Environmental Impact Assessment

For Williams Cay

The Exumas, The Bahamas

September 2016

Revision 1

waypoint CONSULTING LTD

ATM APPLIED TECHNOLOGY & MANAGEMENT

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EXECUTIVE SUMMARY

In May of 2016, the Bahamas Environment, Science and Technology (BEST) Commission approved the Terms of Reference (TOR) provided by CBC Services for the development of a comprehensive Environmental Impact Assessment (EIA) for a proposed luxury resort hotel, marina, golf course, and residential community on Children's Bay Cay and Williams Cay, Exuma, The Bahamas.

CBC Services has conducted an Environmental Impact Assessment (EIA) for a proposed resort development on Williams Cay, a sparsely inhabited island near Barraterre off the northern tip of Great Exuma. The purpose of this EIA is to support the master planning of the island and identify potential environmental impacts, explore alternatives and identify mitigation opportunities to offset both short term and long term potential environmental impacts. The planned out-island resort development will consist of 16 low density private villas, four rental villas and a golf course with clubhouse facility for guests and residents. The Owner intends to maintain the existing natural shoreline, select undisturbed areas, and will revegetate disturbed areas with native vegetation, transplanting existing trees where feasible.

The island golf course construction, along with the Children's Bay Cay development, is expected to generate several hundred temporary jobs which will evolve into 200 to 300 permanent staff jobs once the golf course becomes operational. In addition, businesses on Great Exuma will directly benefit from increased demand for local goods and services from this development. Facilities to accommodate service vessels will primarily be provided on Children's Bay Cay with some additional service vessels utilizing the existing docking area on Williams Cay.

Currently, the island is sparsely developed with onsite power generation and water desalinization. The new development will require power generation, a desalination plant for potable water and a wastewater treatment plant. The electrical power and potable water facilities will be constructed on an off-island site to be located on Barraterre and the wastewater treatment facilities will be constructed on Williams Cay. Alternative renewable energy sources such as photovoltaic solar arrays are being considered to provide a sustainable electrical source for the project and to reduce the demand from Barraterre. These systems will be further investigated as the electrical supply system engineering moves into the design stages.

The Owner's planning and design team has given the highest level of attention to environmental aspects, existing natural features and planning for environmental management, for development of a golf course on Williams Cay. The project team is committed to utilization of comprehensive and state-of-the-art environmental technologies and management methodologies to mitigate and manage impacts. Careful consideration has been given to the environmental impacts and sequence of development activity to minimize long-term and short-term adverse impacts to the upland and marine ecology. In support of this goal, the following project components and methodologies will be implemented.

- Clearing for all required areas will be limited to the immediate area necessary for golf course, roadway, dwelling construction and amenities. Adjacent area clearing will be restricted to thinning the underbrush and clearing areas with invasive or low resource value underbrush.
- During clearing and grading activities necessary for golf course construction, trees listed under the Conservation and Protection of the Physical Landscape Act, Protected Trees Order, including the *Guaiacum sanctum* (lignum vitae), which are known to be native to this area will be temporarily relocated as much as possible and replanted on this island and Children's Bay Cay. The EMP will outline further details for the replanting plan as well as the invasive species control plan.
- Landscaping around the golf course, villas, and clubhouse areas will make extensive use of the diverse selection of native vegetation representative of the island with emphasis on reusing impacted trees listed under the Conservation and Protection of the Physical Landscape Act, Protected Trees Order.
- Detailed management programs for the construction and operation of the golf course will be developed to provide state of the art techniques for both of stormwater runoff management and leachate control to minimize environmental impacts. These plans will be included with the future EMP submittal.

- Stormwater runoff will all be directed to drain internally and be collected where feasible and reused for irrigation.
- As part of this development, the Owner seeks to establish a marine protected area that will incorporate Windsock Cay and will exclude power boats and serve as a protected area for conch and other marine species.
- The existing shoreline and beaches will be left undisturbed in their natural condition.
- All power and potable water infrastructure will be constructed offsite, will be purpose built for the project and should create no impacts to adjacent community electrical, water and wastewater infrastructure. Electrical power and potable water for the project will be generated on Barraterre and wastewater will be treated on Williams Cay. Solid wastes will be removed from the island for offsite disposed in an approved landfill on Great Exuma. During construction, waste wood products will be burned and waste concrete products will be utilized as fill onsite or landfilled offsite.

In support of the EIA, the Owner has conducted a survey of the island to identify important natural and cultural resources. The studies included the following:

- An inventory and mapping of the upland plant and animal species and habitats.
- A qualitative reconnaissance survey and mapping of dominant species within the marine habitats in the areas of interest around the island with descriptions of dominant marine species and benthic communities.
- An assessment of cultural and historic resources on the island.

These studies serve as the baseline to design and develop Williams Cay in a manner that minimizes environmental impacts and preserves the coastal zone, including the nearshore marine environment. These studies also provide the baseline conditions upon which positive and negative impacts have been quantified. The following summarizes the key impacts, both positive and negative, defined under this EIA.

- Approximately 132 acres of upland habitat will be impacted due to clearing for the golf course, villas and roadway. This will likely result in the reduction of habitat for some species of nesting birds and permanent loss of dry broad-leaved evergreen forested area. A nursery area will be established during construction to temporarily maintain notable trees that can be moved without damage for subsequent planting in revegetated areas of Williams Cay and on Children's Bay Cay.
- The project's landscape architects will emphasize planting trees listed under the Conservation and Protection of the Physical Landscape Act, Protected Trees Order, including the Guaiacum sanctum (lignum vitae), which are fairly frequent on Williams Cay.
- The entire shoreline and all beaches will be managed to preserve and enhance native vegetation and habitats.
- Additional habitat will be created through enhancement of the two existing salt ponds on the island and creation of an additional three ponds with permanent pools to allow for more substantial invertebrate colonization and foraging opportunities for birds. All ponds will be planted with a fringing mangrove community.
- Leachate impacts from the golf course will be controlled via the use of minimal applications of slow release fertilizer, stormwater runoff collection, and seashore paspalum cultivars to allow for the use of higher salinity irrigation water with a resultant reduction in the use of herbicides and pesticides. A nutrient management plan will be included in the Williams Cay EMP to address fertilizer application, ground water management, and runoff control.
- The bridge between Williams Cay and Children's Bay Cay will be designed with all pile supports landward of the high water line.
- Minimal impacts to SAV and hardbottom resources are expected due to the careful design and management of the golf course and no dredging or overwater construction activities other than replacement of the existing dock on Williams Cay.
- Elimination of unregulated anchoring and potential illicit discharges to the waters adjacent to the proposed marine protected area will have a positive impact upon water quality conditions, SAV and benthic resources within the area.

- Impacts to existing water and wastewater infrastructure on adjacent islands will not occur since these services will be provided fully on Barraterre (potable water) and Williams Cay (wastewater treatment).
- Minimal cultural and historic resources were found to exist on the island. However, any additional resources discovered during construction will be preserved and studied in cooperation with the government.
- This EIA presents the design and planning conducted to date for the development of Williams Cay and the environmental, social and cultural impacts associated with the present master plan.
- All additional planning and detailed design efforts will be conducted in accordance with the objectives of this EIA document, with additional details to be provided to the Bahamas Government as addendums to this EIA as the project develops should any additional regulatory requirements be identified.

In accordance with this EIA document and with the proper planning, application and monitoring of the Environmental Management Plan and if Best Management Practices are conscientiously planned, engineered and implemented, many of the impacts that are generated during construction and operation should be minimized or completely eliminated for the proposed project.

This document is a revised version of the original submitted in July of 2016 and reflects clarifications and additional information requested by the BEST Commission following their review.

1.0 Introduction and Objectives

This study presents an environmental impact assessment (EIA) for the Williams Cay project proposed by CBC Services, Ltd. The general location of Williams Cay in the Exuma chain of islands is shown in Figure 1-1. This EIA was completed in accordance with best practices and the objectives of the EIA and the scope are described in the following sections. CBC Services, Ltd. is the owner of Williams Cay and Children's Bay Cay.

1.1 Key Issues from the Terms of Reference Meetings

The following key issues were identified based on input from BEST during the March 2016 site visit and during a meeting with BEST on April 25, 2016. They were incorporated into the draft TOR provided to the Best Commission on May 5th 2016 which was approved on May 20, 2016. Per the approved TOR, the EIA effort must include or address the following:

1 *A comprehensive EIA covering all aspects of the project including cumulative impacts will need to be completed. Two (2) EIAs will be submitted under separate cover, one for Children's Bay Cay and one for Williams Cay.*

2 *An in-depth review and analysis of back-of-house operations on Barraterre, Exuma will be provided as a supplemental report. The EIAs for Children's Bay Cay and Williams Cay will outline back-of-house operations as it relates to specifically the Cays. The islands will generate wastewater, garbage, grey water and other wastes that will be treated either on island or exported to other appropriate facilities for proper disposal or treatment. The EIA will address the handling of these wastes, as well as the utilities to be placed on the island or offshore on Barraterre* [and Lee Stocking Island[1]]. *The facility will require potable water, irrigation water, electrical power and fuel for accessory vehicles and boats. The EIA will address the storage, handling and transfer of these resources.*

3 *For Children's Bay Cay, a comparison of the existing marina and placement of the proposed marina will be presented under the project details. The EIA will note the*

[1] The original plan was to place the wastewater plant on Lee Stocking Island. Since the original TOR efforts, the proposed plant location has been changed to the central maintenance area of Williams Cay.

placement of a channel and dredge requirements to allow for vessel access to the marina.

4 *For Williams Cay, the golf course and its aspects will be specifically addressed in that EIA. Per discussion with BEST on April 25, 2016, materials sourcing and a fill balance for golf course sands/fill materials will be included in addition to terrestrial and marine impacts analysis.*

5 *Techniques to mitigate impacts identified in the EIAs will be outlined. Mitigation measures will align with best practices in The Bahamas including the removal and maintenance of invasive species, planting with native vegetation, natural beach accretion, and protection of marine habitat through a proposed marine reserve.*

6 *To note, the EIAs will reference the potential future development of Lee Stocking Island but will not contain field investigations or technological studies which will be included in a Supplemental EIA when appropriate. A review of readily available literature pertinent to Children's Bay Cay and Williams Cay from the former Perry Marine Institute and will be included in the EIA as an appendix.*

The following EIA is intended to meet all of the requirements as listed in the approved TOR for the Williams Cay portion of the project. To meet all of the approval requirements for the overall project, the following additional documents will be provided under separate covers:

- Environmental Management Plan (EMP) for Williams Cay
- EIA and EMP for Children's Bay Cay
- Supplemental back of house (BOH) report for Barraterre Cay
- Lee Stocking Island Report

At the time of this EIA, complete earthwork and grading plans have not been completed and as such the cut and fill calculations have not been completed. They will be supplied to the BEST Commission as a supplement to the EIA on completion and will address the fill questions needed to meet the requirements of the Terms of Reference.

1.2 Objective of the Environmental Impact Assessment

This report provides a EIA for the proposed development on Williams Cay, located approximately 2.5 miles north of the northern tip of Great Exuma. Figure 1-2 is a recent aerial photograph of Williams Cay and is representative of existing conditions. Low-density development is proposed throughout the approximately 160-acre Williams Cay. The EIA process is necessary to ensure that potential environmental impacts from this development are identified and considered during the development planning process, as well as to assure unavoidable impacts are minimized and mitigated.

The report is formatted in general accordance with the *General Outline for an Environmental Impact Assessment of Resort Developments* provided by the Bahamas Environmental, Science, and Technology Commission (BEST). The owner of the island will work with Government to establish a marine protected area on the leeward side of the island that will encompass Windsock Cay and is intending to restrict this area to non-power vessels.

1.3 Scope of the Environmental Impact Assessment

In general, this effort has included detailed evaluations of the project site and the plans conceived during the planning process. The report summarizes the nature, type, duration and extent of potential environmental impacts both during and after construction.

Figure 1-1 - General Location Map

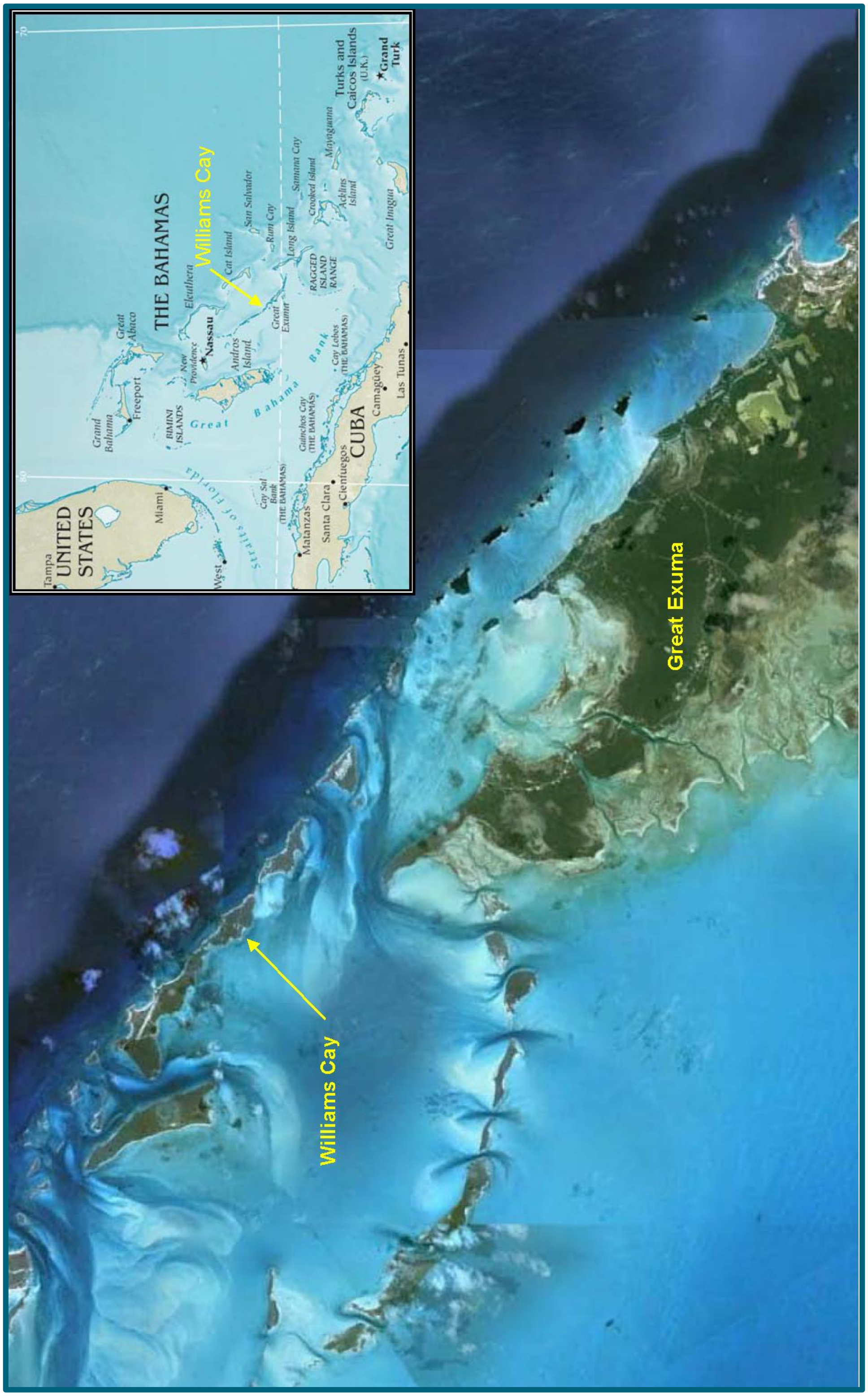


Figure 1-2 - Aerial Photograph - Williams Cay

2.0 Project Description

2.1 Conceptual Master Plan

The owner has proposed to develop a boutique golf resort on Williams Cay, a sparsely developed island approximately 2.5 miles to the north of Great Exuma. The conceptual master plan for development of Williams Cay is presented in Figure 2-1. In addition to the golf course and its attendant clubhouse and support facilities, the development will include 16 villas and 4 additional two-bedroom resort villas (Table 2-1).

Utilities (water and power) will be developed in Barraterre to serve the resort and residences. Wastewater treatment for the Williams Cay and The Children's Bay Cay projects will be addressed with a new MBR wastewater treatment plant to be located on Williams Cay near the center of the island. Underwater pipelines and cables will connect the resort to its Barraterre-based utilities. Limited support staff will reside permanently on the island, with the majority commuting from Barraterre via water or from Children's Bay Cay.

The proposed development includes an 18-hole golf course with a clubhouse and maintenance facilities. Docking facilities on Williams Cay will be limited to access for golf maintenance equipment and supplies. A roadway running the length of the island will provide access from a bridge to the adjacent Children's Bay Cay for guests, staff and supplies. The existing shorelines and beach areas will not be disturbed by this development

Table 2-1- Major Project Components

Description	Qty.	Size (ft2) Total
2 – Bedroom Resort Villas	4	2,800
Williams Cay Villas 1-16	16	120,000
Club House and Sunset Pavilion	1	2,150
	Total	124,950

2.1.1 Villas

As noted in Table 2-1, the Williams Cay development includes 16 villas and 4 additional two-bedroom resort villas. Site preparation for the villa lots will be generally be limited to 5 feet (ft) outside of the area of construction to preserve as much vegetation and habitat as possible. Disturbed areas will primarily be revegetated with native species.

Figure 2-1 - Conceptual Master Plan

Figure 2-2 - Conceptual Master Plan - Enlarged View - West

Figure 2-3 - Conceptual Master Plan - Enlarged View - East

2.1.2 Golf Course

Williams Cay will feature an 18-hole, Tom Fazio designed golf course for exclusive use by guests. Course amenities will include a clubhouse and a sunset pavilion. A golf course maintenance area will be separated in the center of the island and serviced by an existing small docking facility tucked into a secluded section of the leeward shoreline. Course construction will require clearing of approximately 95 acres of the existing vegetation, which is primarily dry broadleaved evergreen forest. After initial contouring of the golf course, an estimated 174,000 cubic yards of sand will be brought in to finish the contouring and create a base for turf grass and revegetated areas.

2.1.3 Bridge to Children's Bay Cay

The adjacent Children's Bay Cay is an integral component to the facilities proposed for Williams Cay. It is anticipated that construction on Children's Bay Cay will be initiated prior to those on Williams Cay and, therefore, are addressed in a separate EIA document. The southeast tip of Williams Cay and northwest tip of Children's Bay Cay are separated by a narrow channel, approximately 70 ft wide at its narrowest point. A single-lane bridge is proposed to span this gap and connect the two islands. The bridge will be a prefabricated structure with concrete abutments placed above the waterline on the ironshore and elevated sufficiently to allow boat traffic that would normally be expected to use this channel (clearance of 9 ft above MSL). The bridge will span the existing natural cut as not to impact the natural processed that occur in this area and the surrounding waters. The bridge will be designed and built to withstand significant storm conditions. The placement of the bridge on the west side of the channel will help to protect it from extreme wind and wave conditions.

2.2 Infrastructure and Utilities

Currently, potable water is produced on the island with a reverse osmosis water treatment plant. Wastewater is disposed of in soakaways, located adjacent to habitable buildings. Electricity is supplied via an underwater cable routed from the Bahamas Electricity Corporation (BEC) system on Great Exuma. Two onsite diesel generators currently provide backup power when needed. Much of this infrastructure will be abandoned with the proposed development and replaced with state-of-the-art facilities on Barraterre and Williams Cay. Temporary power during construction will be provided by diesel generators.

2.2.1 Transportation

Williams Cay is currently accessible only by boat, but future access will be provided via the bridge to Children's Bay Cay, as discussed in Section 2.1.5. Staff access and egress from the island, along with transport of construction materials, solid wastes and provisions will be primarily through the docking and back-of-house facilities on Children's Bay Cay. Guests to Williams Cay will first disembark on Children's Bay Cay and cross to Williams Cay via the bridge.

The existing informal roadway network on Williams Cay, primarily concrete pathway and native soils, will be mostly abandoned and replaced with an engineered system utilizing crushed lime rock, concrete or asphalt, depending on location. Drainage and other design details necessary will be done in accordance with the standards and specifications of the Ministry of Works and Utilities and best management practices (BMPs). Vehicular traffic will be limited to golf carts and other small service vehicles. Some standard-sized trucks (1/2 ton or smaller) and utility vehicles will be located on the island for use by the maintenance and other support facilities.

2.2.2 Potable Water

All proposed development on Williams Cay will be served by a potable water distribution network extending throughout the island. Potable water will be delivered to the island via subsea water line extending from a reverse osmosis water treatment plant located in Barraterre. The specific locations of the reverse osmosis water treatment plant and water line have not yet been identified. When formally identified, this information will be provided in an addendum to this document.

2.2.3 Wastewater

A new membrane bioreactor (MBR) wastewater treatment plant is proposed to serve Williams Cay and the development on Children's Bay Cay. The new plant will be located near the center of Williams Cay the island in the golf course maintenance area. Treated effluent from the MBR wastewater treatment facility will be utilized for irrigation of nursery areas and other areas as needed on Lee Stocking Island. Excess treated water would be conveyed through deep wells for disposal. There will be no surface water discharge of treated effluent.

2.2.4 Electricity

An underwater cable from Barraterre currently provides electricity to Williams Cay. Project development will require upgrading this existing system to include a new electrical generating facility at Barraterre. Smaller electrical generators located on Williams Cay will provided backup power. The specific location of the subsea electrical cable from Barraterre, along with the landing locations of the cable will be addressed in an addendum to this document. All electrical distribution wiring required for this development will be below ground, in conduit.

Alternative renewable energy sources such as photovoltaic solar arrays are being considered to provide a sustainable electrical source for the project and to reduce the demand from Barraterre. These systems will be further investigated as the electrical supply system engineering moves into the design stages.

2.2.5 Solid Waste

Williams Cay will have no permanent solid waste disposal facilities. All solid wastes generated both during and after construction will be collected, processed for volume reduction and barged to Barraterre for disposal in an appropriate manner. Landscape clippings and other organic wastes may be composted onsite for reuse as a soil amendment. All solid wastes will be collected and shipped to the landfill on Great Exuma operated by the Department of Environmental Health Services.

2.2.6 Stormwater Runoff

Stormwater runoff from the roadway network will be handled through standard accepted BMPs and will be directed to strategically placed drainage wells. Stormwater runoff from buildings will be collected for reuse where feasible. Where this is not feasible, stormwater runoff will be routed to drainage wells for disposal.

Stormwater runoff from the golf course and associated areas will be designed to drain internally to golf course area. Stormwater runoff will be directed to a series of BMPs including vegetated swales for pretreatment, vegetated buffer zones, underdrain systems & lift stations, drainage wells, and lined storage ponds for reuse as irrigation water. Detailed engineering will determine the exact number and placement of BMPs to accomplish the goal of preventing any stormwater runoff from leaving the golf course site.

No direct discharge of stormwater runoff to surface waters will be allowed from the project site during the construction or operations phase except in the case of a severe rainfall event such as a hurricane.

