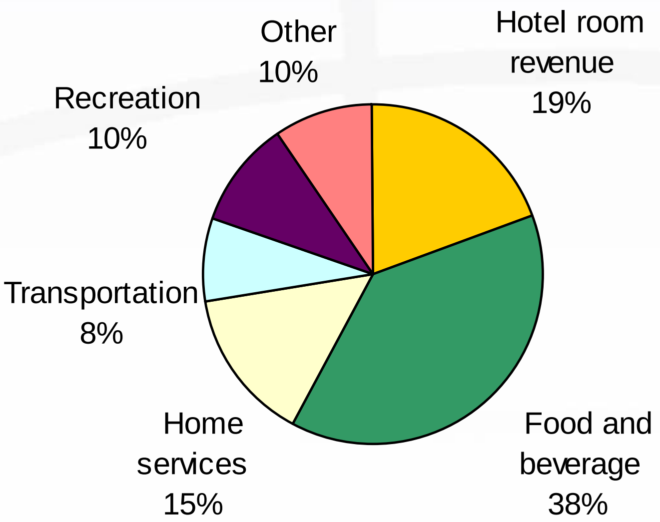
- Person visits to the property will reach nearly 170,000 by 2016.
- Direct employment at the resort will tally 1,700 at full operation.

Total annual tourist visits and full-time employment



Visitor spending

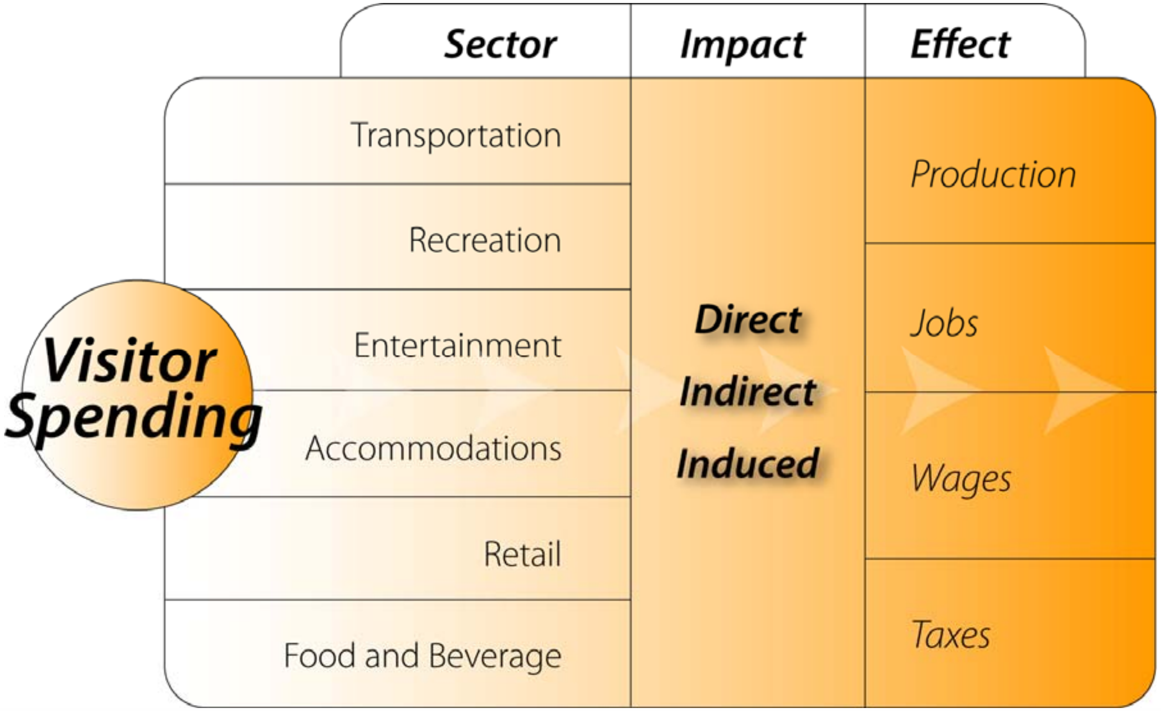
- In 2016, the new property will inject $262 million in visitor spending into the Bahamian economy.
- In addition, direct taxes-- including stamp, departure, property, and occupancy taxes–exceeding $17 million a year will be paid by visitors.