3.0 Development Area and Boundaries

3.1 Site Location

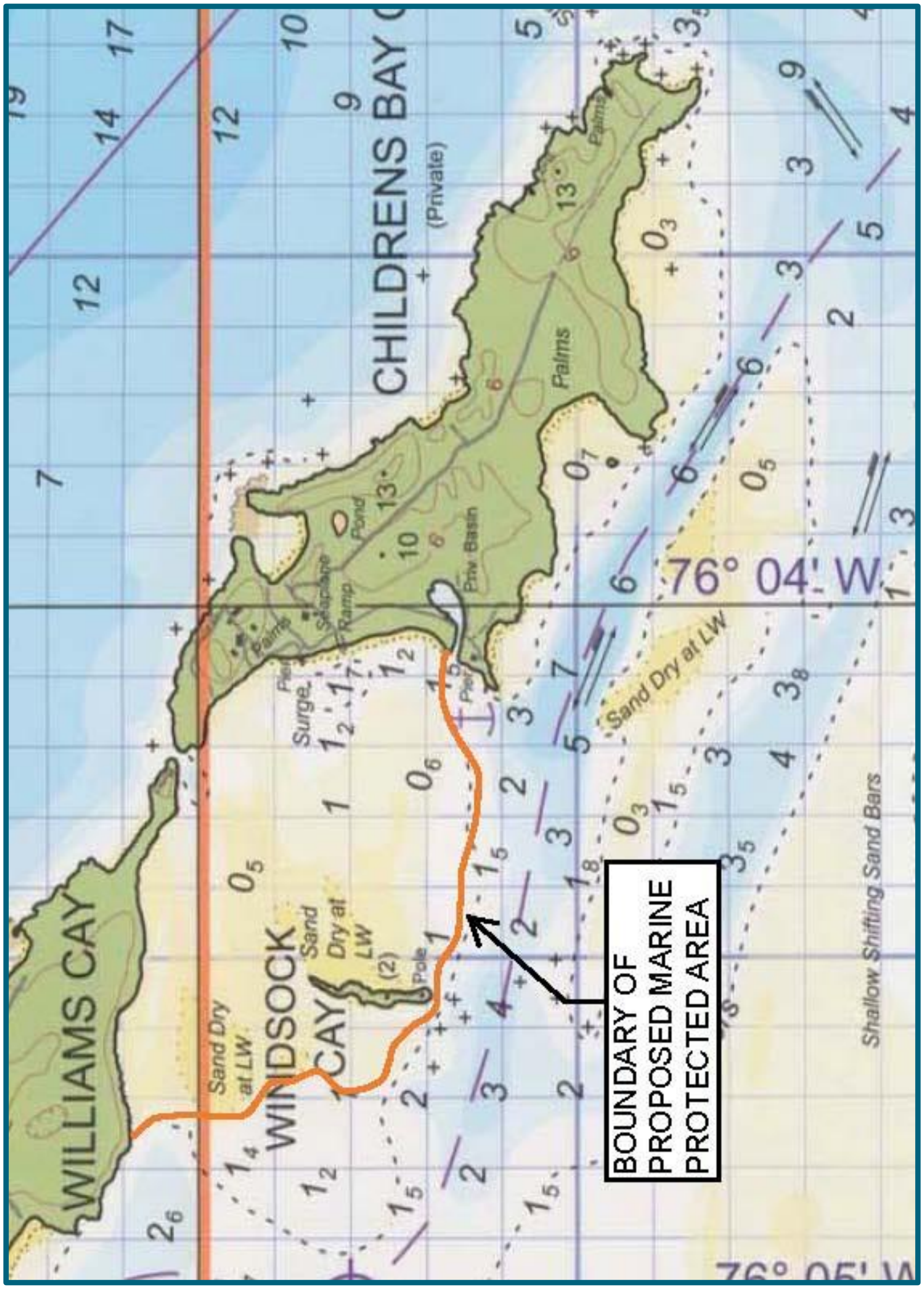
Williams Cay is located toward the southern end of the Exuma chain of islands, approximately 2.5 miles off the northern tip of Great Exuma and 4.5 miles north of the nearest settlement at Barraterre, as shown in Figure 1-1. The latitude and longitude at a central point on the cay is 23°45' 21" N, 76° 4' 50" W. Williams Cay is located directly southeast of Lee Stocking Island and northwest of Children’s Bay Cay. The island has a southeast-to-northwest orientation and lies along the eastern edge of the shallow Great Bahama Bank.

Williams Cay is situated on the eastern boundary of the Great Bahama Bank, with the deep water of the Tongue of the Ocean being approximately 25 miles [40 kilometers (km)] to the west and deep water of Exuma Sound just over 1 mile to the east. The windward side of the island faces Exuma Sound and leeward side faces the Great Bahama Bank.

3.2 Site Boundaries

The boundaries for this project include all of Williams Cay, the channel between Children’s Bay Cay and Williams Cay, and the proposed marine protected area surrounding Windsock Cay (Figure 3-1).

Figure 3-1 - Site Boundary and Marine Protected Area



3.3 Areas of Influence

This development will be primarily limited to Williams Cay and the bridge to the adjacent Children's Bay Cay. Local areas of influence due to this project include the following:

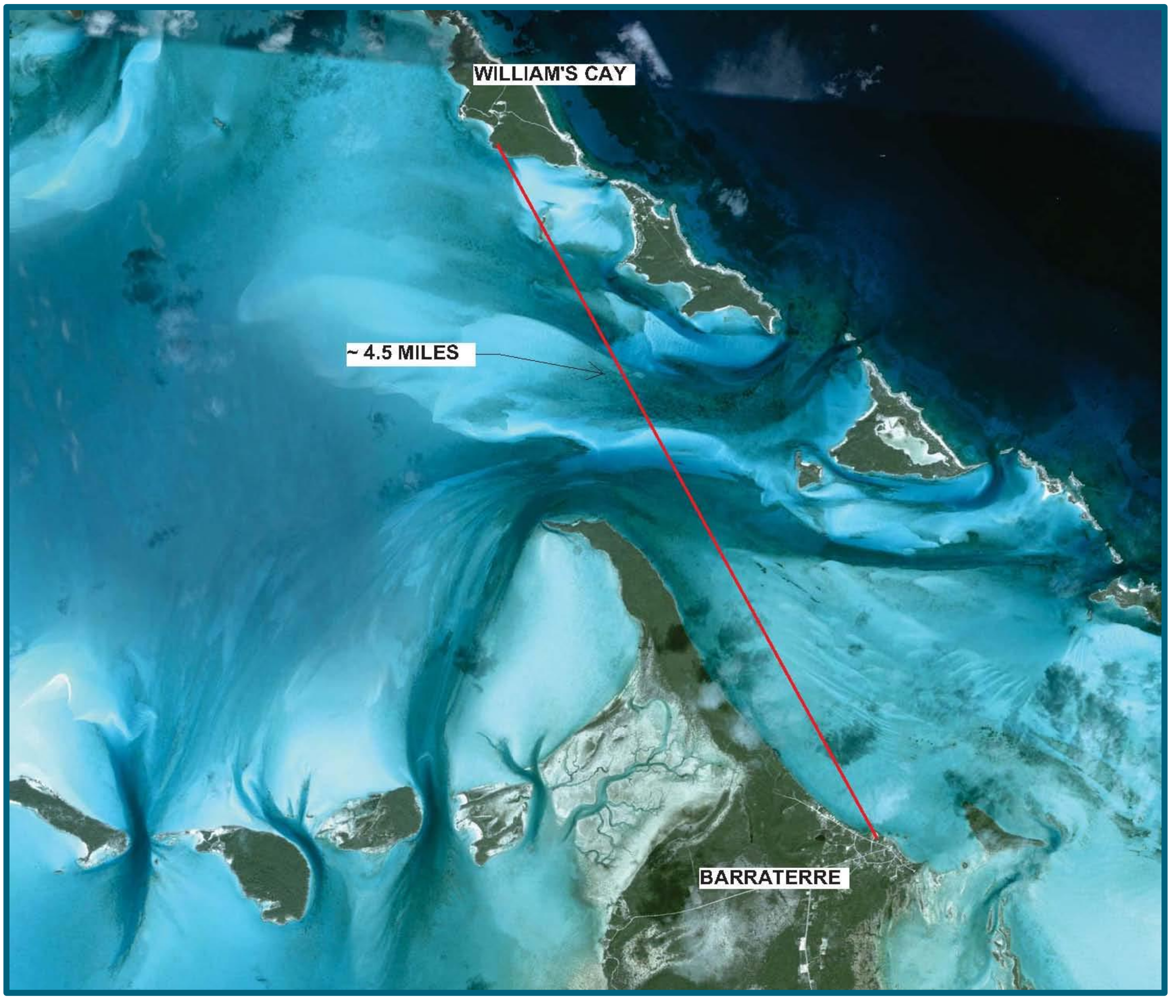
- Direct and secondary impacts to Williams Cay and Windsock Cay, including impacts to the marine bottom.
- Direct and secondary impacts at the infrastructure support facility near Barraterre, including impacts to marine bottom near the pier and docking facilities.
- Direct impacts to the submerged bottom within and adjacent to the utility crossing alignment.
- Secondary impacts to adjacent marine areas, cays, and communities.
- Impacts to Barraterre (electrical supply and potable water supply).

Upland onsite influences include land clearing associated with the development, roadways, golf course, infrastructure, and modifications to the existing small docking area to be used for maintenance access. Marine influence areas include marine bottom under and around the docking facility, as well as the marine bottom and waters around Windsock Cay, where a marine preserve is proposed. Marine influence areas also include coral reef, hardbottom, and seagrass communities impacted by the utility crossing installation. If depths are sufficient, it is anticipated the utilities (i.e., power cables and potable water lines) will be placed directly on the bottom. However, in shallower areas, trenching will be necessary to bury the cables and pipelines for security. This EIA provides an inventory of all proposed project components and details their potential environmental impacts, with the exception of the utility lines, which will be addressed in an addendum to this document.

3.3.1 Adjacent Communities

The only adjacent community to Williams Cay is Barraterre, located approximately 4.5 miles south-southeast of the island (Figure 3-2). Williams Cay is entirely privately owned and has no existing communities or settlements. Similarly, Lee Stocking Island to the northwest and Children's Bay Cay to the southeast are both privately owned and have no communities or settlements.

Figure 3-2 - Williams Cay in Relation to Barraterre



3.3.2 Natural Parks, Protected Areas and Marine Reserves

There are no formally established natural parks, protected areas, or marine reserves currently located on or immediately adjacent to the project components on either Williams Cay or Great Exuma. The Exumas Land and Sea Park is located farther northwest along the Exumas chain, beginning approximately 40 miles northwest of Williams Cay.

While no marine reserves are currently located within the project area, the developer is proposing establishment of a marine protected area around Windsock Cay. A subsequent section provides details for this proposal.

3.4 Alternatives

3.4.1 No Action Alternative

As a component of the EIA, planning and impacts alternatives are compared to the “No Action” alternative. This is an important part of the EIA process as it sets the baseline for comparison.

No action alternatives typically fall into one of two scenarios, one where absolutely no further activities occur and the other where the property continues to be used for a similar use as it had been historically. In almost every scenario where property isn’t specifically purchased or otherwise obtained for the intent of restoration and preservation, the assumption is that the property would continue to be used and maintained as it has been during recent history. That is our assumption for the no action alternative.

Under this scenario, Williams Cay would continue to have occasional construction of residences and smaller impacts that would not fall under a master planned program. Wastewater would continue to be disposed of via soakaways and electrical would continue to be generated by individual diesel generators. The more natural areas would likely remain in a similar condition as they are today. All economic stimulus to adjacent islands and to the Bahamas being gained through construction, increased investment, increased tourism and new jobs would be lost.

The “No Action” alternative would keep Williams Cay in a similar condition as it is today and would not consider any new construction effectively eliminating the original purpose for purchasing the property.

3.4.2 Proposed Alternative

The proposed alternative is provided within this EIA. The island is privately owned and the development footprint has been minimized wherever possible. Shoreline areas will be left undisturbed. Along with the environmental and mitigation planning discussed herein, an Environmental Management Plan will be supplied to the BEST Commission further outlining steps to be taken to minimize or eliminate negative environmental impacts.

4.0 Baseline Description of the Development Site

4.1 Present Condition

Williams Cay is an approximately 160-acre island consisting predominately of Dry Broadleaf Evergreen habitat. Williams Cay is privately owned and consists of several private residences, support buildings and a docking facility. A modest network of unimproved roads provide access between the north and south shorelines. Two small docks, a boat lift, and a boat ramp are located on the leeward side of the island.

Limited clearing has occurred in areas surrounding the existing buildings and roadways. The windward side of the island is dominated by long stretches of beach, punctuated by several dramatic rock outcrops. The leeward side of the island is primarily ironshore, but several small pocket beaches are interspersed along the shoreline.

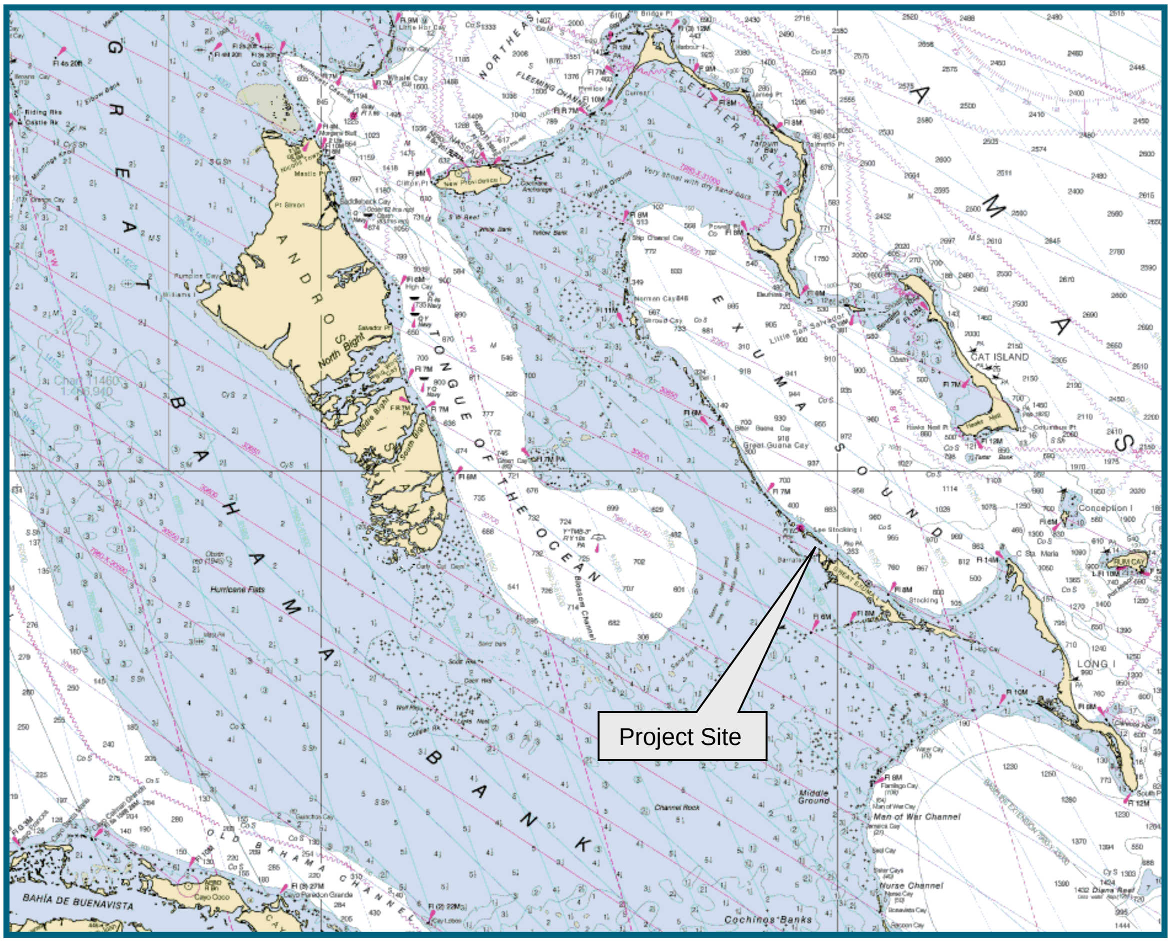
4.2 Geography and Topography

4.2.1 Physical Geography

The Bahamas archipelago is a system of carbonate banks and islands with a common geological origin. The archipelago stretches over almost 7 degrees in latitude (420 nautical miles or 770 km), from the tropical dry islands of the Turks and Caicos, to the subtropical island of Grand Bahama. The archipelago includes territories of three countries: The Bahamas, the Turks and Caicos Islands, and the Dominican Republic. Williams Cay lies along the eastern edge of the Great Bahama Bank (Figure 4-1).

Williams Cay is approximately 160 acres and approximately 1.3 miles long and 0.5 miles wide at its widest point. The windward side of the island borders Exuma Sound and the leeward side borders the Great Bahama Bank. The island generally has a northwest-to-southwest orientation. Barraterre is the closest community, located approximately 3 miles south-southeast.

Figure 4-1 - Williams Cay Location in Reference to Great Bahama Bank Formation (NOAA Chart #11013)



4.2.2 Upland Topography

Site topography (Figure 4-2) varies along the length of the island, with areas of higher relief along the windward (northeastern) side. The high point on the island approaches 70 ft. The island ground elevations average 5 to 45 ft above mean high water (MHW). There are two salt ponds on the island, with bottom elevations near 1 ft.