Expenditures, $ million				
	20-Year Sum		2016 (Full Build)	
Hotel room revenue	$	948	$	47
Food and beverage	$	1,860	$	96
Home services	$	707	$	32
Transportation	$	388	$	20
Recreation	$	496	$	26
Other	$	465	$	24
Sub-total	$	4,863	$	244
+ direct taxes	$	1,186	$	17
TOTAL	$	6,049	$	262

Economic Impact Levels

Tourism Economics has built a model of the economy of The Bahamas based on data from the Department of Statistics. The below diagram summarizes the flow of the economic model. Capital investment, real estate transactions, and visitor spending all flow into the local economy, creating direct, indirect, and induced (income effect) impacts. The model calculates these impacts on local production (GDP), jobs, wages, and taxes. These are then benchmarked against the value of any concessions typically over a twenty-year period.



Economic Impact Levels

- The impacts are measured on three levels:
  - Direct impact: The immediate benefit to persons and companies directly providing goods or services to the visitor.
  - Indirect impact: The secondary benefit to suppliers of goods and services to the directly-involved companies. For example, a food wholesaler providing goods to a restaurant. The model is careful to exclude imports from the impact calculations.
  - Induced impact: The tertiary benefit to the local economy as wages of employees in the prior two levels of impact are spent on goods and services. For example, a restaurant employee spends his wages on retail goods, generating addition economic output.

Construction impact

Development	
	Total (Cumulative)
Total Construction Expenditures	**984,587,069**
Gross Domestic Product	
Direct	**263,728,112**
Indirect	**41,781,689**
Induced	**61,101,960**
TOTAL	**366,611,761**
Wages	
Direct	**148,513,137**
Indirect	**12,093,448**
Induced	**32,121,317**
TOTAL	**192,727,902**
Employment	**Average ('09-'15)**
Direct	**736**
Indirect	**73**
Induced	**195**
TOTAL	**1,004**

- Over ten years, total hard construction expenditures of $985 million will generate $366 million in GDP, $264 million of which will be directly in the construction sector.
- This will generate $193 million in wages and salaries.
- The construction process will directly employ an average of 736 persons during the peak seven years of development.
- The modeling assumes a mix of Bahamian and non-Bahamian companies for the repatriation of profits.

Operations impact

Operations	20-Year Cumulative
GDP Summary	
Direct	**1,584,000,506**
Indirect	**251,856,080**
Induced	**515,875,701**
TOTAL	**2,351,732,287**
Wages Summary	
Direct	**1,247,124,946**
Indirect	**119,994,591**
Induced	**246,862,580**
TOTAL	**1,613,982,117**
Employment Summary	**Full Build**
Direct	**1,727**
Indirect	**194**
Induced	**397**
TOTAL	**2,318**

- Over a 20-year horizon, resort operations will generate $2.35 billion in GDP.
- This will supply $1.6 billion in local wages and salaries.
- At full operation, the new facilities will directly sustain 1,727 direct jobs (FTE) and a total of 2,318 jobs.

Government revenue

Government Revenue*		23-Year Cumulative
Stamp conveyance on property purchase	$	6,100,000
Stamp Conveyance, first sales (10%)	$	62,763,227
Stamp Conveyance on Resales (3% of stock/yr)	$	53,699,439
Property Tax on lots/homes	$	97,520,175
Business License Fee	$	12,271,958
National Insurance	$	109,746,995
Construction Import Duties	$	24,388,866
Operations Import Duties	$	666,249,698
Departure Tax	$	44,146,677
Occupancy Tax	$	113,750,751
TOTAL REVENUE	**$**	**1,185,837,786**

*Net of concessions. Includes 3 construction years and 20 years of operations.

- Over a 23-year horizon, (beginning with the purchase year, 2007) the new project will generate $1.19 billion in government revenues, the majority of which will come from import duties.
- It is assumed that 3% of the residential and fractional units will turn over per year, generating ongoing stamp tax.
- Property tax is assessed on the single family homes, which are outside of the Hotels Encouragement Act.

Concessions benefit-to-cost

Concessions	23-Year Cumulative	
HEA Construction Import Duties (all development)	**$**	**130,417,901**
HEA Real Property Tax (rental units)	**$**	**290,752,297**
Land Concession		
TOTAL	**$**	**421,170,198**

ROI Metrics	23-Year Cumulative	
Total GDP Impact	**$**	**2,718,344,048**
Total Tax Impact	**$**	**1,185,837,786**
NPV (5%)	**$**	**609,880,724**
Total Concession	**$**	**421,170,198**
NPV (5%)	**$**	**247,818,688**

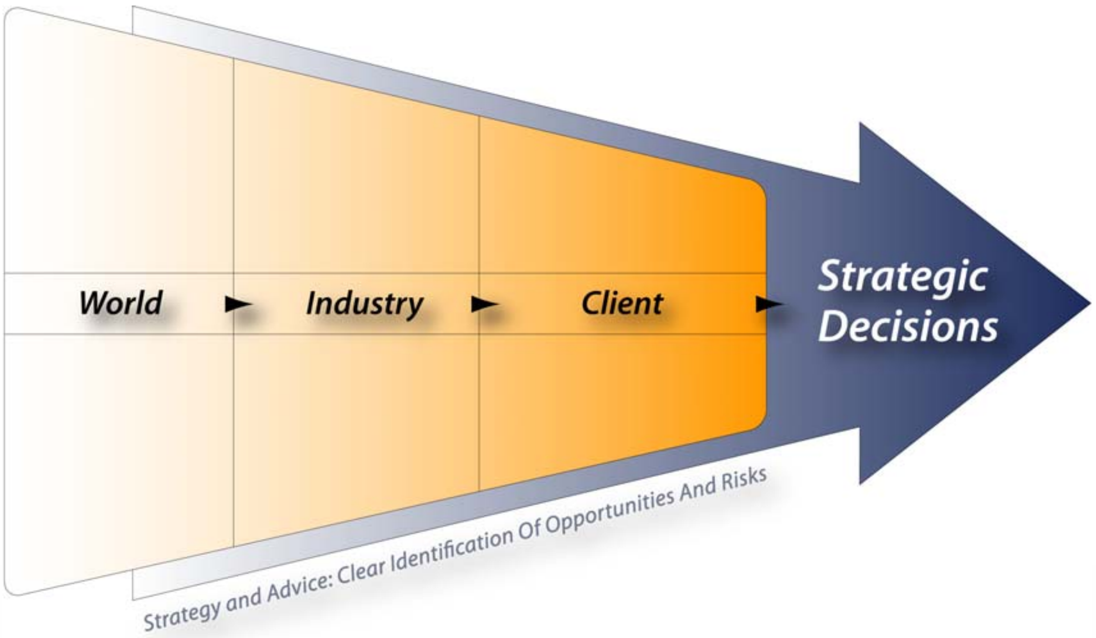
Benefit to Cost	23-Year Cumulative
CAPEX / Concession (NPV)	**3.0**
Tax Revenue / Concession (NPV)	**2.5**
GDP Impact / Concession (NPV)	**6.0**

- Concessions requested include: The Hotel Encouragement Act for property tax and construction import duties.
- The total value of these concessions is $421 million ($247 million NPV).
- The project's local capital investment is 3.0 times the value of the concession.
- The expected tax generation is 2.5 times the value of the concession.
- The expected GDP impact is 6.0 times the value of the concession over the same time period.

Our partner: Oxford Economics

- Founded in 1981
- Over 300 clients including blue chip companies and government agencies throughout the US, Europe, Asia and the Middle East.
- 50 staff, including more than 30 professional economists with at least Masters qualifications in economics from top-flight universities around the world.
- Offices in Philadelphia, Oxford, London & Switzerland.