Figure 4-2 – Williams Cay Site Topography

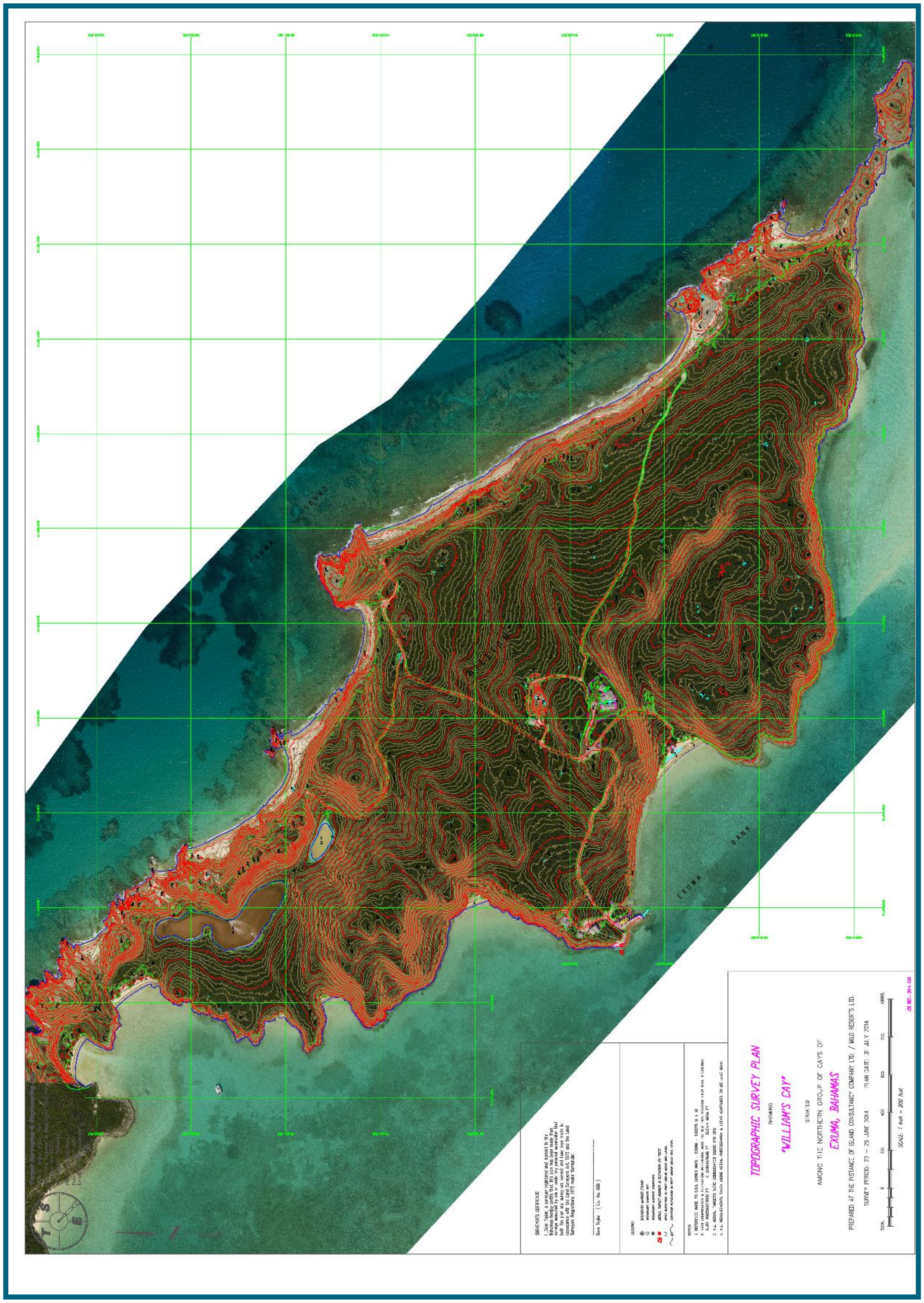


Figure 4-3 – Williams Cay Site Topography - West

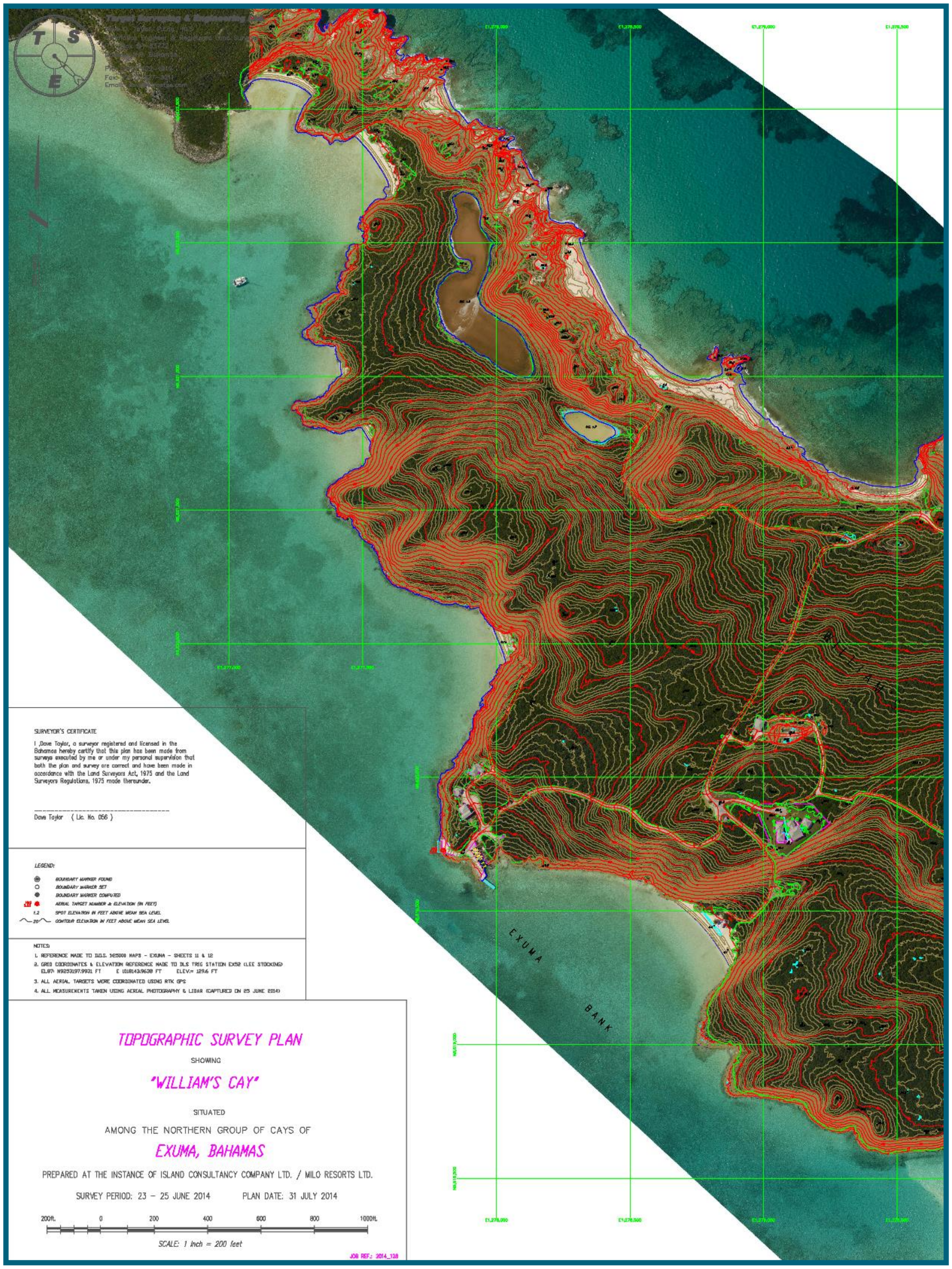
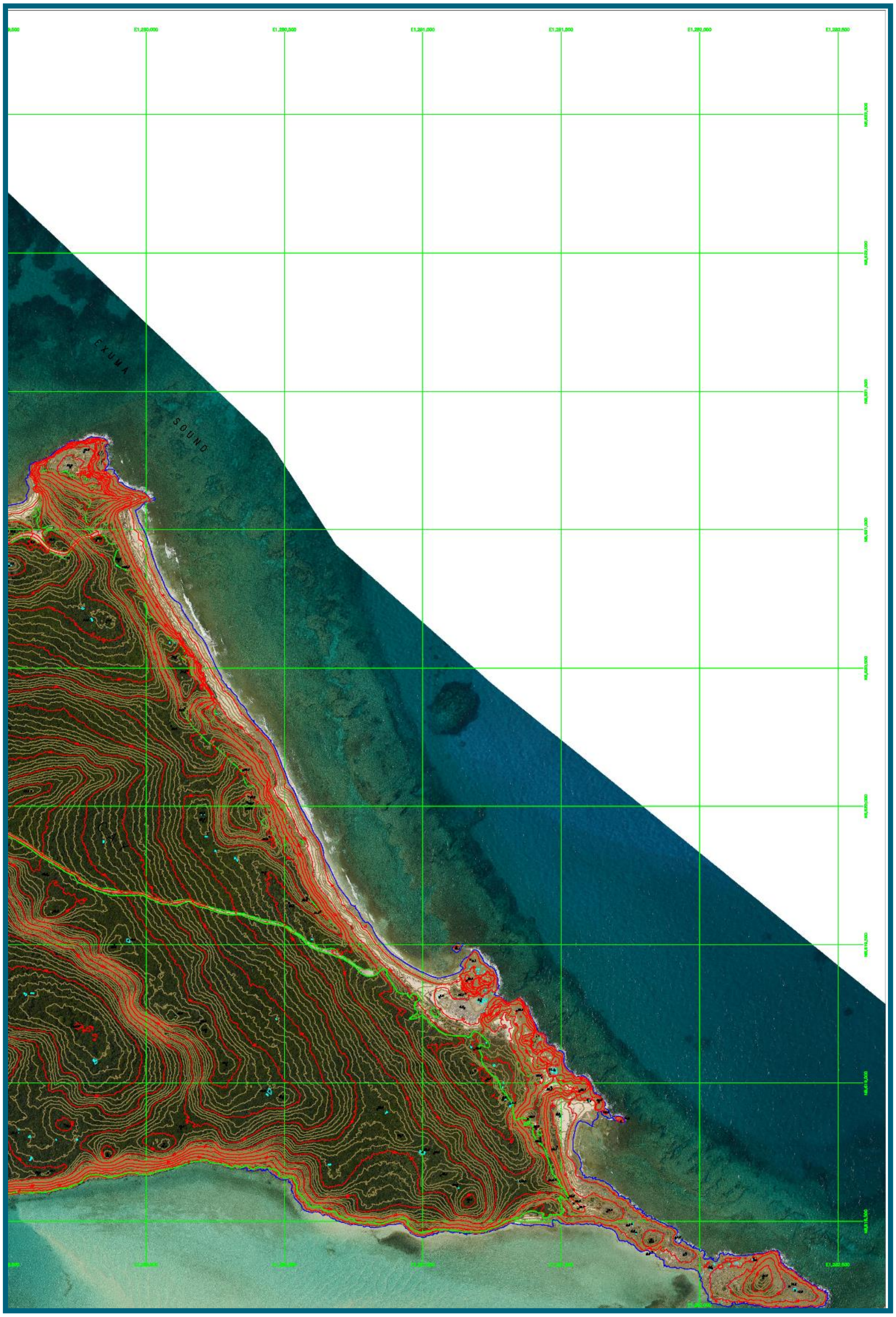


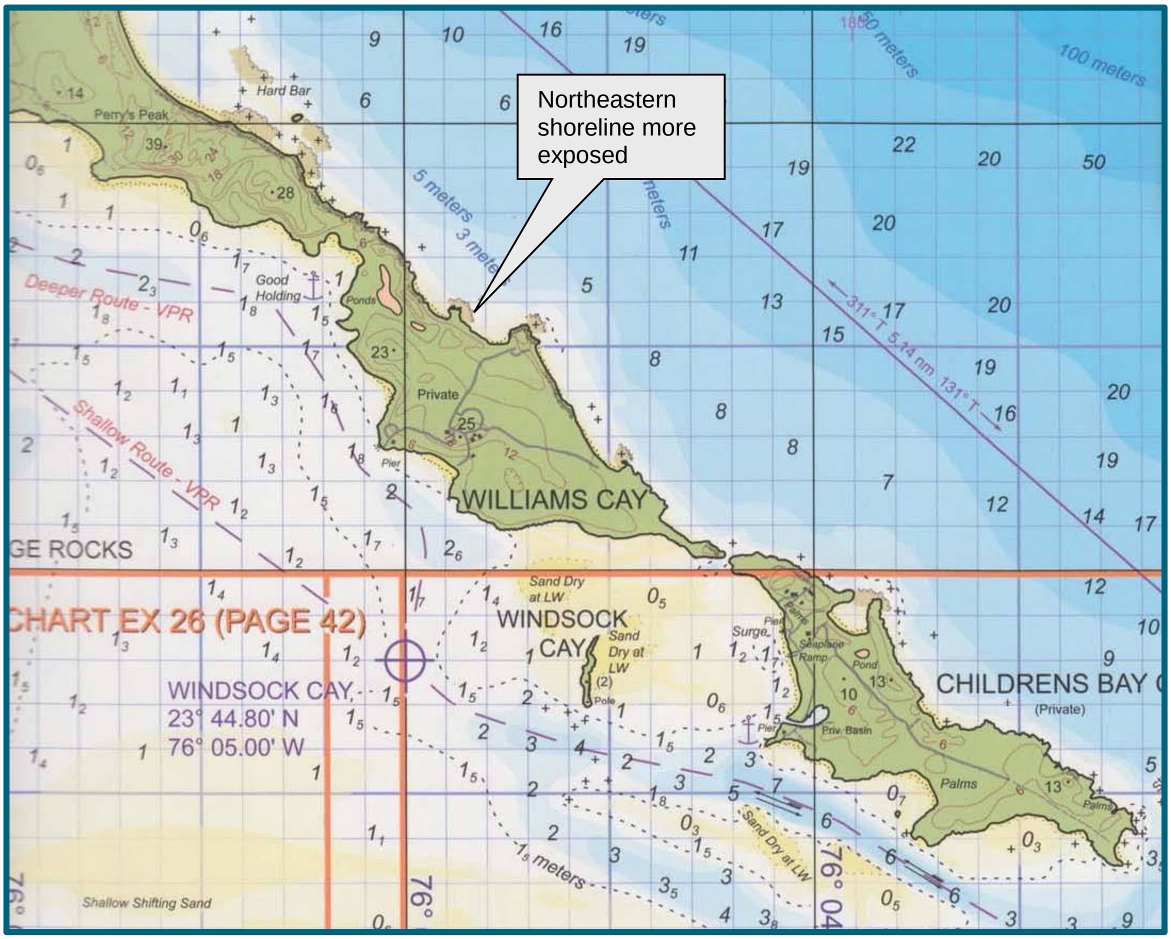
Figure 4-4 – Williams Cay Site Topography - East



4.2.3 Bathymetry

Offshore water depths vary dramatically, with Exuma Sound to the east and the Great Bahama Bank to the west. Exuma Sound exceeds 3,000 ft [914 meters (m)] deep, while the Great Bahama Bank is very shallow, with depths typically less than 20 ft (6 m). The Great Bahama Bank also contains many shallow reefs and navigational hazards. Depths near Williams Cay provide relatively safe navigation for most recreational vessels, including yachts. Regional bathymetry is presented in Figure 4-5.

Figure 4-5 - Regional Bathymetry



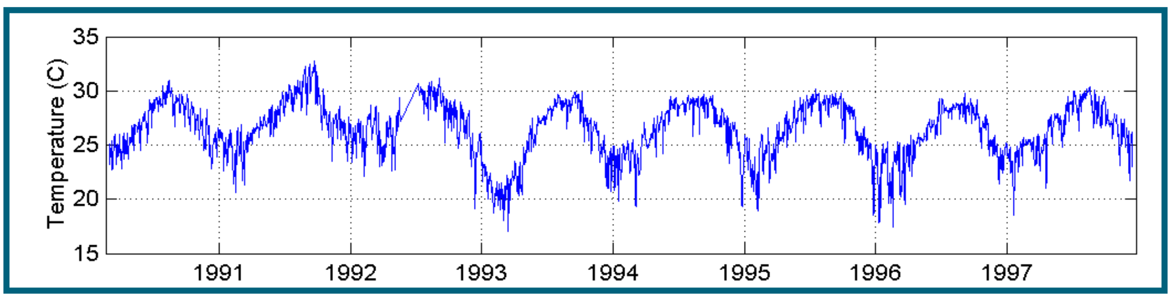
4.3 Climate and Meteorology

Like the other islands of the Bahamas, Williams Cay enjoys a subtropical climate characterized by relatively warm, wet summers and drier, cooler winters. In summer, persistent easterly trade winds predominate, bringing warm, humid air to the island. In winter, the influence of high-pressure cells over the North Atlantic and North America produce periodic influxes of drier continental air, marked by the passage of cold fronts that sometimes bring rain but do not subject the island to freezing temperatures.

4.3.1 Temperature

The climate of Williams Cay is subtropical, with a mean temperature of 23 degrees Celsius (°C) [73 degrees Fahrenheit (°F)] in January to 29°C (84°F) in August. The island is characterized by generally warm, moist summers and drier, cooler winters. Figure 4-4 presents daily temperature data from the Perry Institute for Marine Science (PIMS). The data reflect the temperate climate of the Bahamas, with a low degree of fluctuation in air temperature

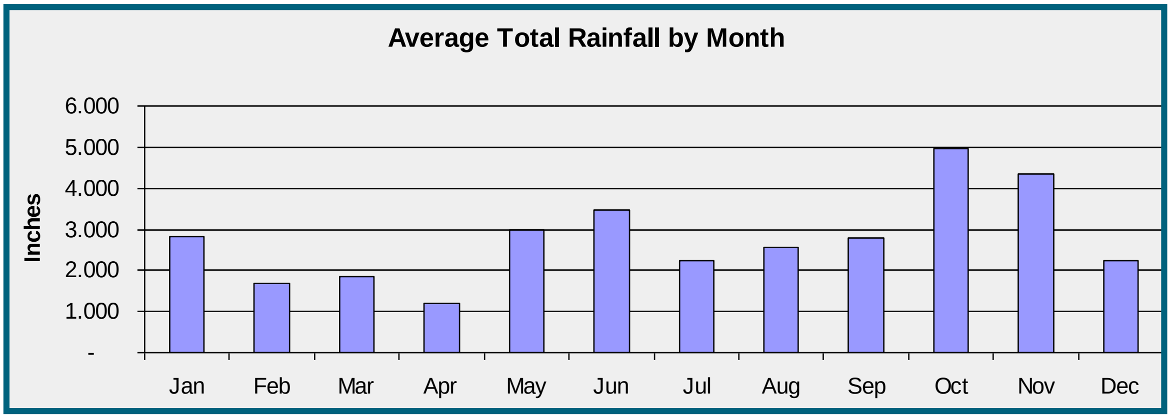
Figure 4-6 - Daily Mean Temperature (1990-1997)



4.3.2 Precipitation

Meteorological data from PIMS on Lee Stocking Island, approximately 2 miles northeast of the project site, were used for the meteorological analyses. The primary source of data extends from 1990 to 1997, while other sources of data include the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) and Georgetown airport [30 miles (48 km) southeast of site]. Annual rainfall averages between 30 and 35 inches per year (Figure 4-5). Precipitation is generally higher during the hurricane season (June to November).

Figure 4-7 - Average Monthly Rainfall (1990-1997)



4.3.3 Winds

The prevailing winds at the site are primarily influenced by the easterly trade winds, although variations in wind patterns associated with tropical storms and/or frontal systems occur sporadically throughout the year. Average annual wind speed is approximately 8 miles per hour (mph) [3.6 meters per second (m/s)] over the data period. Average wind speeds are generally stronger in the winter (Figures 4-8 through 4-10), while extreme wind speeds generally occur during tropical storms (refer to Section 4.3.4 for more information).

Figure 4-8 - Annual Wind Rose (1990-1997)

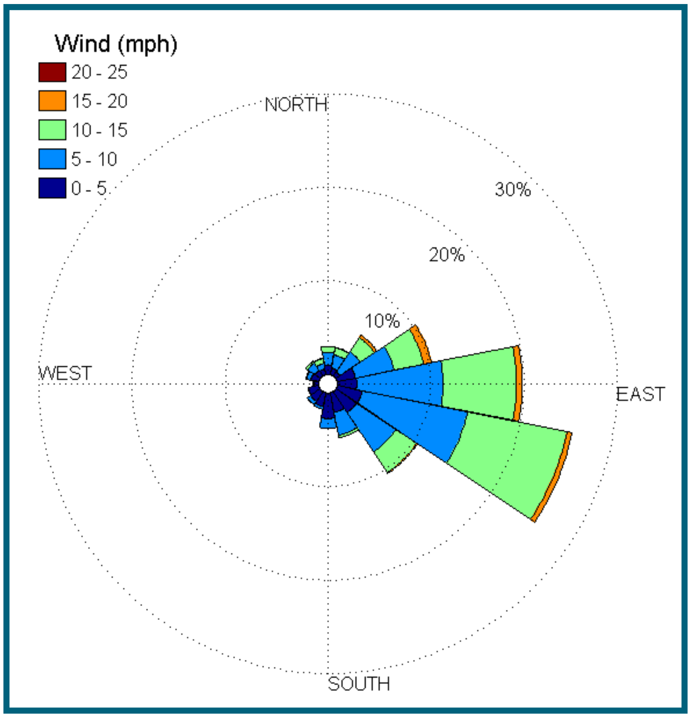


Figure 4-9 - Wind Rose, November-May (1990-1997)

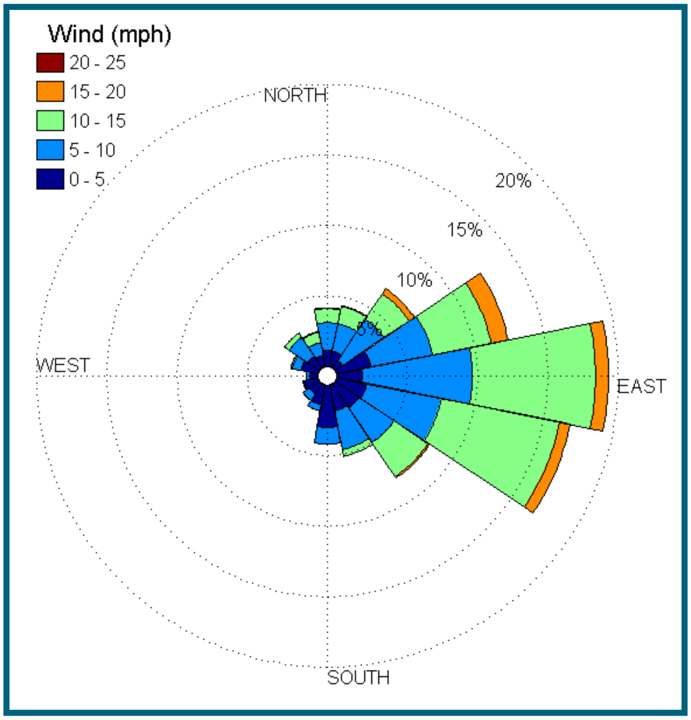
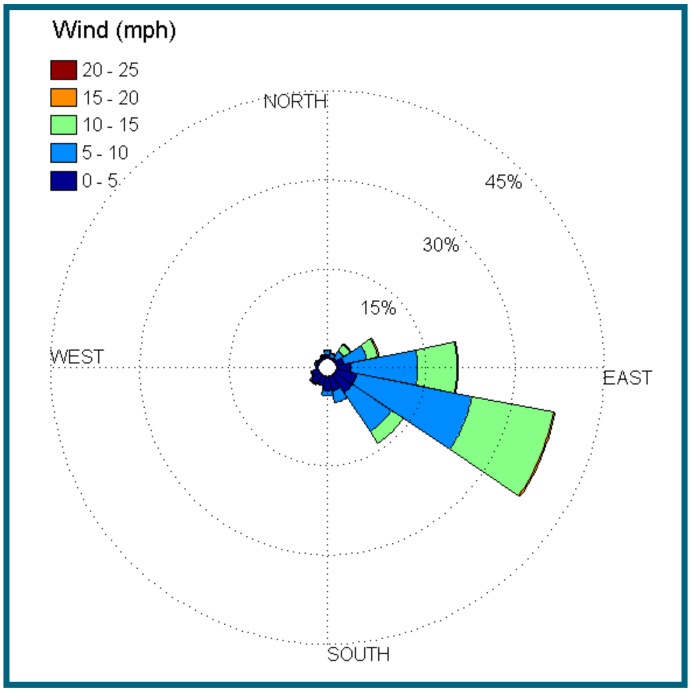


Figure 4-10 - Wind Rose, June-October (1990-1997)

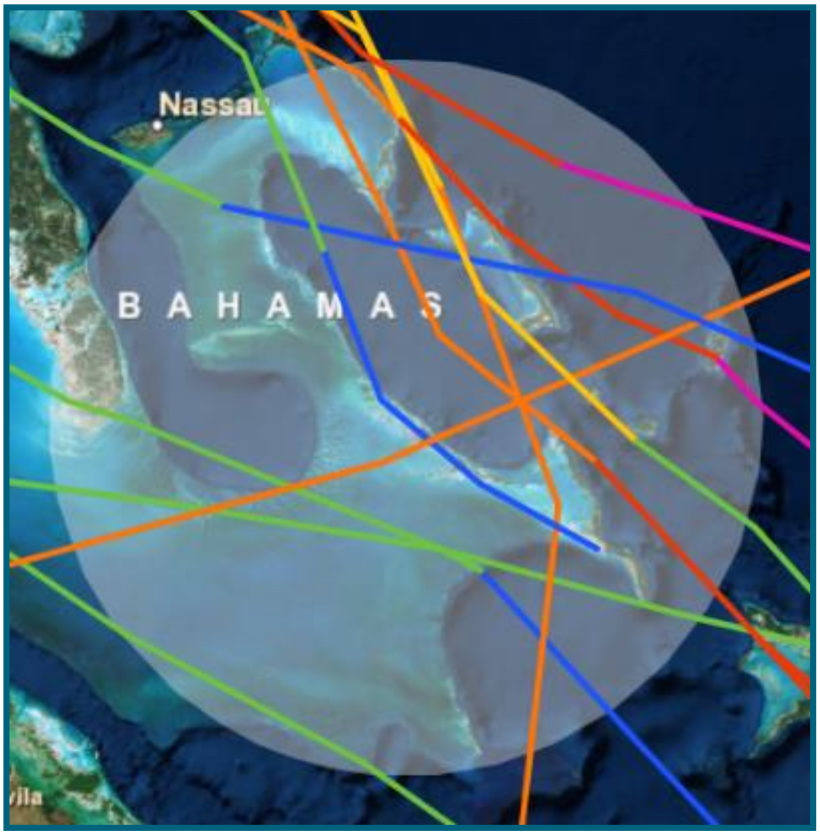


4.3.4 Storms

Williams Cay is located within the Atlantic tropical cyclone basin. This basin includes much of the North Atlantic, Caribbean Sea and the Gulf of Mexico. On the average, six to eight tropical storms per year form within this basin. The formation of these storms, and possible intensification into mature hurricanes, occurs over warm tropical and subtropical waters. Eventual dissipation or modification, averaging 7 to 8 days later, typically occurs over the colder waters of the North Atlantic, or when the storms move over land and away from the sustaining marine environment.

Due to the destructive nature of these storms, landfall can result in significant damage to upland development and facilities from storm surge, waves and wind. Eleven tropical storms and hurricanes have passed within 100 miles of the project area over the past 30 seasons (from 1984 through 2014), as reported by the NOAA Coastal Services Center (Figure 4-9).

Figure 4-11 - Hurricanes and Tropical Storms within 100 miles of Great Exuma (1984-2014)



A recent storm of record is Hurricane Lili in 1996. This storm passed over Great Exuma as a Category 2 storm, with 85-knot winds near the project site. This storm resulted in an estimated storm surge of 15 ft on parts of Great Exuma. In 2011, Hurricane Irene passed to the east of the project area as a Category 2 storm, with sustained winds of up to 95 knots as it passed Great Exuma. This storm caused extensive damage throughout the Bahamas.

4.4 Geology

4.4.1 Regional Geology

As is the case for islands throughout the Bahamas, Williams Cay is the result of shallow water deposited carbonate sediments building on the stable, but aseismically subsiding Great Bahama Bank. The shallow strata at Williams Cay are anticipated to correlate with the Pliocene/Pleistocene age Lucayan Formation, that is comprised of a laterally discontinuous sequence of fossil coral and carbonate deposits (Ewbank Preece Limited, 1996). The carbonate/evaporitic sequences of the Bahamas are geologically young and have generally not been deformed, folded or faulted through regional tectonic forces. However, relatively small-scale growth faults are commonly present in outcrop exposures such as the sea cliffs at Clifton, New Providence.

4.4.2 Seismology

Inasmuch as the Great Bahama Bank is located on the North American Plate and more than 700 miles from the North American-Caribbean Plate boundary, it is usually thought of as being aseismic. The closest potential large-scale seismic source is most likely the North Hispaniola fault, located offshore of northern Dominican Republic, some 750 miles southeast of New Providence (Dixon et al., 1998) and the Septentrional fault, which is exposed within the Cordillera Septentrional of Hispaniola (Prentice et al., 1997). The Septentrional fault zone (SFZ) continues to the west of Hispaniola as a transform boundary comprised of a complex of left-lateral faults extending across the Caribbean Sea and into Central America. To the east of Hispaniola, the plate boundary is located within a transition zone between a subduction zone and a transform zone. The primary geologic structures associated with the transform zone to the east of Hispaniola and offshore of northern Puerto Rico are the North and South Puerto Rico Slope faults (Prentice et al., 1997).

Paleoseismology studies conducted by the U.S. Geological Survey (USGS) and cooperating universities indicated that the most recent earthquake that ruptured ground surface along the SFZ in the northern Dominican Republic occurred about 800 years ago. These studies were based on identifying and analyzing paleoliquefaction structures in shallow Holocene age alluvial deposits in the western and eastern Cibao Valley. In general, an earthquake of magnitude 5.5 to 6.0 is considered to be the threshold at which soils will undergo liquefaction. Under soil liquefaction conditions, soils become quick and lose their load-bearing capacity.

Analysis of global positioning system (GPS) measurements collected during 1986, 1994, and 1995 at various stations in the Dominican Republic, Puerto Rico, Cuba and Grand Turk Island provided an estimate of the velocity of the Caribbean Plate relative to the North American Plate. The data analyses indicated a relative motion of the Caribbean Plate toward the east at 21 ± 1 millimeter per year (mm/yr). The data were combined with elastic strain models to provide estimates of slip rates for major left lateral strike-slip faults on Hispaniola and environs. Slip along the North Hispaniola fault (offshore of the north coast of Hispaniola) was calculated to be 4 ± 3 mm/yr and 8 ± 3 mm/yr for the Septentrional fault, located onshore in northern Dominican Republic (Dixon et al., 1998). The authors concluded that the relatively high plate motion and the slip rates on the major left lateral strike-slip faults, strain accumulation, and historical seismicity might indicate an increased risk of moderate or larger earthquake occurrence in the northern Caribbean basin than prior estimates had predicted (Dixon et al., 1998). These data notwithstanding, seismic concerns relative to the Bahama Archipelago in general, and the project site specifically, are minimal.

4.4.3 Geomorphology

Williams Cay is located proximal to a major submarine canyon (Exuma Sound). The dropoff or wall of the bank is situated several miles northeast of the project site. The average water depth within the Exuma Sound is approximately 6,500 ft.

The dominant geomorphology of Williams Cay is karst landscape, typified by solutional features such as erosional vugs, caves and shafts, sink holes and dolines and solutionally enlarged joints and fractures within the surface and subsurface limestone country rock. The stability of the shoreline is and will continue to be a function of eustatic sea level rise, carbonate sediment supply and asymmetrical subsidence of the larger carbonate platform.

Williams Cay and the surrounding cays are the emergent portion of the larger Great Bahama Bank carbonate platform. The interior of the larger carbonate platform is shallow and dissected by fringe reef, patch reef, intertidal shoals, and emergent island landforms. The emergent landform known as Williams Cay is a cay composed of carbonate sand and a series of weathered limestone ridges. These topographic high, ridge features were formed by the solidification and partial solidification of carbonate sand dunes during the Pleistocene geologic time period of lower sea level. The carbonate sand was provided by the original and persistent carbonate reef system that has developed into the Great Bahama Bank carbonate platform.

4.4.4 Site Geology

The geology of Williams Cay is all dominated by high topographic relief limestone that is partially overlain by a thin soil veneer. Exposed limerock (i.e., ironshore) is visible throughout much of the site, particularly in shoreline areas of exposed coastal rock. Sand beaches exist intermittently along the shoreline and significant soil exists in low areas. With the exception of areas mapped as sand strand community, the majority of the site has a notable absence of soil cover or, at most, a thin veneer. Organic topsoil occasionally accumulates within forested areas or seasonal wetland depressions, but the limestone typically lies just below the surface soil layer.

4.4.5 Hydrogeology and Water Resources

Hydrogeologic resources are not estimated to be significant on Williams Cay. For purposes of the proposed development, it is unlikely that freshwater resources are of a magnitude and degree of reliability that they could be adequate to serve the proposed development. Therefore, potable water will be supplied to the project area through an offsite reverse osmosis water treatment plant.

4.4.6 Soils

Soils on Williams Cay are dominantly composed of windblown and hydraulically deposited calcareous sand, silt and clay. These soils range from lagoonal, inter-tidal, supra-tidal and upland deposits, with moderate to low organic content. The upland soil, where it exists, is a very thin veneer over the underlying calcareous limestone. The upland soil has undergone only minor soil genesis and generally is not considered as significant. The humus content of the upland soil is minimal, and the shallow soil horizons lack significant trace elements and basic nutritional compounds (nitrogen, phosphorus and potassium) that would sustain traditional agriculture without considerable anthropogenic assistance.

4.4.7 Caves and Blue Holes

Several minor solution features were noted on Williams Cay. No caves, blue holes or solution shafts of notable size were observed during the landside assessment.

4.4.8 Air Quality and Noise

No specific testing of air quality or noise was conducted. However, the island is currently undeveloped, with the exception of a single private residence and several support buildings. No significant source of air pollution is known in the vicinity of the project site. Electricity is provided through an underwater cable from Great Exuma and onsite diesel generators are only intermittently used for backup power. Existing site management activities (e.g., diesel generators and solid waste management practices that involve occasional burning of combustible materials in a burn pit located near the marina basin) make minor contributions to degradation of existing air quality. The only sources of noise pollution on the island are the generators and reverse osmosis water treatment plant. The overall noise levels are likely low and commensurate with remote cays with established single-family residences.

4.5 Surface Waters

Williams Cay is surrounded by the Exuma Sound on the northeastern side of the island and the shallower Grand Bahama Bank on the southwest side. Nearshore, on the Grand Bahama Bank side of the island, surface waters are generally shallow, with areas of exposed flats at low tide. These waters are fairly protected, and navigable waters generally range from 4 to 12 ft in the deeper waters outside of the flats. Adequate depths are available without dredging to accommodate a range of boat sizes. Currents are tidally driven and increase at both ends of the island, where the Grand Bahama Bank connects with Exuma Sound.

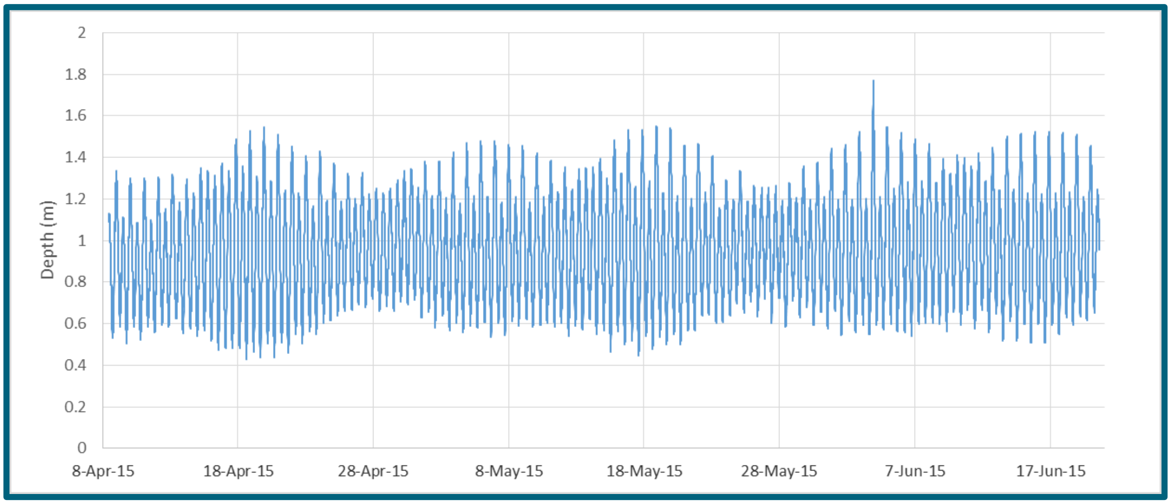
The Exuma Sound side of the island is marked by higher wave and stronger current conditions because it is on the windward side of the island and adjacent to the deep waters of Exuma Sound. The nearshore depths along the shoreline generally range from 3 to 10 ft. The depth gradually increases to more than several thousand feet within several miles of the shoreline.

The two isolated areas of surface water on the island are ephemeral salt ponds, with water levels that depend on tidal conditions and rainfall. Both are located on the northwestern half of the cay. Neither has any direct connection to marine waters.

4.5.1 Water Levels and Circulation

The tides at Williams Cay are semi-diurnal (12.42-hour period). A tide gauge was deployed near the project site for more than 60 days. This gauge was located on the main dock on the leeward side of Children's Bay Cay, approximately 1.25 miles south of the mid-point of Williams Cay. The resulting data are presented in Figure 4-10. Omitting an outlier on June 3, likely due to a storm event, the largest observed tide range was 3.6 ft. The smallest observed range recorded was 1.7 ft.

Figure 4-12 - Excerpted Relative Water Surface Elevations



The currents around Williams Cay vary widely and are predominantly wind driven in the coastal area, with additional influence from the tide range and the local geometry (i.e., depths and shoreline features). Near Williams Cay, the tidally driven flood currents nominally move from Exuma Sound through the cut between Children's Bay Cay and Williams Cay and around the southwest tip of Children's Bay Cay. The surface currents also respond to the local wind forcing and can dominate the tidal currents at times. The predominant direction produced by the wind forcing is from the southeast in the summer months, reversing periodically to come from the northeast during the winter months.

4.5.2 Water Quality

This area of the Bahamas is known for its extremely clear, nutrient-deficient, oligotrophic water. Overall water quality conditions in the waters surrounding Williams Cay are very good, with no areas showing any significant degradation. Upland impacts to water quality are also minimal due to the Island's undeveloped nature as well as the undeveloped nature of adjacent islands. It is not anticipated that upland sources will contribute to water quality degradation within the area due to runoff or other sources.

4.6 Shoreline and Coastal Processes

4.6.1 Wave Climate

The prevailing wave conditions near Williams Cay are representative of the prevailing wind direction and magnitude. The project area can also be impacted by waves resulting from tropical storms, hurricanes, frontal systems and other weather events with elevated wind conditions. As described in Section 4.3.3, the prevailing winds are from the east, and are influenced by the trade winds. Generally, the trade winds vary seasonably from the east-northeast to southeast directions, resulting in the southwest (leeward) side of the island being well protected from waves.

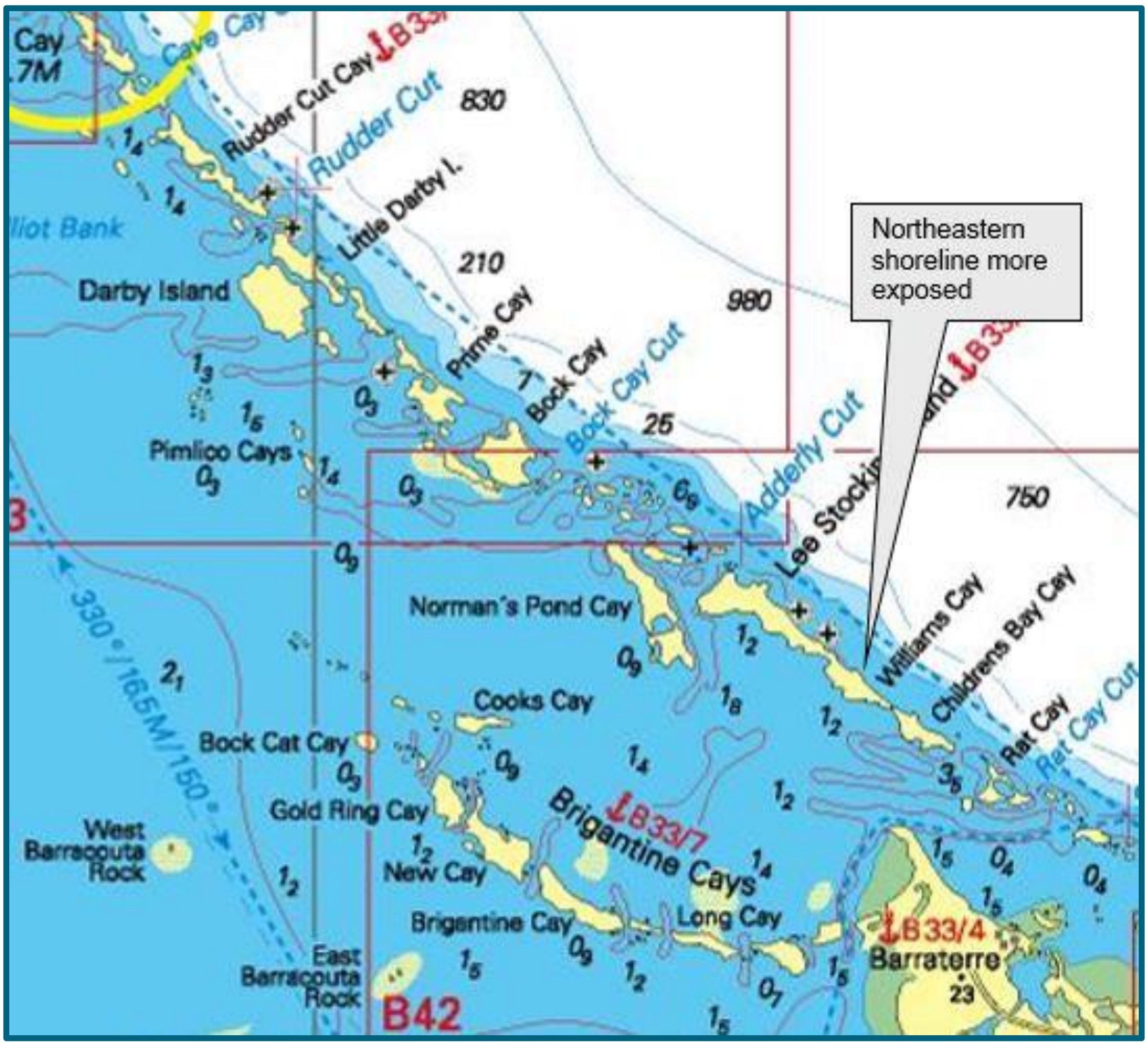
Williams Cay is relatively well protected from distant storm swells due to sheltering effects from nearby islands including Andros, Eleuthera, Cat Island, Great Exuma, and Cuba. In addition to these larger islands, smaller nearby islands and cays also provide shelter from wave events to varying degrees. Nonetheless, all shorelines are susceptible to wave energy, and any undesirable erosion will be mitigated in the future on a site-specific basis.

Figure 4-11 presents a British Admiralty Chart of Williams Cay and adjacent islands. The northeastern shoreline is the most exposed to waves, as predominant easterly winds create consistent small to moderate wave energy conditions. The southwestern shoreline also has some exposure to wind waves, with approximately 6 miles (11 km) of open-water fetch extending to the Brigantine Cays. Note that wind conditions from the south are relatively infrequent; therefore, the southwestern leeward shoreline is exposed to a relatively low-energy wave climate, although susceptible to episodic storm conditions.

4.6.2 Shoreline Distribution

Extensive sand beaches interspersed with high-relief rock outcrops and long stretches of sheer, wave-pounded rock cliffs dominate the windward shoreline of Williams Cay. Ironshore dominates the leeward shoreline but is punctuated intermittently by relatively small, isolated pocket beaches. Two of the larger pocket beaches on the leeward side, one about 200 ft in length, the other 250 ft, are situated in a shoreline cove at the extreme northwest end of Williams Cay. These pocket beaches lie adjacent to one another but are separated by a rock outcrop. The shoreline cove is a popular yacht anchorage. Nearshore bottom on the leeward side is generally sand and seagrass beds. The nearshore bottom on the windward side is high relief rock interspersed with sand.

Figure 4-13 - Williams Cay Bathymetry from British Admiralty Chart



4.6.3 Existing Coastal Processes

There is limited knowledge of the coastal processes at Williams Cay. The leeward shoreline is predominantly ironshore, with sand collecting in a few pocket beaches. However, a review of historical aerial photographs indicates that along the 1,600-ft-long beach on the leeward side of the island, the transport of sand has generally a northwest-to-southwest component. This is likely due to tidal currents emanating from the cut at Williams Cay.

Sand on the windward beaches is reported to be transient due to high current and wave conditions experienced on this side of the island. The pocket beaches on the leeward side of the island are much more stable than the beaches on the windward side of the island.

4.7 Marine Ecology

Williams Cay is a small, mostly undeveloped island set in an Exumas location with high current flows and surrounded by a high-quality, highly biodiverse marine ecosystem. With no intensive human development nearby, and surrounded by Exuma Sound to the east and the Exuma Bank to the west, the nearshore area around the approximately 160-acre island consists of extensive beds of submerged aquatic vegetation, sandy bottoms and coral reefs intermixed with hardbottom. Several aspects of the proposed development activities have the potential to adversely affect the surrounding marine environment. These include both direct and indirect impacts from construction along the shore and installation of pipelines that will transport wastewater to off-island treatment facilities. Less direct, but equally important, are potential impacts that could result in land-based activities that could filter nutrients into the marine environment. These impacts may occur during the short-term construction phase or the longer-term operation on the island.

Initial steps in determining potential environmental impacts are field investigations and the creation of a benthic habitat map that identifies and characterizes the existing benthic communities within the areas of potential project-related influence. This process allows for development of a site plan that is based on avoidance and minimization of impacts to irreplaceable marine resources.

4.7.1 Data Acquisition and Methods

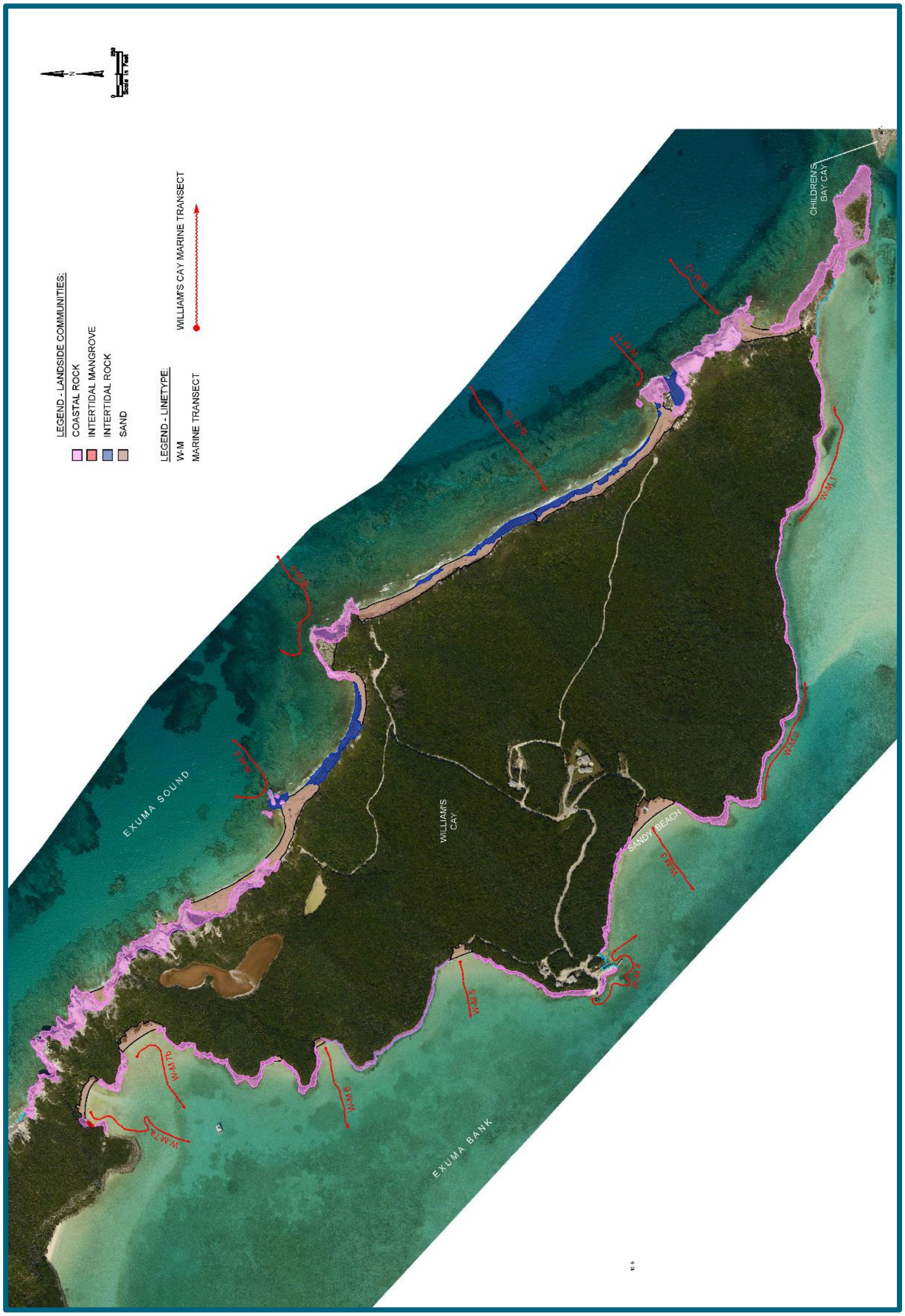
Prior to conducting field investigations, scientists from Applied Technology & Management, Inc. (ATM) acquired and performed a desktop analysis of recent (June 25, 2014) aerial imagery of Williams Cay. This analysis suggested the presence of a highly variable benthic ecosystem that would likely include: a) extensive areas of submerged aquatic vegetation (SAV) on the west (Exuma Bank) side of the island; b) a mosaic of coral, hardbottom and sandy sea floor on the east (Exuma Sound) side of the island, and; c) coral and macroalgal communities in the shoreline intertidal and sub-tidal zone. The likely presence of these communities was based on the results of marine investigations that were previously conducted on Children's Bay Cay, located immediately to the southeast.

Overlaying the conceptual master plan for landside development onto aerial photographs showing marine habitats indicated the need to assess conditions in 12 different areas to be able to adequately assess existing conditions and determine potential future impacts. The location of these 12 marine investigation transects, which are numbered in consecutive order in a clockwise direction beginning at the southeast tip of the island, are shown on Figure 4-12 and consisted of the following:

- W-M-1 (i.e., Williams Cay Marine-1): A shore-parallel transect on the south side of the island adjacent to a proposed residence
- W-M-2: A shore-parallel transect on the south side of the island adjacent to an area that is being considered for over-the-water villas
- W-M-3: A shore-perpendicular transect extending offshore from the largest sandy beach on the west side of the island
- W-M-4: A shore-parallel transect on the west side of the island adjacent to an existing jetty, boat ramp and vessel maintenance area
- W-M-5: A shore-perpendicular transect extending offshore from a small beach known as Cabana Beach
- W-M-6: A perpendicular transect that included intertidal rock and benthic communities adjacent to an area where a harbor is being considered for construction of a golf course maintenance area

- W-M- 7: Benthic habitats in two small bays on the western side of the island near the northern boundary of the property that abuts Lee Stocking Island
- W-M-8: A shore-perpendicular transect on the Exuma Sound (east) side of the island adjacent to a rocky headland
- W-M-9: A shore-perpendicular transect on the Exuma Sound side of the island near the island's mid-point
- W-M-10: A shore-perpendicular transect on the Exuma Sound side of the island near the mid-point of a sandy east-facing beach
- W-M-11: A shore-perpendicular transect on the Exuma Sound side of the island near a rocky headland in the southeastern quadrant of the island
- W-M-12: Nearshore benthic habitats offshore of the transition zone between rocky shore and east-facing sandy beach near the pass to Children's Bay Cay

Figure 4-14 - Marine Transects



Marine communities and bottom types identified around Williams Cay are provided in Figure 4-12.