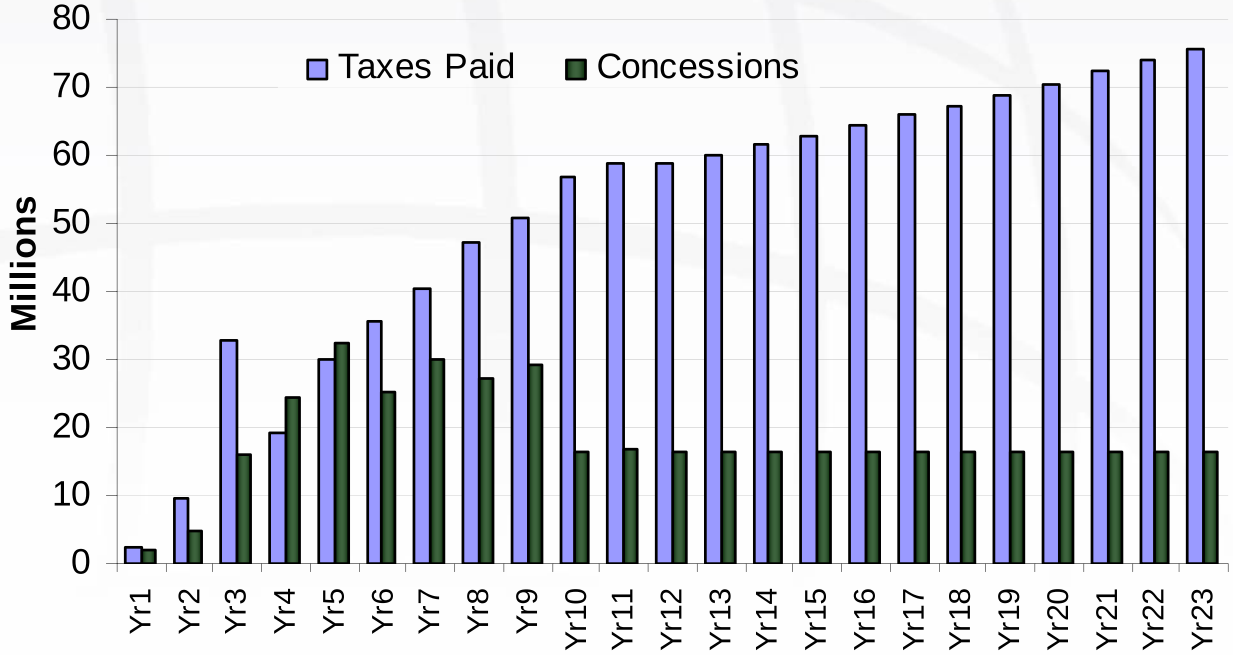
Economic models and analysis cover 175 countries and industrial sectors in detail.



Concessions schedule

Concession run throughout the development period via import duty and property tax abatements. The property tax abatement tracks with development on a rolling 20 years with a full concession for 10 years. (HEA indicates a $20 / room property tax for the next ten years.)

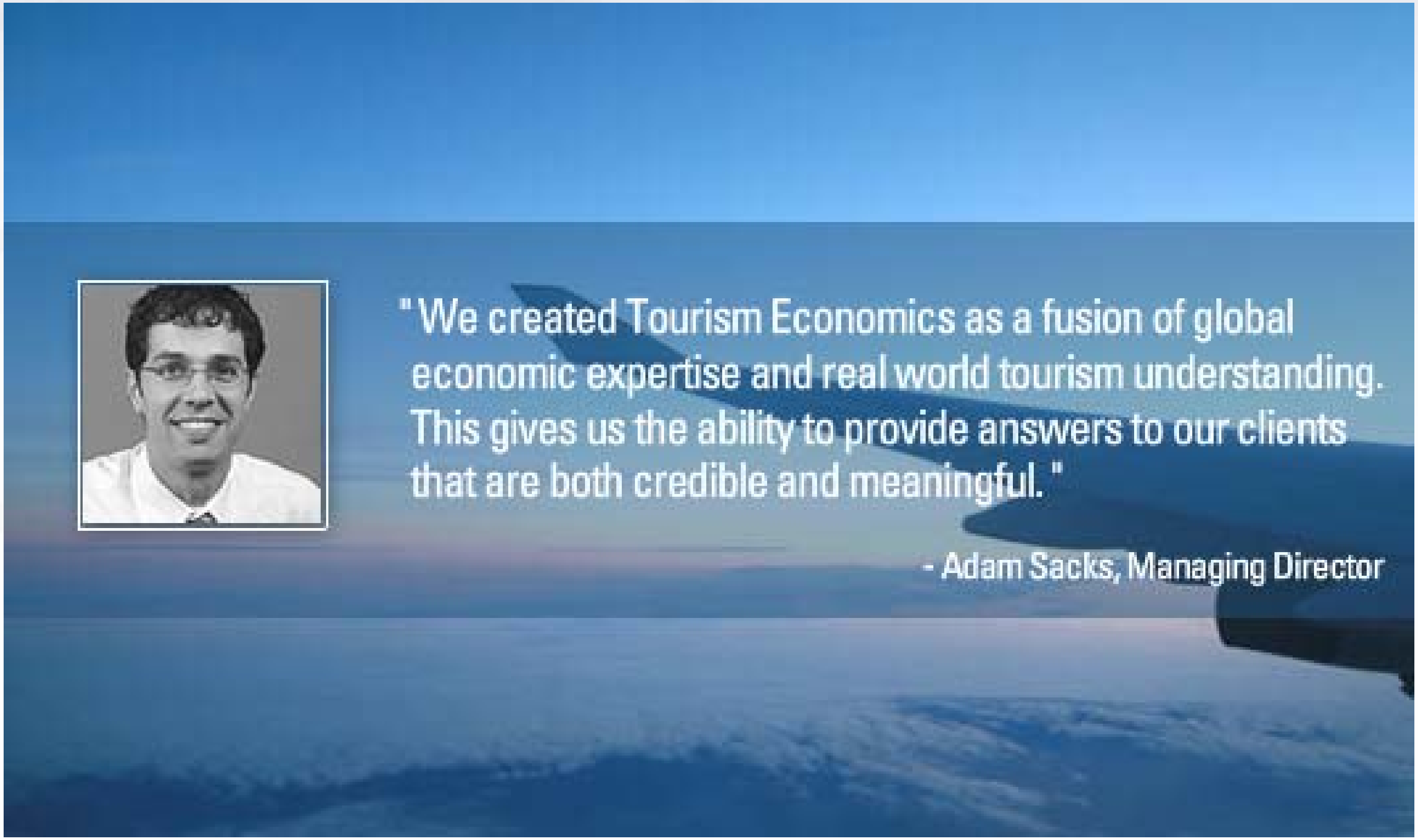
Over this period, tax generation exceeds tax abatements by a factor of 2.5 on a net present value basis.