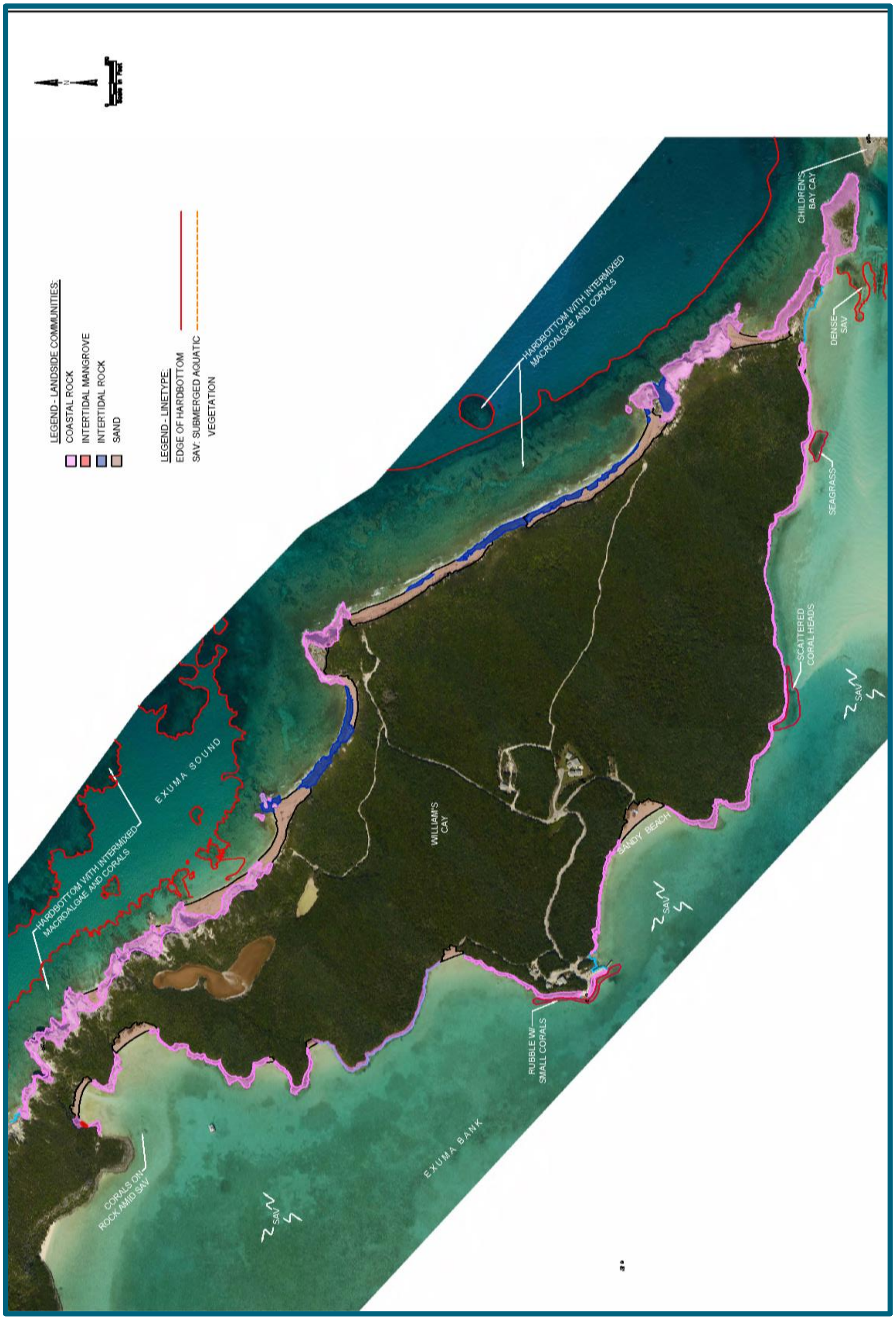
Underwater investigations in the area near the pass to the Children's Bay Cay were conducted and previously reported in the Environmental Impact Assessment (EIA) for the Children's Bay Cay development.

A three-person team consisting of two ATM scientists experienced in underwater assessments and the Children's Bay Cay island manager conducted reconnaissance mapping investigations of marine habitats surrounding Williams Cay on several days during the week of April 6 through 10, 2015. The underwater investigations were conducted by snorkeling along current-swept drift transects through the 12 survey areas. Digital photographs of representative and/or notable conditions were taken using an Olympus Stylus 770 SW with a marine housing. A 55-centimeter (cm) by 55-cm polyvinyl chloride (PVC) frame was used as a size reference for underwater photographs.

Approximate habitat boundaries were sketched on aerial photographs. Benthic habitats were described by assigning general habitat classifications, identifying dominant submerged aquatic vegetation, coral reef and hardbottom biota, and noting the general locations of dominant and ecologically significant coral reef species within the survey areas. Additional descriptive data included general rugosity and relief features of hardbottom and reef habitats and visual assessment of health and condition of coral reef biota. Representative photographs were taken along each of the survey areas. Marine scientists reviewed these data and documentation to develop a marine benthic habitat classification system and identify marine flora and fauna.

Figure 4-13 shows marine benthic conditions that were extrapolated from the results of the 12 survey areas. In general, the lines separating benthic habitats should not be interpreted as discrete boundaries. In most areas, there were transition zones (e.g., seagrasses grew amid hardbottom, macroalgae was present on coral outcrops, barren patches existed within beds of SAV etc.).

Figure 4-15 – Shoreline Communities



A list of the dominant stony corals, octocorals, SAV, fishes and other marine life observed within the 12 survey areas is included in Appendix A. This marine species list is not a comprehensive list of all marine benthic and fish species in these habitats because survey methods did not include collection of quantitative data.

4.7.2 Description of the Existing Marine Environment

The following sections provide descriptions of the benthic habitats encountered within the 12 assessment areas around Williams Cay. Due to the similarities encountered in some of the transects, the habitats are separated into three generalized categories: 1) mixed hardbottom, corals and sandy bottoms on the east (Exuma Sound) side of the island; 2) SAV and sandy bottoms on the west (Exuma Bank) side of the island; and 3) shoreline and intertidal rock. The following subsections include descriptions of dominant floral and faunal species and the results of quantitative evaluations of each habitat.

4.7.2.1 Mixed Hardbottom, Corals and Sandy Bottoms on the East (Exuma Sound) Side of Williams Cay

The nearshore benthic community along most of the east-facing and northeast-facing shorelines of Williams Cay consisted of a highly variable mosaic of coral-dominated hardbottom and algae-dominated hardbottom with intermixed patches of sand. A more or less shore-parallel corridor of sandy patches intermixed with low-relief hardbottom was present approximately 300 to 500 ft offshore in water depths of 20 to 30 ft. (Photo 4-1). In this area, sandy bottom trenches occurred in a shore-perpendicular alignment between rising hardbottom in a spur and groove formation. Sea rods reaching heights of up to 2 to 4 ft were occasionally present, extending upward from the low-relief hardbottom, but most corals were low-growing hard corals, for example, brain corals (Photo 4-2) or sea rods that were attached in protected niches under ledges (Photo 4-3). Boulders that were either algae-dominated (Photo 4-4) or coral-dominated occasionally extended upward in 3- to 5-ft outcrops).

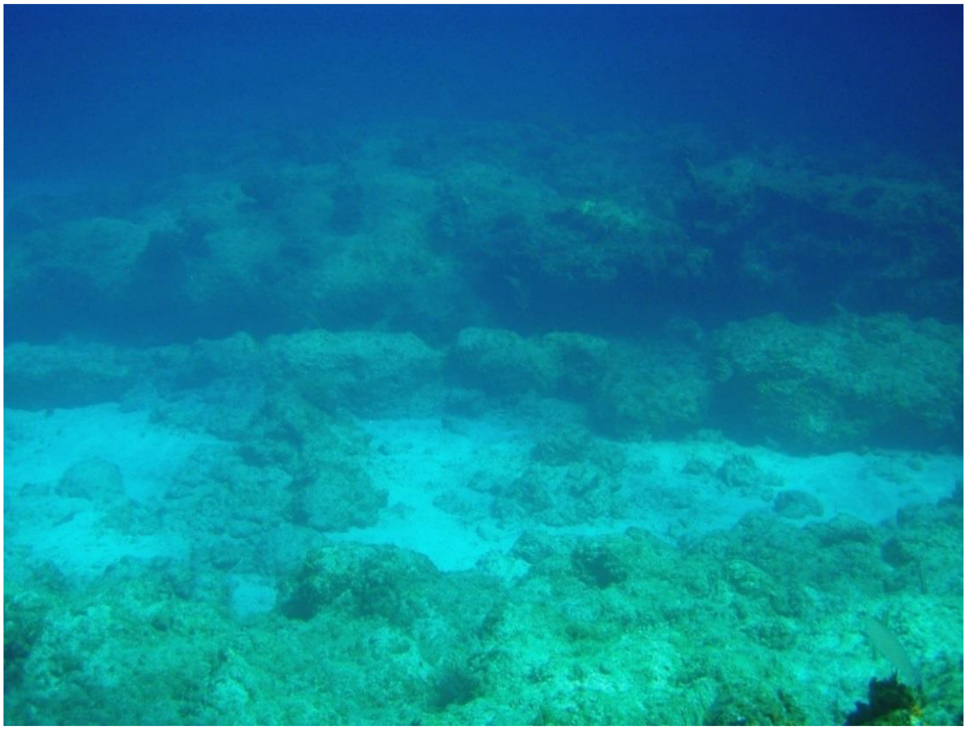


Photo 4-1. Typical Intermixed Hardbottom and Sands at Waterward Ends of Transects

Photo 4-2. Brain Corals and Sea Rods

Photo 4-3. Soft Corals Growing in Portions of the Hardbottom that Are Sheltered from Pounding Surf

Photo 4-4. Hardbottom Dominated by Sargassum

As water depths decreased closer to shore, the epibenthic hardbottom community became highly variable. Hard corals, including blade fire coral (*Millepora complenata*) (Photo 4-5), were abundant in some areas. Sea fans (*Gorgonia ventalina*) (Photo 4-6), both yellow and purple varieties, were more abundant in other areas. In areas that were the most exposed to rough seas, neither hard corals nor soft corals were present; the hardbottom had a nearly continuous (greater than 90 percent cover) of low-growing macroalgae, typically phaeophytes (Photo 4-7). Small pockets of loose rubble, likely deposited during rough sea conditions associated with tropical storms, hurricanes or large ground swells, were interspersed in the hardbottom, providing habitat for various juvenile reef fishes, including wrasses, squirrelfish, blue tangs, porcupinefish and others.

Photo 4-5. Fire Coral and Sea Fans

Photo 4-6. Sea Fans Were Abundant in Some Nearshore Areas

Photo 4-7. Coral-Less Hardbottom with Dense, Low-Growing Algae

Photo 4-8. Hardbottom Dominated by Green Algae

Most of the corals appeared to be in excellent condition, with no major signs of natural or human-influenced coral bleaching or disease. Macroalgae were generally present in healthy abundances, but had colonized and intermittently become over-abundant in widely spaced areas (Photo 4-8).

Qualitative Condition

Overall, the quality of this mosaic of benthic habitats was excellent. The reefs and hardbottom communities appeared healthy and consisted of floral and faunal populations typical of healthy reef fringes. No human-related debris (e.g., abandoned fishing nets) was observed. The area did not appear to be adversely affected by any degradation of water quality. The occasional presence of damaged corals appeared to be likely related to intermittent rough sea conditions. The intermittent presence of algae-dominated hardbottom is most often associated with artificially elevated nutrient concentrations that result from human-related, land-based sources of runoff, but Williams Cay has so little development, this seems unlikely to be the cause. Algae-dominated hardbottom can also occur when populations of reef-grazers (e.g., herbivorous fishes, sea urchins etc.) are eliminated or reduced, but no such deficiencies were noted.

4.7.2.2 SAV-Dominated Sandy Bottoms on the West (Exuma Bank) Side of the Island

The majority of the benthic community along the western side of Williams Cay was found to consist of SAV (Photos 4-9, 4-10 and 4-11). Turtle grass (*Thalassia testudinum*) was by far the most abundant species, occasionally covering extensive areas of sandy bottom in densities often more than 80 percent of the grassbeds.

In areas close to shore, Green macroalgae, including *Halimeda incrassata*, *Rhipocepalus phoenix*, *Batophora oerstedi*, and/or various species of *Caulerpa* and *Udotea* were frequently intermixed with the dominant seagrasses (Photo 4-12). Areas where the cover of seagrasses was extremely high are specifically identified on Figure 4-13. In other areas, where analysis of aerial photography had suggested that bottoms were barren sand, seagrasses were typically present, but in relatively low densities of less than 25 percent cover.

A PVC conduit reportedly containing an electrical cable (Photo 4-13) was found in a shore-perpendicular orientation near the existing boat ramp, boat lift and vessel maintenance area. Seagrasses and macroalgae has re-colonized the areas adjacent to the conduit.

Juvenile and mature cushion sea stars (Photo 4-14), sea pens (*Pinna carnea*) and sting rays (*Dasyatis americana*) of varying sizes were frequently seen in the beds of seagrass-dominated SAV.

Seagrasses are an important food source for green sea turtles and provide critical habitat for many commercially and recreational important fishery species, such as conch and lobster. The beds of SAV along the south and west sides of Williams Cay appear to provide valuable foraging habitat and refuge for fishes, queen conch and other marine life.

Juvenile reef-fish, including wrasses, rays and barracudas, were common in the grassbeds. Conical mounds indicating the presence of interstitial marine invertebrates (e.g., southern lugworms – *Arenicola cristata*) (Photo 4-15) were present in areas where the SAV beds were the least dense, the currents least strong, and the sediments most fine grained.

Photo 4-9. Dense Grassbed Dominated by Turtle-Grass (Thalassia testudinum)

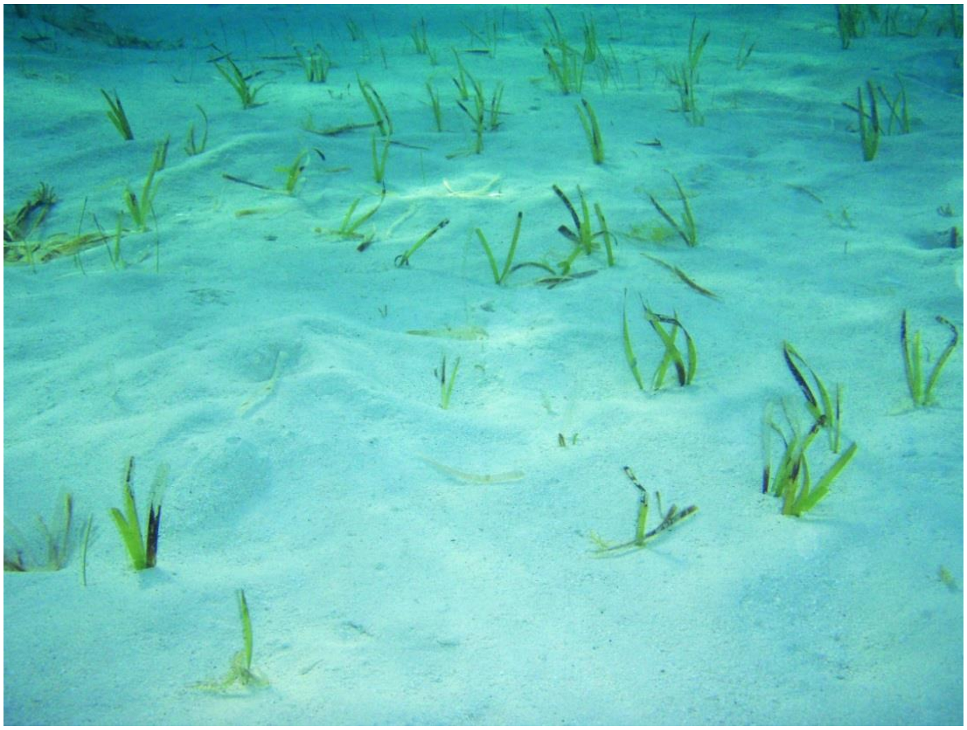


Photo 4-10. Seagrasses Density Was Sparse in Many of the Areas that Appear on Aerial Photographs to be Barren

Photo 4-11. Manatee Grass (Syringodium filiforme) (Narrow Blades) Growing Intermixed with Turtle-Grass (Wide Blades)

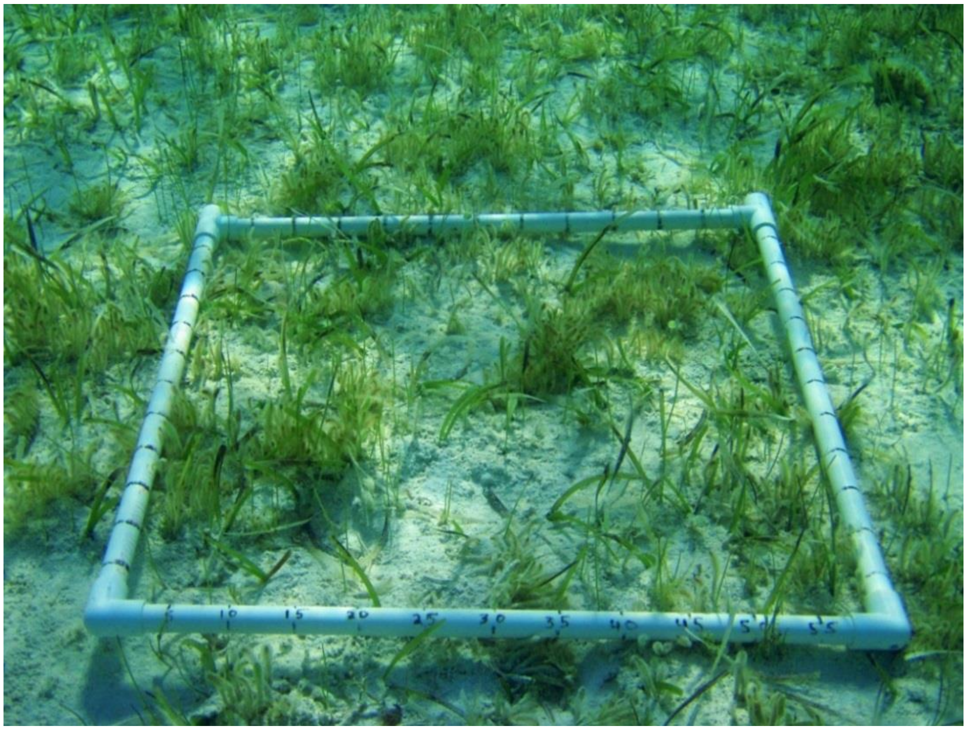


Photo 4-12. Seagrass and Macro-Algae in Moderately Dense SAV Bed

Photo 4-13. Seagrass Growing along Electrical Cable Conduit near Williams Cay Boat Lift

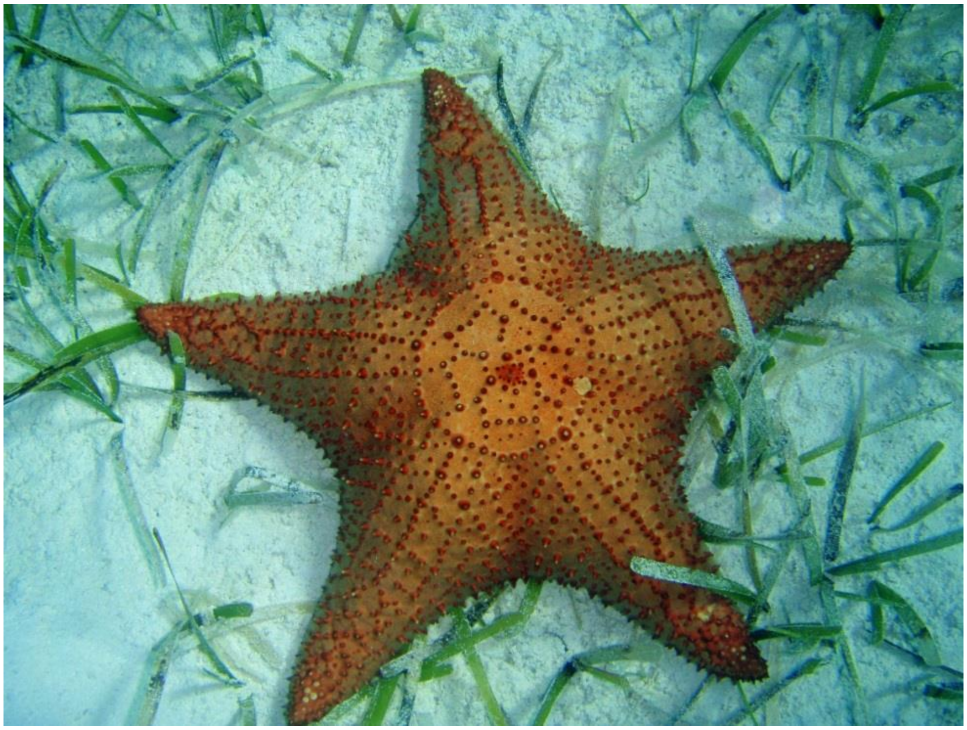


Photo 4-14. Cushion Starfish in Seagrass Bed

Photo 4-15. Lugworm Mounds and Sparse Seagrass in Bays on the Exuma Bank (West) Side of Williams Cay

Qualitative Condition

Overall, the quality of these beds of SAV was excellent. They appeared healthy and consisted of floral and faunal populations typical of healthy grassbeds. No human-related impacts (e.g., abandoned fishing nets, debris, propeller scars) was observed, and the area did not appear to be adversely affected by any degradation of water quality.

4.7.2.3 Shoreline Rock

Intertidal and subtidal rock was found In a narrow band located under the over-hanging coastal rock (Photo 4-16) along nearly the entire western shoreline, providing habitat for a variety of corals, anemones, sea urchins and other marine life that require a hard substrate. The band of this habitat is too narrow (typically less than 6 to 8 ft) to be visible on the marine habitat map (Figure 4-13).

Photo 4-16. View of Overhanging Ironshore that Provides Some Protection for the Marine Resources Below

Above or near the water line, bleeding tooth nerites (*Nerita peloronta*), chitons (*Acanthopleura granulata*), and beaded periwinkles (*Tectarius muricatus*) were common. Brown algae (e.g., *Turbinaria turbinata* and *Dictyota* spp.) and sponges (Demospongiae) were often observed attached to the rock substrate. The abundance of these organisms attracted various grazing invertebrates, including rock boring urchins (*Echinometra lucunter*), West Indian sea egg urchins (*Tripneustes ventricosus*), long-spined urchins (*Diadema antillarum*) and variegated urchins (*Lytechinus variegatus*). This diversity of potential food items attracted assemblages of juvenile reef fishes, including, snappers, grunts, blue tangs, and squirrelfish.

The areas that had the highest water flows (e.g., in the vicinity of Transect W-M-1) appeared to have the highest densities of corals and marine life. Fire corals (Photo 4-17) and massive starlet corals were often growing at or near the rock overhangs. In this area, coral-covered boulders with high species diversity were occasionally present within approximately 25 ft of shore, rising out of the seagrass-dominated sea floor. Most were heavily colonized with soft corals (Photo 4-18), while others had hard corals and sponges (Photo 4-19). Occasionally, in this nearshore area, large-size individual coral colonies were present (Photo 4-20). The proximity of these coral colonies to the shore suggests that they may have formerly been coastal ironshore rock that had broken off. Areas where flow was less had reduced coral, sponge and marine life densities. Photo 4-21 shows an above-water view typical of this area

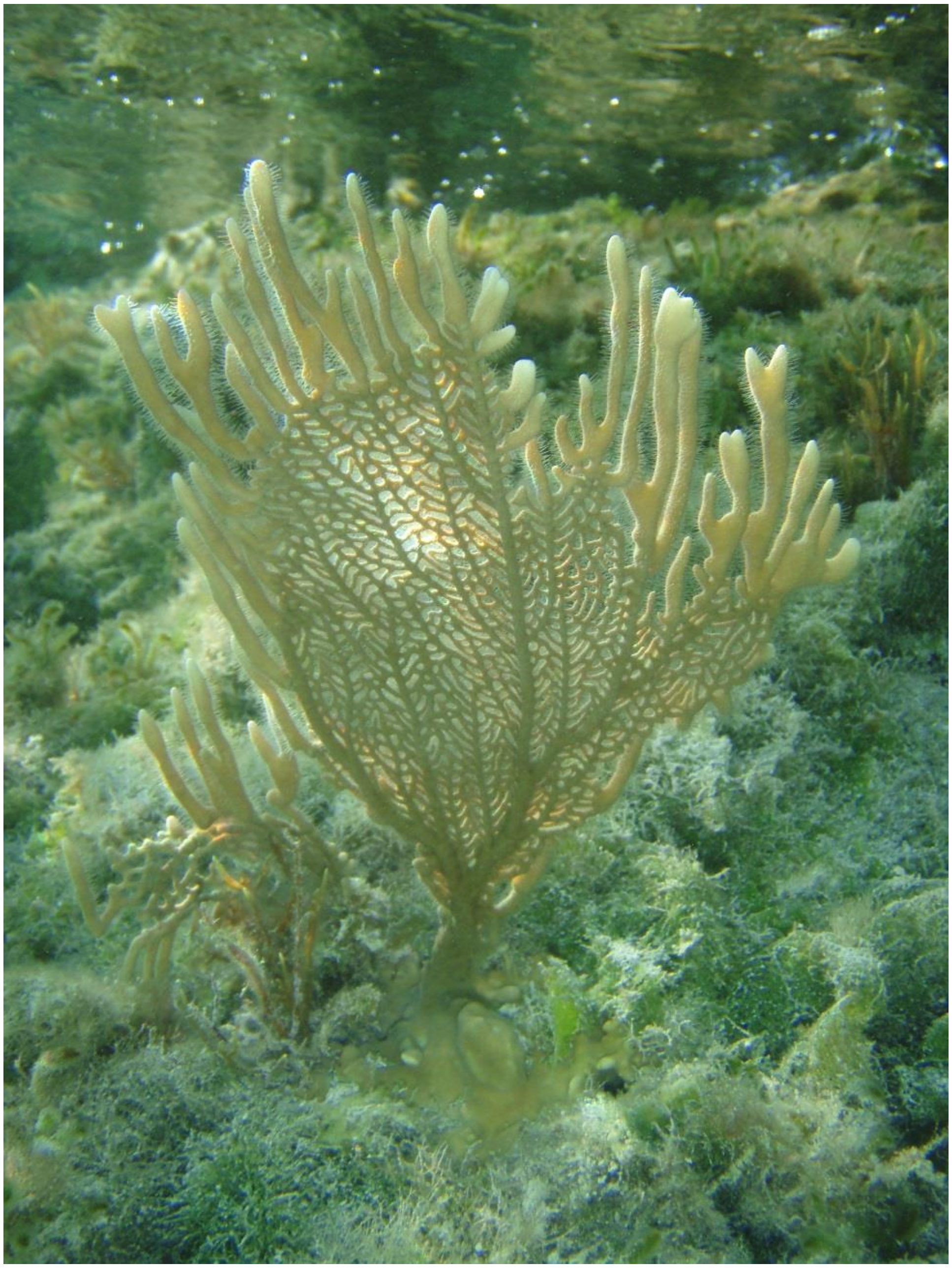


Photo 4-17. Fire Coral Growing In Nearshore Rubble

Photo 4-18. Soft and Hard Corals Reached Heights of 3 ft at Locations Where a Rock Substrate Was Present

Photo 4-19. Rock Outcrops Rising from Grassbeds Were Hot-Beds of Floral and Faunal Diversity

Photo 4-20. Large Coral Colonies Were Occasionally Present Rising out of the Sparsely Vegetated Seafloor

Photo 4-21. View Above-Water View Typical of the Nearshore Shoreline

Qualitative Condition

The quality of this shoreline rock community was excellent. It appeared healthy and consisted of floral and faunal populations typical of this habitat and likely serves as a nursery area for juvenile reef fishes and lobster. No human-related impacts (e.g., abandoned fishing nets, debris) was observed, and the area did not appear to be adversely affected by any degradation of water quality.

Occasionally, large pieces of the previously overhanging rock that had apparently been affected by erosion (Photo 4-22) had broken off and fallen to the sea floor, likely as the direct result of rough sea and wave conditions. The variation in habitat and relief in these areas provided edge-effect habitat benefits, often as the nucleus of fish density and marine life (Photo 4-23).

Photo 4-22. Some Corals along the Shoreline Wall Were Damaged

Photo 4-23. The Vertical Relief Provided in the Nearshore Rubble Zone Attracted a Variety of Juvenile Reef-Fish

4.8 Terrestrial Ecology

In terms of its terrestrial ecology resources, Williams Cay is a typical example of a small, mostly undeveloped island in the Exumas chain; having relatively low topographic relief and being densely vegetated with the dry broad-leaved evergreen coppice, the most abundant natural community throughout the Bahamas archipelago. Like similar islands lying alongside the western edge of the Exuma Sound and exposed to the trade winds blowing from the east, Williams Cay has both a distinct windward side, with a high-energy shoreline and wind and salt-spray pruned vegetation, as well as a leeward side, which harbors gently sloping pocket beaches. The only surface water bodies on the island are two intermittently flooded ponds and a low-lying *Conocarpus*-dominated area that likely holds standing water during the rainy season.

Williams Cay is separated from Children's Bay Cay to the southeast by a narrow (less than 100-ft-wide) open-water pass, which often has swift tidal currents. To the northwest, Williams Cay is directly connected to Lee Stocking Island, with no notable landscape features separating the two land masses.

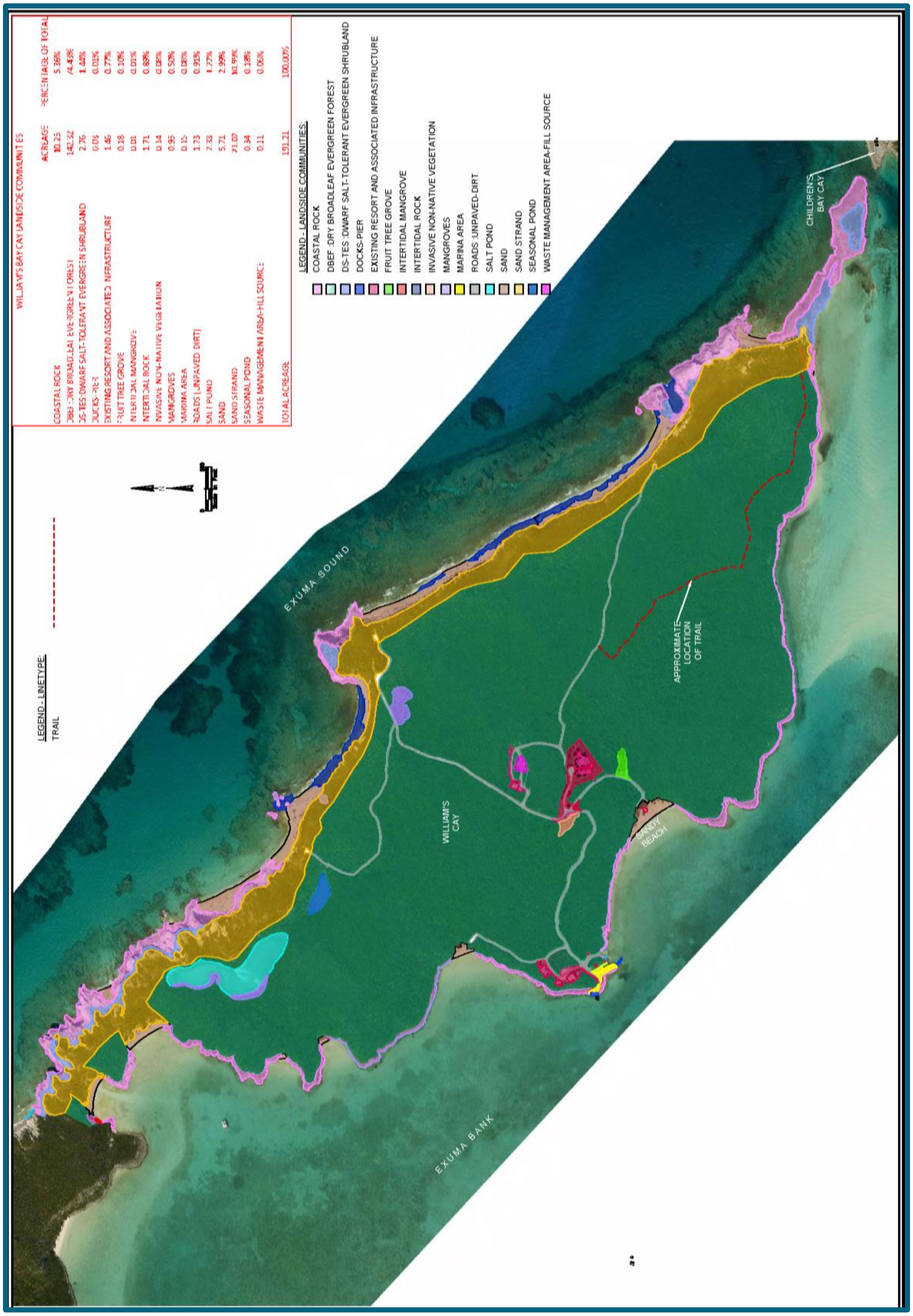
Privately owned for many decades and generally used only as a residential retreat, only a small portion of the island has been cleared or developed. Existing development is very limited and includes an owner's residence, a caretaker's residence, a few utility buildings, two small docks, a boat ramp, and some unpaved roadways. Accordingly, much of the dense coppice vegetation remains undisturbed. The proposed resort and golf course will require clearing for additional roadways, building footprints, and utility installation; however, a substantial portion of the coppice vegetation will remain. Potential construction-related impacts, most notably stormwater management for erosion and turbidity control, will require consideration, especially since these can cause runoff to the marine environment. Post-construction secondary impacts from waste disposal may also affect the marine environment and are included in the impact analyses.

4.8.1 Data Acquisition and Methods

Field surveys to characterize Williams Cay terrestrial flora and fauna were conducted during April 2015. Plant community types, as well as other land cover and land uses, were characterized, and observations were made regarding the presence of birds and other animal species. While the late spring season was not optimal for conducting breeding bird surveys, the potential for protected plants and animal species to occur on Williams Cay, particularly birds during migration, was addressed.

Vegetative assessments were conducted April 6 through 11, 2015. Field methodology consisted of inspections around the perimeter of the island and along roads and footpaths. The field reconnaissance was guided by high-resolution color aerial photography flown on June 25, 2014. Areas discerned on the aerials as discrete signatures were located in the field and inspected. Based on these field inspections, boundaries for each cover type were delineated to produce a comprehensive land cover map for Williams Cay (Figure 4-14).

Figure 4-16 – Landside Communities



Observations of plant and animal species encountered were recorded and, where necessary, GPS coordinates were recorded at edges of transition zones and/or at other notable locations. In addition, the entire island shoreline was inspected either on foot or from a boat.

Vegetation was identified to species whenever possible. A list of the plant species observed is included as Appendix B. Vegetative community classification follows *A Guide to Caribbean Vegetation Types: Preliminary Classification Systems and Descriptions* (Areces-Mallea, et al., 1999) and *Flora of the Bahama Archipelago* (Correll and Correll, 1982). Plant nomenclature follows Correll and Correll (1982) and/or *Flowers of the Bahamas and the Turks and Caicos Islands* (Wood, 2003). Vegetative communities and other land cover and land uses are listed and quantified in Table 4-1, along with their areal extents.

During the vegetation survey and habitat mapping, observations of terrestrial animals were recorded. Most often, these observations were of birds, including passerines and shorebirds, but also included five kinds of crabs, two snails, and two reptiles. A list of animals observed and identified on Williams Cay is included as Appendix B.

4.8.2 Description of the Existing Terrestrial Environment

The following sections provide descriptions of the terrestrial vegetative habitats, land cover, and land uses identified on Williams Cay. Figure 4-14 provides the vegetation and land cover map that was developed. Mapping units are keyed to the various cover types listed in Table 4-1. The following sections provide descriptions for each land cover and land use type.

4.8.3 Dry Broad-Leaved Evergreen Forest (DBEF)

Dry Broad-Leaved Evergreen Forest (DBEF) dominated the Williams Cay vegetative cover, covering more than 74 percent of the island. DBEF consisted of dense forest canopy with a diverse tree assemblage. Except in areas where it abutted disturbed areas, the DBEF community typically began at the landward edge of the Coastal Rock, Dwarf Salt-Tolerant Evergreen Shrubland, or Sand Strand (described in subsequent sections) and continued up-slope to the height of the land, dominating most interior areas protected from wind and salt spray.

Table 4-1 - Williams Cay Vegetative Communities and Land Cover/Land Use Types

Vegetative Community or Land Cover/Land Use Type	Code	Areal Extent	
		Acres	**Percent Total**
Vegetative Community or Natural Land Cover			
Dry Broad-Leaved Evergreen Forest	DBEF	142.32	74.44
Sand Strand (Dune)	SS	21.02	10.99
Coastal Rock	CR	10.25	5.36
Sand (Beach)	SAND	5.71	2.99
Dwarf Salt-Tolerant Evergreen Shrubland	DS-TES	2.76	1.44
Salt Pond	SP	2.33	1.22
Intertidal Rock	R_i	1.71	0.89
Mangrove	MAN	0.95	0.50
Seasonal Pond	POND	0.34	0.18
Invasive Non-Native Vegetation	INV	0.14	0.07
Intertidal Mangrove	M_i	0.01	0.01
	Subtotal	187.54	98.09
Existing Development-Related Land Cover and Land Uses			
Roads (unpaved/dirt)		1.73	0.90
Marina Area		0.15	0.76
Existing Buildings and Associated Infrastructure		1.46	0.09
Fruit Tree Grove		0.18	0.08
Docks/Piers		0.03	0.06
Waste Management Area – Fill Source		0.11	0.02
	Subtotal	3.66	1.91
	Total	**191.20 acre**	**100.00**

Tree diameters for mature trees were relatively large for a small Bahamian cay (generally between 4 and 12 inches [diameter at breast height (dbh)]) and of substantial density, with many trees having multiple trunks. The tallest trees were 15 to 20 ft in height and grew in such high density that their crowns coalesced into a dense canopy that generally limited the understory. Despite the limited understory, the high density of tree trunks and interlocking branches generally made the DBEF impassible to casual walking. A view of typical DBEF canopy on Williams Cay is provided in Photo 4-24. Photo 4-25 shows a section of unpaved roadway through the DBEF and provides another example of how densely the DBEF grows.

Photo 4-24. Overlooking DBEF Canopy on Williams Cay

Photo 4-25. Unpaved Road through Dense DBEF on Williams Cay

Common tree and shrub species within the DBEF included cinnecord (*Acacia choriophylla*), numerous poisonwood (*Metopium toxiferum*), pigeon-plum (*Coccoloba diversifolia*), sea grape (*Coccoloba uvifera*), Yellow-wood (*Zanthoxylum flavum*), abundant seven-year apple (*Casasia clusiifolia*), wild dilly (*Manilkara bahamensis*), blackbead (*Pithecellobium keyense*), and silver thatch palm (*Coccothrinax argentata*). Gum elemi (also known as gumbo limbo) (*Bursera simaruba*) and Century plants (*Agave* sp.) were also occasionally present. Several large mastic (*Mastichodendron foetidissium*) trees were found in interior portions of the DBEF community.

Lignum vitae (*Guaiacum sanctum*) and narrow-leaved blolly (*Guapira discolor*) were occasionally present within the DBEF on Williams Cay. These two tree species are protected by law under the *Conservation & Protection of the Physical Landscape of The Bahamas Act.* With the exception of the lignum vitae and the narrow-leaved blolly, no other protected tree species were found.

Occasionally, lignum vitae trees were found in clusters, with many individuals growing within a few yards of one another. For example, when following the eastern footpath that extended through the DBEF (refer to Figure 4-14 for footpath location), a cluster of five lignum vitae trees (Cluster A) grew alongside the footpath (GPS location: 390119E, 2627418N UTM WGS84 meters). This narrow, meandering footpath was hand cut through the DBEF to allow access for the golf course designers to review the vegetative cover and terrain. A second cluster of lignum vitae trees (Cluster B) were growing further along the footpath (GPS location: 390108E, 2627424N UTM WGS84 meters). A more extensive count was conducted at a third location (Cluster C) where 22 lignum vitae trees grew. A representative central GPS location for Cluster C is 390116E, 2627419N (UTM WGS84 meters). The lignum vitae trees in Cluster C had trunk diameters (dbh) ranging from less than 2 inches to approximately 12 inches and heights to 15 ft (Photo 4-26). However, within Cluster C, most of the trees were small, with trunk diameters of less than 2 inches and heights of only 3 to 4 ft. The several largest lignum vitae trees within Cluster C had multiple trunks, two with two trunks each and one tree with five trunks (Photo 4-27). The trunk diameters for these multi-trunked trees were individually measured and ranged from 6 to 12 inches. Appendix B provides a summary table for the lignum vitae trees measured at Cluster C.

Photo.4-26 Example of Trunk Size for Lignum Vitae Tree Growing Alongside Footpath on Williams Cay

Photo 4-27. Example of Notable Multi-Trunked Lignum Vitae Tree Growing Alongside Footpath on Williams Cay

Another notable lignum vitae tree was observed along the road near the main north-south road, about 550 ft north of the turnoff to the rock pit (GPS location: 389897E, 2627749N UTM WGS84 meters). This tree had an 11-inch dbh trunk and estimated height of 20 ft. (Photo 4-28).

Photo 4-28. Notable Lignum Vitae Tree Observed along the Main N/S Road, 550 ft North of Turnoff to Rock Pit (GPS Location: 389897E, 2627749N UTM WGS84 Meters)

The lignum vitae tree observations on Williams Cay were made during a general field reconnaissance conducted primarily to map the extent of various vegetation cover types found on the island. During this field reconnaissance, lignum vitae tree counts were conducted quickly and informally to obtain an impression for the potential frequency with which this protected tree species can be expected to occur on the island. Correll and Correll (1982, pg. 718) describe the lignum vitae (*Guaiacum sanctum*) as a “small or sometimes rather large tree or a large shrub, to about 10 m [about 33 ft] tall, with dense spreading crown and a thick trunk rarely more than 3 dm [about 12 inches] in diameter.…” Based on this description, more than a few of the lignum vitae noted on Williams Cay had trunk diameters that approach the maximum expected size of about 12 inches (Photos 4-26, 4-27, and 4-28), and these trees’ crowns could certainly be described as dense and spreading. In addition, although no lignum vitae trees approaching 33 ft in height were noted on Williams Cay, heights for several trees were in excess of 15 ft, which, in relation to the overall height of the general tree canopy on Williams Cay, is substantial. These limited observations indicate that lignum vitae trees are indeed fairly abundant on Williams Cay, and a number of fairly notable specimens can be expected. Obtaining more precise estimates for density or spatial variability would require use of a more formal sampling methodology.

Narrow-leaved blolly trees were intermixed with other dry broadleaf evergreen forest species, and were typically less than 15 ft in height. Tree trunks and branches within the DBEF occasionally hosted specimens of the air plant swollen wild pine (*Tillandsia utriculata*). However, no orchids, either terrestrial or epiphytic, were observed.

Soils within the DBEF were poorly developed and typically included a peat layer of varying thickness over the underlying limestone. The DBEF was consistent with the Blackland community type classification of Correll and Correll (1982).

The bananaquit (*Coerba flaveola*) (Photo 4-29), a fairly common year-round breeding resident, was the most common bird species observed within the DBEF community. Other birds occasionally observed were the common ground dove (*Columba passerina*) (Photo 4-30), great egret (*Ardea alba*) and Greater Antillean bullfinch (*Loxigilla violacea violacea*). The Bahamas woodstar hummingbird (*Calliphlox evelynae*) and white-crowned pigeon (*Columba leucocephala*) were noted also. White-crowned pigeons are reported to nest on the smaller cays offshore from Williams Cay, and visit Williams Cay to forage on berries from poisonwood and/or gum elemi trees.

Other animal species noted within the DBEF community included the peanut snail (Cerion sp.), and Bahamian brown anoles (*Anolis sagrei ordinatus*). The island's caretaker indicated that the Bahama boa (*Epicrates striatus strigulatus*) was fairly common and reached lengths in excess of 6 ft.

Photo 4-29. Bananaquit on Williams Cay

Photo 4-30. Common Ground Dove on Williams Cay

4.8.4 Sand Strand (SS)

Sand Strand (SS) totaling 21.02 acres, or nearly 11 percent of Williams Cay was present along the entire eastern side of the island. Typical sand strand vegetation consisted of a mix of grasses, such as sea oats (*Uniola paniculata*), sand spur (*Cenchrus* sp.), and seashore rushgrass (*Sporobolus virginicus*); trailing vines such as morning glory (*Ipomoea pes-caprae*); shrubs such as inkberry (*Scaevola plumieri*) and bay cedar (*Suriana maritima*); and small trees such as seagrape (*Coccoloba uvifera*), which grew in dense stands. Coconut trees (*Cocos nucifera*) were also common, and buccaneer palms (*Pseudophoenix sargentii*) were observed. Photo 4-31 provides a representative view of typical sand strand along the windward shoreline of Williams Cay. Photo 4-32 provides another example taken at the island's eastern end. A few invasive non-native Australian pines (C*asuarina equisetifolia)* were occasionally present within the sand strand.

Photo 4-31. Example of Sand Strand Community Type on Windward Side of Williams Cay

Photo 4-32. Sand Strand Community at Eastern End of Williams Cay

4.8.5 Coastal Rock (CR)

Nearly the entire leeward shoreline of Williams Cay was a coastal rock environment, also known as ironshore, composed of a low, narrow fringe of barren, exposed limestone, often undercut by erosive wave action to create an overhang (Photo 4-33). In contrast, the windward side of Williams Cay, facing Exuma Sound, did not have a continuous rock shoreline but was interrupted by relatively long stretches of sandy beach. However, the windward side coastal rock was characterized by dramatic cliffs and headlands that abruptly rose to elevations of nearly 60 ft (Photo 4-34). The coastal rock shoreline covered 10.25 acres, or 5 percent, of Williams Cay.