About Tourism Economics

- Tourism Economics, headquartered in Philadelphia, is a distinct unit of Oxford Economics USA dedicated to providing high value, robust, and relevant analyses of the tourism sector that reflects the dynamics of local and global economies. By combining quantitative methods with industry knowledge, Tourism Economics designs custom market strategies, project feasibility analysis, tourism forecasting models, tourism policy analysis, and economic impact studies.
- Oxford Economics USA is one of the world's leading providers of economic analysis, forecasts and consulting advice. Its services cover three main areas: economic forecasts, for around 200 countries globally and over 70 sectors; user-friendly economic models for scenario analysis and policy assessment; and economic consultancy, including detailed work for the tourism and aviation sectors.
- Founded in 1981 as a joint venture with Oxford University's business college, Oxford Economics has a reputation for high quality, quantitative analysis and evidence-based advice. For this, it draws on its own staff of 30 highly-experienced professional economists; a dedicated data analysis team; global modeling tools; close links with Oxford University, and a range of partner institutions in Europe, the US and in the United Nations Project Link.
- This study is based on an impartial analysis of economic impact using various data sources including The Bahamas Department of Statistics and the developer. Changing market conditions could effect visitor demand for the attraction which could affect the results of this study positively or negatively.
- Full annual schedules and key assumptions are available upon request.

Our mission


"We created Tourism Economics as a fusion of global economic expertise and real world tourism understanding. This gives us the ability to provide answers to our clients that are both credible and meaningful."
- Adam Sacks, Managing Director

Our focus


How can we help you?
- Feasibility Studies
- Market Assessments
- Impact Models
- Policy Analysis

Past clients

The Ginn Company
Dubai Tourism & Commerce Marketing
New York City and Company
Singapore Tourist Board

Baha Mar Development Company
Tourism Authority of Thailand
Discover America Partnership
London Tourism Authority

Travel Industry Association
Travel Business Roundtable
Grand Bahama Promotion
US Office of Tourism Industries

Gulf Air
Etihad Airways
Intercontinental Hotels Group
Airbus
Hong Kong Tourist Board
World Travel & Tourism Council
Bahamas Ministry of Tourism
Visit Britain
Tourism Ireland
Canadian Tourism Commission
Hungary Ministry of Tourism
Kerzner International

Saudi Tourism Commission
Visit Scotland
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