Antillean nighthawks (*Chordieles gundlachii*) are well known for nesting in non-vegetated areas, where eggs are laid on open rock or shallow scrapes in the sand. Particular attention was given to identifying nighthawk nests along all sections of the coastal rock shoreline, however, no nests or eggs were found.

Photo 4-33. Coastal Rock (Ironshore) on Leeward Side of Williams Cay, Facing Southeast

Photo 4-34. Coastal Rock Headland on Windward Side of Williams Cay, Facing Northwest

4.8.6 Sand (SAND)

Sand beaches of various lengths intermittently interrupted the coastal rock shoreline. The windward, eastern side of Williams Cay, facing Exuma Sound, had several relatively lengthy stretches of sandy beach. These beaches were fully exposed to the trade winds and wind-driven waves (Photo 4-35). The leeward, western side had six pocket beaches, with the two largest ones located in the northwestern-most section of Williams Cay shoreline (Photo 4-36). In total, Williams Cay had 5.71 acres of sand beaches, which accounted for approximately 3 percent of the land cover. The beaches have the potential to provide nesting habitat for sea turtles, but no adult turtles, juvenile turtles or turtle tracks were observed.

4.8.7 Dwarf Salt-Tolerant Evergreen Shrubland (DS-TES)

Dwarf Salt-Tolerant Evergreen Shrubland occurred on the windward side of Williams Cay and was characterized by low-growing evergreen shrubs that grow directly from slight fractures and solution holes in the weathered limestone rock on the landward extents of the otherwise barren coastal rock shoreline (Photo 4-37). This is an extremely harsh environment that is frequently subjected to wind pruning and salt spray. Vegetation within the DS-TES was very limited, consisting of primarily sandfly bush (*Rhachicallis americana*), rosemary (*Strumpfia maritima*), bay cedar (*Suriana maritima*), and button bush (*Conocarpus erectus*), with the sandfly bush and rosemary being most abundant and commonly occurring together. DS-TES occupied only 2.76 acres on Williams Cay, or 1.44 percent of the total land cover.

Photo 4-35. Williams Cay, Windward Side Sandy Beach, Facing Northwest

Photo 4-36. Williams Cay, Leeward Side Sandy Beach, Facing Southeast

Photo 4-37. Dwarf Salt-Tolerant Evergreen Shrubland Vegetation Growing from Coastal Rock, Williams Cay Windward Shoreline

4.8.8 Salt Pond (SP) and Seasonal Pond

Williams Cay has two open-water ponds (Figure 4-14). One is a hypersaline salt pond and the other appeared to be a seasonal pond that, when flooded, is possibly fresh water or only moderately brackish.

The larger salt pond on Williams Cay is located near the northwestern end of the island. It is approximately 2.33 acres in size (Photo 4-38). A topographic aerial survey conducted on June 25, 2014, found the water elevation in the pond to be 1.3 ft, which, when photointerpreting the aerial imagery taken at the same time, appeared to fill the pond to its vegetated periphery (Figures 4-2 and 4-14). The water level was lower during field reconnaissance in April 2015, filling the pond to about 90 percent of its total area and leaving a ring of exposed mud around the perimeter (Photo 4-39). Figure 4-14 shows a shoreline promontory that divides this salt pond into a larger south lobe and a smaller northern lobe. Photo 4-39 was taken from the northern shoreline of this promontory, facing north across the pond's smaller northern lobe. The photo clearly shows the shallow water in the pond and the exposed mud periphery. A water sample collected from the very shallow standing water within the pond was very hypersaline [salinity of 273 parts per thousand (ppt)] when measured with a refractometer. This measurement required a double-dilution of the original sample to bring it within the range of the refractometer's scale.

The smaller of the two open-water ponds on Williams Cay is located just southeast of the larger pond and covers 0.34 acre. No water was present in the pond during the April 2015 field reconnaissance (Photo 4-40). At that time, the pond bottom was firm, dry mud with scattered desiccated mats of an unidentified filamentous alga that apparently flourishes during times of higher water. Photo 4-40 shows the low-growing salt-tolerant seashore salt-grass (*Distichlus spicata*) in the foreground, and the shrub sea ox-eye (*Borrichea frutescens*) growing along the pond periphery on the right of the frame. A number of large palms (*Sabal palmetto*) were growing along the pond periphery and are visible on the left side of Photo 4-40. A review of the June 25, 2014, aerial photograph used in mapping Figure 4-14 indicates that standing water was present on that day, with a water surface elevation of 1.7 ft, which is 0.3 ft (3.6 inches) higher than the water level in the larger salt pond on that same day. The lack of water in the smaller salt pond during April 2015, while shallow water was still present in the larger salt pond, indicates the substrate of the smaller pond may have a slightly higher topographic elevation or permeability than the larger pond, allowing it to drain and dry more quickly than the larger pond.

Photo 4-38. From Adjacent Hillside Overlooking the Larger of the Two Salt Ponds on Williams Cay (Photo Taken April 9, 2015 from the Northwest End of the Pond, Facing Southeast)

Photo 4-39. View of Shallow Water and Exposed Mud Edge in the Larger of the Two Salt Ponds on Williams Cay, April 9, 2015 (Photo Taken Along South Shoreline of Northern Lobe of Pond, Facing North)

Photo 4-40. View of Smaller of the Two Salt Ponds on Williams Cay (Photo Taken April 9, 2015 from the Southeast End of the Pond, Facing Northwest)

Accordingly, the smaller pond may not become as hypersaline as the larger pond and, depending on the pond's size relative to its surrounding drainage basin, may become only moderately brackish before it dries. This condition leads to classifying (Table 4-1) this pond as a seasonal pond instead of a salt pond. The substrate of the smaller pond also had a number of fiddler crab (*Uca* sp.) burrows (Photo 4-41), which also indicates that, when flooded, the pond does not become excessively hypersaline. Bird tracks in the ponds indicate use by wading birds (likely yellow-crowned night-herons) and gallinaceous birds.

4.8.9 Intertidal Rock

Intertidal rock, 1.71 acres in extent, is found along the windward shoreline. It consists of a narrow strip of rock located just waterward of the sand beach and, as its classification suggests, is intermittently covered at high tide and exposed at low tide (Photos 4-42 and 4-43). This land cover classification is distinguished from the coastal rock, which receives salt spray, but not regular tidal inundation.

Photo 4-41. Fiddler Crab Burrow in Exposed Mud Bottom of Smaller Salt Pond

Photo 4-42. Intertidal Rock Shoreline along Windward Side of Williams Cay, Facing Northwest

Photo 4-43. Another Example of Intertidal Rock Shoreline along Windward Side of Williams Cay, Facing Northwest

4.8.10 Mangrove (M) and Intertidal Mangrove (Mi)

Mangroves were found at three locations on Williams Cay (Figure 4-14). One mangrove area is a very small stand (0.01 acre) of dwarf intertidal red mangrove (*Rhizophora mangle*) located on the leeward side of the northwest property boundary, adjacent to Lee Stocking Island.

Non-intertidal black mangroves (*Avicennia germinans*) form a narrow fringe along the western side of the larger salt pond (as described previously) located near the northwestern end of Williams Cay.

The largest stand of mangroves found on Williams Cay was another non-intertidal stand, this one consisting of buttonwood mangrove (*Conocarpus erectus*) growing in a monotypic cluster near the windward end of the main southwest-to-northeast road that extends across the middle of the cay, from the residences and boat ramp. This area is a topographic low, with a bottom elevation of 1.9 ft, which approximates the elevation of the salt pond perimeters.

4.8.11 Invasive Non-Native Vegetation (INV)

This mapping unit is comprised of a dense, 0.14-acre monotypic stand of ornamental candlewood (*Scaevola taccada*), growing to a height of 8 to 10 ft. This stand is located just west of the main residence, adjacent to the west side of the road. Other common names for this plant include Asian Scaevola, white inkberry, beach naupaka, and Hawaiian seagrape. The National Invasive Species Strategy, a document issued in 2003 by the BEST Commission, identifies ornamental candlewood is as an invasive, non-native species (Appendix C). This strategy document identifies nonnative plants and animals that represent a threat to the biodiversity of The Bahamas and recommends their eradication or control. Eradication is recommended for ornamental candlewood.

Individual candlewood bushes were found to be fairly common along the beaches on the windward side of the island where they are interspersed with native beach dune species.

4.8.12 Other Existing Development-Related Land Cover and Land Uses

Williams Cay has been privately owned for many decades and was generally used as a residential retreat. During that time, the island's several owners have collectively cleared or developed only a small fraction of the island. Existing development-related land cover and land uses are listed in Table 4-1 and further described in the following sections.

4.8.12.1 Roads

Although most of the existing development was clustered toward the center of Williams Cay, a few roads provide access to other points on the island (Figure 4-14), primarily connecting the leeward-side marina area to the residence and the residence to the windward shoreline fronting Exuma Sound. These roads total about 7,500 linear feet. While most of the roads were unpaved limerock, the roadway between the marina area and the residence was paved with macadam. Photo 4-25 provides an example of a typical section of unpaved roadway on Williams Cay. The trail noted on Figure 4-14 is a hand-cleared footpath.

4.8.12.2 Marina Area, including Docks and Piers

The marina area is located on the leeward, Exuma Sound shoreline, just west of the residence (Figure 4-14). Facilities include two small docks (Photos 4-44 and 4-45), a large, steel-framed boat hoist (Photo 4-46), and a concrete boat ramp.

Photo 4-44. Small Dock adjacent to Steel Boat Hoist on Williams Cay

Photo 4-45. Second Small Dock and Boat Hoist on Williams Cay

Photo 4-46. WT115: Boat Hoist with Concrete Boat Ramp on Far Side of Hoist

4.8.12.3 Existing Buildings and Other Infrastructure

Existing 1990s-era buildings on Williams Cay are minimal, consisting largely of a main residence (Photo 4-47), a caretaker's residence, some beachside gazebos (Photo 4-36), and a few utility and storage buildings. Various native and non-native plant specie, such as Oleander (*Nerium oleander*), Bougainvillea (*Bougainvillea spectabilis*), weeping bottlebrush (*Callistemon viminalis*) are in use as ornamental plantings.

Utility infrastructure is limited, consisting of a small reverse osmosis plant located in a building adjacent to the boat ramp, and a water line that is buried along the edge of the main road to the primary residence and caretaker's residence. An underwater cable from Great Exuma supplies electricity. This cable crosses the Exuma Bank and makes landfall on Williams Cay at the boat ramp. An on-island generator provides backup electrical power. Septic tanks and associated drainfields provide wastewater management for both the primary residence and the caretaker's quarters.

Rock walls, vintage unknown, were encountered at various locations in the Deciduous Broadleaf Evergreen Forest, suggesting possible former use as animal enclosures.

Photo 4-47.   Main Residence on Williams Cay

4.8.12.4 Fruit Tree Grove

The remnants of a fruit tree grove are located just to the south of the main residence, adjacent to the roadway that leads from the residence to the beach. Fruit trees present included mango (*Mangifera indica*), Barbados cherry (*Malpighia punicifolia*), breadfruit (*Artocarpus altilis*), Ju plum (*Ziziphus mauritiana*), Genip (*Melicoccus bijugatus*) and various citrus fruits, including orange, key lime, and tangelo (*Citrus x* spp.).

4.8.12.5 Area – Fill Source

As indicated on Figure 4-14, a rock pit is located just north of the main residence. This pit was used for source material to fill and level the ground on which the main residence is located. The rock pit is about 175 ft long, 75 ft wide, and about 20 ft deep, in comparison to the surrounding grade (Photo 4-48). The rock pit and immediately surrounding area serve as the central location for abandoned equipment and scrap material storage, as well as a trash burn area. This area will be entirely renovated as part of the proposed resort development.

Photo 4-48. Rock Pit Just North of the Main Residence

4.8.13 BEST Commission National Invasive Species Strategy

The BEST Commission issued a national invasive species strategy in 2003 (Appendix C). This strategy identifies nonnative plants and animals that represent a threat to the biodiversity of The

Bahamas and, therefore, recommends their eradication or control. The Williams Cay environmental assessment conducted in April 2015 identified three plant species (Table 4-2), but no animal species, listed in the invasive species strategy document.

Table 4-2 - Invasive Plant Species Identified on Williams Cay, April 2015

Genus/Species	Common Name	Occurrence Notes	Recommendation[a]
Casuarina equisetifolia	Australian pine	Occasional along sandy shorelines and disturbed areas	Control
Scaevola taccada	Ornamental candlewood, Asian Scaevola, white inkberry, Hawaiian seagrape	Abundant along beaches	Eradication
Leucaena luecocephala (formerly *L. glauca*)	Jumbay, jumbie bean	Common in coppices and disturbed areas	Control

[a]As noted in BEST Commission (2003), *The National Invasive Species Strategy for The Bahamas*. BEST, Nassau, The Bahamas, 34 pp.

For the Australian pine, which the strategy document recommends for control (versus total eradication), the current landowner has undertaken an Australian pine removal program that is ongoing as of mid-2015. Only a few Australian pines remain in isolated locations on Williams Cay and their removal is anticipated in the near future as the resort development progresses.

4.9 Socioeconomic Aspects

4.9.1 Adjacent Communities

The only adjacent community to Williams Cay is Barraterre located on Great Exuma. The adjacent community and its geographic relationship to Williams Cay is shown on Figure 3-1. The total population of Great Exuma is approximately 7,300 (2010 census), with the entry point generally located at George Town. Based on a 2010 census, Barraterre has a permanent population of approximately 120 residents.

4.9.2 Economic Base and Status

Williams Cay has no significant settlements and, therefore, no existing economic base, although its proximity to Barraterre would make it a component of its economic base.

4.9.3 Existing Opportunities for Employment

Based on the undeveloped nature of Williams Cay, there is currently little direct opportunity for employment on the island except for a caretaker.

4.9.4 Current Land Uses

Current land uses on the island are primarily undeveloped land, with several residential buildings and maintenance structures. There is a limited road network and two docks used for delivering supplies. The only other use of the island area is currently as an anchorage for cruising sailors and boaters, although access to island itself is prohibited.

4.9.5 Existing Transportation

A limited, informal roadway network exists on the island and connects the residential structures with the landing dock and several beaches located on both the windward and leeward sides of the island.

4.9.6 Existing Infrastructure and Public Services

Existing infrastructure on Williams Cay is limited to a reverse osmosis water treatment plant, with a limited distribution network and several diesel generators. Williams Cay is a private island and no public services are provided.

4.9.7 Air Quality

No specific testing was accomplished to measure ambient air quality on Williams Cay but based upon present conditions and the lack of potential pollutant sources, air quality is deemed to be good.

4.10 Cultural Resources

4.10.1 Historic Overview of Williams Cay and Vicinity

The Lucayans, indigenous people in The Bahamas, lived throughout the Bahamas archipelago (which includes the Turks & Caicos Islands). Archaeological evidence of their presence is generally categorized by the size and intensity of the occupation. Living sites would have been villages or groups of households. Processing sites are those locations where it seems residents gathered their catch of fish, conch, etc., to package for taking back to their village. Many of the smaller cays have these type of sites. Sacred sites would include burials in caves as well as caves used exclusively for duho (the cacique's/ chief's seat) ceremonies. A member of the Bahamian Archeological Society conducted a site visit, and no indication of this type of site was found on Williams Cay.

4.10.2 Assessment of Cultural Resources

Dr. Grace Turner conducted an archaeological surface survey of Williams and Children's Bay Cays on July 16, 2015. This survey noted that the profile of both cays is similar and that there was little non-native vegetation. From a distance, the only non-local trees visible were noted as the occasional coconut palm, casuarina and sisal bloom. This led to the conclusion that these islands have not had any large-scale land clearing for at least 100 years. A number of random stops were conducted along the shoreline and further inland to search for evidence of human activity. The usual materials seen were a variety of plastics and aluminum containers, which corroborates anecdotal evidence that there was some development on Children's Bay Cay in the 1960s and 1970s.

The only cultural evidence more than 50 years old found during this survey was dry stone walls found on both islands (Photo 4-49). Historically, this type wall was erected to mark property boundaries and to keep grazing animals out of cultivated fields. The island's caretaker stated that several older locals claimed the walls were to keep sheep and goats within designated areas. He also said that an elderly man told him that his grandparents told him they used to gather rocks to build these walls. This oral history fits with information from archival documents.

Photo 4-49. Dry Stone Wall – Children's Bay Cay

Resident Justice Reports from the late 1800s and Commissioners' Reports from the early 1900s indicate that the cultivation of sisal (*Agave sisalana*) began in the Exumas by 1889. Sisal was still a major export crop in 1918, but the effects of drought and hurricanes and the difficulty of getting the fiber to market presented constant challenges. By the 1920s, stock raising was the more prevalent economic activity for the Exumas. These administrative reports do not specifically refer to the Exuma Cays but the assumption is that persons living on Great Exuma travelled by boat to tend fields and livestock on the cays. This hypothesis is supported by the fact that so little older cultural material can be found on these cays. The only cultural material found other than the stone walls was the base of an early 20th century clear glass bottle found on the north coast of the cay and was likely washed ashore (Photo 4-50). This find fits the historical pattern of people travelling by dinghy boats to work their fields and tend their flocks on the cays.

Photo 4-50. Clear Glass Bottle Base - c. Early 20th Century

Throughout The Bahamas, these stone walls are a common reminder of a bygone era. Since these walls were part of the historical landscape, it has become usual for the Antiquities, Monuments & Museum Corporation to recommend that developers save these walls wherever possible. In the absence of buildings, these walls represent a part of the historical built environment of these islands.

The knowledge of how to construct such walls remains within the local community even today (Photo 4-51). It was the opinion of Dr. Turner that including this historical technique of dry stone wall construction during development would serve to enhance the historical ambience of any future development on these cays.

Photo 4-51. Contemporary Dry Stone Wall – Children's Bay Cay

4.11 Existing Utility Services

4.11.1 Potable Water

Potable water is currently provided to Williams Cay via the reverse osmosis water treatment plant. Influent water to the treatment plant is drawn from surface waters and concentrate water is discharged overland to surface waters. Several concrete-lined cisterns on the island are not utilized currently.

4.11.2 Wastewater

Currently, no wastewater treatment facilities are located on Williams Cay. All wastewater generated on the island by is discharged to septic tanks, with disposal via soak aways.

4.11.3 Electricity

Electricity is provided by an underwater cable from Great Exuma. Several on-island diesel generators provide backup power.

4.11.4 Roads

A limited, informal roadway network exists on the island and connects the residential structures with the landing dock and several beaches located on both the windward and leeward sides of the island.

4.11.5 Solid Waste

Solid wastes generated on Children's Bay Cay are currently transported to Barraterre for disposal or burned onsite.

4.12 Regulatory and Legal

The current Bahamian Building and Land Development Code does not set forth a definitive permit application and land development approval process. In order to best interpret the Bahamian Code and relevant legislation, a list of applicable legal and regulatory statutes together with relevant Government Agencies will be developed during the planning process.

5.0 Environmental Impact Analyses

5.1 Impacts to Shoreline/Nearshore and Coastal Processes

With the exception of the dock servicing the golf maintenance area, no in-water structures, such as jetties, groins, or navigation channels, are proposed. No shoreline erosion, changes in littoral transport, or shoaling are anticipated to result from any aspect of the project.

5.2 Impacts to Local Circulation and Currents

Since there will be no placement of in-water structures, other than minimal pile placement at the boat dock, and no dredging, no impacts to local circulation and currents will result from any aspect of the project.

5.3 Impacts to Surface Water and Ground Water Quality

Existing surface waters on Williams Cay are limited to two small, ephemeral salt ponds that are often largely or completely dry. These two salt ponds will be expanded and deepened to create two ponds with permanent water for use in the golf course irrigation plan. Three other small ponds for stormwater runoff storage will be constructed and incorporated into the golf course irrigation system.

At this time, no testing has been done to determine if small, isolated freshwater lenses may still exist on the island. If so, it is likely small lens areas may be supporting the older natural vegetation on the island and should be preserved if identified.

5.4 Terrestrial Ecology Impacts

5.4.1 Upland Impacts

This section describes the expected direct impacts to terrestrial habitats that are likely to occur as a result of the construction and operation of the proposed project. Impacts to terrestrial habitats were determined by overlaying the master plan (Figures 2-1 & 2-2) onto the terrestrial land cover map (Figure 4-16) and totaling the acreage of each land cover type impacted by the master plan components. These master plan components include those for the golf course (i.e., tees, fairways, greens, as well as clubhouse and maintenance facilities) and those for the guest villas and associated support infrastructure. Terrestrial impacts are summarized in Table 5-1.

Table 5-1 - Impacts to Williams Cay Vegetative Communities and Land Cover/Land Use Types

		Areal Extent		
Vegetative Community or Land Cover/Land Use Type	**Code**	**Existing Acres**	**Impact Acres**	**Percent Loss/Change**
Vegetative Community or Natural Land Cover				
Dry Broad-Leaved Evergreen Forest	DBEF	142.32	112.43	79%
Sand Strand (Dune)	SS	21.02	10.72	51%
Coastal Rock	CR	10.25	0.00	0%
Sand (Beach)	SAND	5.71	0.00	0%
Dwarf Salt-Tolerant Evergreen Shrubland	DS-TES	2.76	0.00	0%
Salt Pond	SP	2.33	2.33	100%
Intertidal Rock	R_i	1.71	0.00	0%
Mangrove	MAN	0.95	0.95	100%
Seasonal Pond	POND	0.34	0.34	100%
Invasive Non-Native Vegetation	INV	0.14	0.14	100%
Intertidal Mangrove	M_i	0.01	0.00	0%
Subtotal (acres)		**187.54**	**128.13**	
Existing Development-Related Land Cover and Land Uses				
Roads (unpaved/dirt)		1.73	1.73	100%
Boat Dock Area		0.15	0.15	100%
Existing Buildings and Associated Infrastructure		1.46	1.46	100%
Fruit Tree Grove		0.18	0.18	100%
Docks/Piers		0.03	0.03	100%
Waste Management Area – Fill Source		0.11	0.11	100%
Subtotal (acres)		**3.66**	**3.66**	**100%**
Total (acres)		**191.20**	**131.79**	

Master plan construction and implementation, including golf course and guest villa construction, will cover a total of 131.79 acres of the existing terrestrial habitats and land cover, or about 70% of the total land area on Williams Cay. This figure represents both a portion of the existing natural land cover, primarily dry broadleaf evergreen forest (112.42 acres) and sand strand (10.72 acres), and all the existing development-related land cover (i.e., the existing roads, buildings, borrow pit, etc.). Of the individual habitat types impacted by master plan construction, the DBEF receives the greatest impact (112.43 acres) simply because it is the most common habitat type on the cay. Currently, Williams Cay has 142.32 acres of DBEF, which covers about 76% of the cay. About 29.9 acres of the existing DBEF will remain after construction. However, a substantial acreage (33.6 acres) of the initial DBEF impact area will be revegetated after construction completion, including approximately 16.7 acres as DBEF and another 16.9 acres of natural shrub vegetation that will be maintained at a low-height. In addition to the DBEF revegetation areas, sand strand vegetation (noted as sandscape on the master plan, Figures 2-1 & 2-2) will be reestablished on an additional 21.8 acres, which is slightly more than the existing sand strand vegetation. The initial impact acreage for the DBEF and sand strand reflects the extra land clearing needed to accommodate earthwork and recontouring for course construction.

Seashore paspalum (*Paspalum vaginatum*) cultivars (e.g., Sea Spray and SeaDwarf) specifically developed for coastal golf course locations will be planted for the golf course turf. Seashore paspalum offers the advantage of very high salt tolerance, while also providing the excellent playing characteristics desired in a golf turf. Once established, seashore paspalum can be maintained with pure sea water, the salt in which provides an advantage for weed control without the need for excessive herbicide use. Seashore paspalum is also noted for low nitrogen requirements, which means less fertilizer will be required to maintain the turf.

As described in the baseline description in Section 4 above, Williams Cay has two small ponds. One, the larger pond (2.33 acres), is clearly a salt pond. The other, smaller pond (0.34 acres) is possibly fresh water, or only moderately brackish. However, both ponds appeared to be ephemeral, holding water only in response to rainfall and frequently going dry, exposing an unvegetated mud substrate. During the field reconnaissance conducted during April 2015, the smaller pond had no water but a number of fiddler crab burrows. These burrows indicate that when the pond does have water it is probably not excessively saline. In addition, bird tracks were noted in the smaller pond's exposed mud flats, indicating use of the area for bird foraging. For golf course construction both ponds will be deepened and incorporated into the course water management system. The new ponds will have permanent pools that will allow more substantial invertebrate colonization, and possibly even fish populations, which may improve foraging opportunities for wading birds working the pond shorelines.

Pond construction will remove two areas of isolated, non-tidally connected mangroves. One area is the narrow black mangrove fringe along the west side of the larger salt pond. The other is a buttonwood stand near the midway point of the windward shoreline (see habitat map, Figure 4-14). Both these mangrove areas total 0.95 acres. Both areas will be incorporated into new ponds within the golf course.

As noted in the terrestrial baseline section, the protected lignum vitae tree is found fairly frequently on Williams Cay. At this time, it is unknown how many lignum vitae will be removed for golf course construction and resort construction; however, estimates will be developed through selective field sampling that will be conducted as part of EMP preparation. The sampling plan will be developed in coordination with BEST and will also include consideration of the narrow-leaved blolly, which is also a protected tree. The narrow-leaved blolly was also noted on Williams Cay, but only a rarely. As will be discussed more fully in the mitigation section below, notable lignum vitae that can be removed during construction, without damage to the tree's viability, will be moved to a temporary nursery and subsequently replanted after construction is completed. This relocation program will also include any notable narrow-leaved blolly as well. Tree relocation protocols will be detailed in the EMP.

5.4.2 Fill

While final grading plans have not been completed, it is expected that fill will be required for some areas of the project. What cannot be sourced on island by balancing cut and fill needs will be sourced locally from the Bahamas from an area to be approved by the BEST Commission.

5.5 Marine Ecology Impacts

Direct impacts to the marine ecology resources at Williams Cay are anticipated to be inconsequential to nonexistent. Project components proposed in the William Cay marine environment are limited to (1) a very small docking facility to service the golf course maintenance facility, and (2) pilings for the bridge connection to Children's Bay Cay.

The golf course maintenance docking facility is located where the marine bottom is primarily sand sparse seagrass. The shoreline at this location is a small embayment lined with ironshore, but has a very small pocket beach at its apex. Some limited dredging may be necessary to deepen the approach to the new docking facility, however, vessels will be limited to shallow draft cargo barges. Since the bottom is primarily sand, dredging impacts are anticipated to be minimal and short-lived, however, any of the sparse seagrasses within the dredge footprint will be removed. Once the channel footprint is determined a detailed bottom inspection will be conducted to determine presence of any adjacent resources that warrant protection from turbidity and sedimentation.

A piling supported bridge across the channel between Williams Cay and Children's Bay Cay will provide a connection between the two cays. This channel is characterized by deep water with swift tidal currents. The channel and adjacent shoreline constantly subjected to wind-driven ocean swells rolling in from Exuma Sound to the east. Bridge construction at this location is anticipated to include piling installation on each side of the channel. The pilings will support a bridge section that spans the channel along its leeward side. The bridge span will have sufficient clearance for moderate-sized boats (e.g., open-decked fisherman without towers) to pass beneath at high tide (approximate clearance will be 9ft. MSL). The shoreline at this location is rock. The bottom is primarily rock and coarse sand. Bridge piling installation is not anticipated to cause any adverse impact to marine resources.

The environmental management plan will address prevention of silt deposits on environmentally sensitive resources. Turbidity, siltation and sedimentation can be detrimental to the growth and survival of coral reef organisms, particularly filter-feeding organisms such as brachiopods, bryozoans, crinoids, and sponges. Turbidity impacts can lead to chronic perturbations that cause long-term reductions in primary and secondary productivity of coral reef communities by reducing the amount of light available for photosynthesis. Most effects of sedimentation upon stony corals are sub-lethal, causing excessive mucous production and increased respiration rates (Porter and Tougas, 2001; Rogers, 1990). Depending upon the species and life stage, direct mortality can result if the sedimentation load is excessive or if sediments accumulate in depressions of large, massive colonies, causing tissue death. Stony coral recruitment can also be negatively affected by sedimentation through increased mortality of juvenile corals and reduced larval settlement rates (Rogers, 1990).

Additionally, overland and subsurface flow have the potential to introduce land-based pollutants into the marine environment. Development and implementation of an environmental management plan that controls the type, amount and location of pesticides, herbicides and other chemicals and outlines environmental sensitive stewardship is recommended to minimize the potential for contamination of marine resources.

5.6 Air Quality Impacts

Air emissions from the operational resort facility will be limited to diesel exhaust from the back-up electrical generators. These air emissions will be diluted and carried away by the nearly constant trade winds so no impaired air quality is expected. Construction work may also generate some limited dust emissions, however, these will be temporary and are not expected to be an issue since there are no nearby populated areas.

5.7 Impacts to Utilities and Local Infrastructure

As Williams Cay is privately owned and has very limited development, the existing infrastructure and utilities on the cay is only sized to serve the existing residences and support buildings. There are no existing connections to public utilities of any kind. All existing utilities and infrastructure will be removed upon construction of the new resort and completely replaced with new utilities to be sited in Barraterre and on Williams Cay, connected via pipelines and cables.

5.7.1 Potable Water

All proposed development on Williams Cay will be served by a potable water distribution network extending throughout the island. Potable water will be delivered to the island via subsea water line extending from a reverse osmosis water treatment plant located in Barraterre. The specific locations of the reverse osmosis water treatment plant and water line have not been identified yet. When formally identified, this is information will be provided in an addendum to this EIA.

5.7.2 Wastewater

A new membrane bioreactor (MBR) wastewater treatment plant is proposed to serve Williams Cay and the development on Children's Bay Cay. The new plant will be located near the center of Williams Cay the island in the golf course maintenance area. The treatment plant will use a Membrane Bioreactor (MBR) Process which combines the physical removal process using filtration with biological treatment using a suspended growth bioreactor. The MBR process allows for high level treatment without the need for additional tanks and reactors. This allows the plant to operate more efficiently, with lower energy consumption and in a smaller footprint than a conventional return sludge wastewater treatment process. Treated effluent from the MBR wastewater treatment facility will be utilized for irrigation of nursery areas and other areas as needed on Lee Stocking Island. Excess treated water would be conveyed through deep wells for disposal. There will be no surface water discharge of treated effluent.

5.7.3 Electricity

Williams Cay will contain no electrical-generating equipment with the exception of several diesel generators used for backup power only. Electricity will be provided via a new subsea cable from Barraterre or connection to the existing electrical system on Williams Cay. Williams Cay is currently served via subsea cable from Barraterre. The specific location of the subsea electrical cable from Barraterre, along with the landing locations of the cable will be addressed in an addendum to this EIA. All electrical distribution wiring required for this development will be below ground in conduit.

5.7.4 Solid Waste

No permanent solid waste disposal facilities will be constructed on Williams Cay. All solid wastes generated both during and after construction will be collected, processed for volume reduction and barged to Great Exuma for disposal in an appropriate manner. The Department of Environmental Health Services will be consulted to determine the preferred landfill to send these materials to. Landscape clippings and other organic wastes may be composted onsite for reuse as a soil amendment.

5.8 Socioeconomic Impacts

The proposed project is expected to provide positive socioeconomic impacts to the Great Exuma area. With the exception of a few caretaker staff, Williams Cay is currently uninhabited. However, golf course construction and operation and expected to generate several hundred jobs. Temporary construction jobs will evolve into 200 to 300 permanent staff jobs (between Williams Cay and Children's Bay Cay) once the golf course becomes operational. In addition, businesses on Great Exuma will directly benefit from increased demand for local goods and services.

5.9 Cultural Resource Impacts

Existing cultural resources on the island is limited to historical stone walls reflecting past agricultural land uses, possibly as animal pens. Walls that remain within undisturbed DBEF will themselves remain undisturbed. Sections of the historical stone walls that are exposed by clearing will be also preserved as much as possible and incorporated into the landscaping.

6.0 Proposed Mitigation Measures

6.1 Marine Protected Area Establishment

The owner of Williams Cay proposes to work with Government to establish a marine protected area (MPA) on the leeward side of the island that will encompass Windsock Cay. Only non-power vessels may enter the area. Fishing, including collecting conch, will also be prohibited.

Figure 3-1 provides the boundaries for the proposed MPA. The boundary passes Windsock Cay to the south and west and extends to Williams Cay to the north, and Children's Bay Cay to the east, where it will take in the length of Welcome Beach. These boundaries were selected to encompass the shallow, sand-dominated flood-tide shoal that is a product of the channel between Williams Cay and Children's Bay Cay. Very strong tidal currents are generated through the channel and they sculpt the bottom for a wide area on the Bahamas bank side. This shoal is readily apparent on aerial photographs, see Figures 1-1 and 1-2, which reflects the robust hydrodynamic conditions under which it was formed and is maintained. Windsock Cay is located at the western edge of the shoal.

The marine reconnaissance found this shoal to be a high quality marine benthic habitat consisting of a patchwork mosaic of sand and SAV of varying densities. However, the shoal is constantly subjected to high speed boat traffic numerous times per day from tourist boats and jet skis out of Great. This is especially concerning for the extremely shallow waters along the east side of Windsock Cay. As this boat traffic has increased over the years, the local island caretakers on both Williams Cay and Children's Bay Cay state they have noticed a significant decline in marine life over and on the shoal. For example, sting rays that used to burrow in the sand are now scarce, indicating the boat traffic is impacting the basic habitat value of the shoal. Also, conch should be fairly frequent on the shoal, but are rare. However, shells of harvested conch are mounded in shallow water on the west side of Windsock, indicating the conch have been stripped from the shoal through overharvesting. The restriction on fishing and conch harvesting within the MPA is anticipated to create a refuge for fish and marine bottom species.

The proposed MPA will be restricted to non-power vessels. The MPA will not interfere with the tourist traffic, which will simply have to bypass Windsock Cay on its west side and not on its east.

6.2 Mangrove Replacement

Lake construction will remove the existing non-tidally connected mangroves on Williams Cay. To offset this loss, the new lakes within the golf course will incorporate mangroves as shoreline plantings and islands. Planting extent and locations will be determined in coordination with BEST during detailed design. Shoreline plantings will include red mangroves near the mean high water point, with black mangroves planted landward at a slightly higher topographic elevation.

Mangroves will be planted as nursery-grown seedlings. Planting locations will incorporate a mixed sand and organic substrate to facilitate root establishment and robust growth. As much of the shoreline will be excavated from limerock, over excavation of rock and backfill with planting substrate will ensure that mangrove roots have a minimum of 3-feet of growth medium before meeting the underlying rock.

6.3 Leachate Prevention

Fertilizer, herbicide and pesticide leachate is a particular concern for golf courses in island locations such as Williams Cay, particularly when the underlying geology is porous limestone. Excessive irrigation and rainfall can wash excess fertilizer and pesticides downward through the turf root zone and into the porous underlying rock, where the nutrients and pesticides can then flow laterally with the ground water until they are discharged into the open marine waters surrounding the cay. Excess nutrients, herbicides and pesticides from a variety of sources are implicated in a number of examples of algae overgrowth, or other detrimental impacts, on or to coral reefs.

A combination of design and operational considerations will minimize potential leachate transport from the Williams Cay golf course. The course will be contoured so that all course irrigation and rainfall runoff is collected internally within the water management system. Collected water will then be reused for irrigation with excess water discharged through deep drainage wells. Greens, tee boxes, and portions of fairways in sensitive areas will be underdrained to direct through-flow to the internal water management system. As discussed earlier, the golf course turf will be seashore paspalum, which can be watered with salt/brackish water. Salt/brackish water irrigation will minimize the need for herbicide use for weed control. Judicious irrigation and soil management on the part of the golf course supervisor will minimize the potential for fungal problems requiring fungicide application.

State of the science strict BMPs will be incorporated into the golf course management plan developed during the EMP process to prevent nutrient, herbicide or pesticide leaching. It is expected that this plan will contain a comprehensive integrated pest management program and determine the bare minimum of slow release fertilizes required for fertility.

6.4 Vegetation Reuse and Replanting

As shown in Table 5-1, a significant portion of the dry broad-leaved evergreen forest habitat on Williams Cay will be disturbed during construction of the golf course. Lignum vitae (*Guaiacum sanctum*) are fairly abundant and narrow-leaved blolly (*Guapira discolor*) were occasionally present within the DBEF on Williams Cay. These two tree species are protected by law under the *Conservation & Protection of the Physical Landscape, Protected Trees Order.* A significant number of these trees within the DBEF habitat will be disturbed during golf course construction.

To mitigate for this disturbance, notable protected trees that will be impacted and can be removed without significant damage will be relocated as much as possible to a temporary nursery area that will be established on site during construction of the golf course. These trees will be replanted on the golf course in areas designated for revegetation after construction or relocated to Children's Bay Cay. During the detailed design process, the actual number of notable protected trees that will be disturbed during construction will be quantified. At that time, the owner will coordinate with government for necessary permits to cover activities that will be undertaken prior to disturbing protected trees on Williams Cay.

7.0 Environmental Management Plan

An environmental management plan (EMP) will be developed in coordination with the BEST commission. The EMP will ensure that the development of Williams Cay proceeds with adequate controls that protect the long-term health of the environmental resources of the project site and immediate vicinity. The EMP will address several areas as follows:

1. Construction planning
2. Upland best management practices
3. BMPs for stormwater management from golf course and roadways
4. BMPs for golf course construction and operation
5. Pest, fertilizer, and herbicide best management practices
6. Construction safety issues
7. Marina and docking facility construction
8. Marina and docking facility operations
9. Cultural resources

7.1 Environmental Management Plan - General Construction and Operation - Table of Contents

An Environmental Management Plan should be considered a “living document” that is adapted to incorporate changes during the progression of the project due to increased available information, including items such as the contractor awarded the project, changes in equipment, construction methodologies and site conditions, and final plans for infrastructure improvements. The proposed Table of Contents for the Williams General Construction and Operation EMP is as follows:

1.0 Introduction

2.0 Environmental Vision & Policy

2.1 Legislative Requirements

2.1.1 Domestic Legislation

2.1.2 International Laws & Standards

2.2 References and Contact Information

2.3 Scope and Purpose

3.0 EMP Administration & Responsibilities

3.1 Roles and Responsibilities

3.2 Environmental Management Team

3.3 Records and Documentation Requirements

3.4 Monitoring Requirements

3.5 Construction and Monitoring Reporting

3.6 Incident Reporting Requirements

4.0 Environmental Procedures for Upland Construction & Operations

4.1 Construction Planning

4.1.1 EMP Implementation Planning

4.1.2 Construction Sequencing and Schedule

4.1.3 Construction Staging and Laydown Areas

4.1.4 Construction Accommodations, Equipment and Materials

4.2 BMP Implementation

4.3 BMP Training

4.3.1 Maintenance Procedure Implementation and Inspection

4.3.2 Pollution Prevention/Spill Awareness

4.4 Upland Clearing and Earthwork

4.4.1 Site Perimeter Controls

4.4.2 Construction Staging Areas

4.4.3 Land Clearing Operations

4.4.4 Earthwork

4.4.5 Disposal or Composting of Waste Materials

4.4.6 Contaminated Soils or Debris

4.5 Construction Best Management Practices

4.5.1 Inspections

4.5.2 Tree Protection & Vegetative Buffer Strips

4.5.3 Erosion and Turbidity Control

4.5.4 Control of Dust & Particulates

4.5.5 Stormwater Runoff During Construction

4.5.6 Spill Prevention Planning

4.6 Construction Safety

4.6.1 Safe Work Plan

4.6.2 Jobsite Medical Plan

4.6.3 Hurricane Plan

5.0 Environmental Procedures for Dewatering, Marine & Nearshore Construction

5.1 Dewatering, Marina Basins and Bridge Construction

5.2 Turbidity Control During Construction

5.3 Cultural Resources

5.4 Coastal Construction BMPs

6.0 Construction Water Quality & Turbidity Monitoring Requirements

6.1 Preconstruction Baseline Monitoring

6.2 Monitoring Frequency

6.3 Water Quality Parameters

6.5 Water Quality Sampling

6.6 Summary Report

7.0 Golf Course Planning and Construction

7.2 Environmental Management Plan – Golf Course Operation -Table of Contents

Proper planning and operation of the golf course will be imperative to ensure minimal short and long-term environmental impacts. As the personnel in charge of operating and maintaining the golf course are unlikely to be involved in construction, it is recommended that this document be a stand-alone publication. This allows the EMP to function as both a permitting requirement and a training guide for those who will be operating the Golf Facilities. The proposed Table of Contents for the Williams Golf Course Operational EMP is as follows:

6.1 Acronyms and Abbreviations

8.0 Public Consultation

Public consultation will be as advised and directed by Government following the review of the EIA.

9.0 Conclusions

To prepare this environmental impact assessment document, studies were conducted addressing infrastructure and utility requirements, golf course construction and management, water quality, and terrestrial and marine ecological impacts.

The shoreline of Williams Cay is to remain unaltered, and protection of existing coastal rock communities is anticipated to provide adequate storm protection to the upland development and residents. The conceptual master plan includes an access roadway running the length of the island, 16 private villas, 4 rental villas and an 18-hole golf course with a clubhouse.

From an impact perspective, a field assessment was conducted that included the characterization of marine and terrestrial natural resources, topography and geology, among others. The project will cause both short and long term impacts to the existing dry broad-leaved evergreen forest and two existing salt ponds. Short term impacts can be minimized through the development of well-defined best management practices (BMPs) during the construction phase that will include mangrove replanting in the pond areas and creation of an onsite nursery area for temporary storage of trees that will be relocated on both Williams Cay and Children's Bay Cay. These detailed BMPs will be incorporated into a detailed environmental management plan (EMP) developed to assure that potential impacts from stormwater runoff, turbidity, etc. during construction. Similarly, the environmental management plan will detail BMPs and operational requirements for the golf course to minimize the potential for leaching and maximize stormwater runoff reuse.

A total of approximately 132 acres of direct upland impacts are expected as a result of the golf course development, the remainder of Williams Cay and the entire shoreline will be managed to preserve and enhance native vegetation and habitats.

Ultimately, a well-designed and conscientiously-managed low density golf course development can provide for long-term maintenance and preservation of habitat for native wildlife and have manageable environmental impacts through comprehensive environmental planning that focuses on wildlife conservation, habitat enhancement, sediment quality and water quality.

It is expected that the residents of the Exuma Cays will benefit from the proposed Williams Cay development project. The project construction is expected to occur over a several year period, providing short-term employment opportunities in construction and services. Once completed, there will be significant permanent employment opportunities.

The project will also catalyze a substantial population increase for the Exuma Cays area. People moving to the area will include not only resort residents and visitors, but staff and employees of the development, as well as their families. In addition to persons directly employed by or at Williams Cay, new entrepreneurial opportunities to provide goods and support services will emerge and likely result in the creation of new businesses that will also need employees. All of these employees and their families will in turn require housing at nearby settlements, health care, utilities, schools, and consumer goods, such as groceries and gasoline, and services, such as auto repair and garbage removal. The long term sustainable economic and civic growth should be a positive effect on the local community of Barraterre.

Construction and long-term operation of the project have the potential to have adverse impacts on natural resources. The project team understands that is imperative to maintain the beauty and integrity of this natural environment both to meet regulatory requirements and for the success of the project. It is our experience that the project can be completed with minimal adverse impact to the marine environment provided Best Management Practices (BMPs) including the creation of a detailed Environmental Management Plan (EMP) is developed and implemented and the mitigation strategies are conscientiously implemented. This plan should be reviewed and approved by the BEST Commission prior to implementation. Despite a potential for some minimal short term environmental impacts, the project has the potential to catalyze the local economy and create viable, long-term opportunities for local employment at a low density golf course development.

With the proper planning, application and monitoring of the Environmental Management Plan and if Best Management Practices are conscientiously planned, engineered and implemented, many of the impacts that are generated during construction and operation should be minimized or completely eliminated for the proposed project.

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Appendix A

Williams Cay Plant List

The following species were observed and identified during a habitat assessment conducted during the week of April 6, 2015. The list should be considered as preliminary, and that additional species would be identified if additional surveys were to be conducted during different times of the year, when other plants would be in bloom. Nomenclature follows “Flora of the Bahama Archipelago’ by D.S. Correll and H.B. Correll and/or 'Flowers of the Bahamas and the Turks and Caicos Islands' by K McNary Wood.

Family/Scientific Name	Common Name	Life Form	Habitat	Abundance
MONOCOTS				
AGAVACEAE				
Agave sp.	Century Plant	Herb	Beach coppices, rocky plains	Occasional
AMARYLLIDACEAE				
Hymenocallis arenicola	Dune Spider Lily	Herb	Grassy dunes along coasts	Common
ARECACEAE (PALMAE)				
Caryota mitis	Tufted Fishtail Palm	Tree	Ornamental - cultivated areas	Occasional
Coccothrinax argentata	Silver Thatch, Silver Top	Tree	Coastal Coppices, Coppices, Whitelands	Common
Cocos nucifera	Coconut Palm	Tree	Coastal sands, Cultivated areas	Common
Phoenix roebelenii	Pygmy Date Palm	Shrub	Cultivated, ornamental	Occasional
Pseudophoenix sargentii	Hog Palm, Buccaneer Palm	Tree	Sandy & rocky soils in coppices & thickets	Common
Sabal palmetto	Pond-top, Pond Thatch	Tree	Edges of and in marshes, Blacklands	Occasional
BROMELIACEAE				
Tillandsia utriculata	Swollen Wild Pine	Epiphyte	Coppice, Blacklands, Whitelands	Occasional
CYMODACEAE				
Halodule sp.	Shoal-grass	Herb	Seagrass	Occasional
Syringodium filiforme	Manatee-grass	Herb	Seagrass	Occasional
HYDROCHARITACEAE				
Thalassia testudinum	Turtle grass	Herb	Seagrass	Abundant
POACEAE (GRAMMINEAE)				
Cenchrus sp.	Burr Grass	Herb	Disturbed Areas, Beach foredune	Common
Eustachys petraea	Finger Grass	Herb	Beach mid-dune, Coppice edges	Occasional

Williams Cay Plant List

Family/Scientific Name	Common Name	Life Form	Habitat	Abundance
Dactyloctenium aegyptium	Crowfoot Grass	Herb	Road shoulders, disturbed areas	Occasional
Distichlis spicata	Seashore Salt-grass	Herb	Salt flats, coastal marshes, mangrove edges	Occasional
Genus & species unidentified	Grass	Herb	Roadside disturbed areas	Occasional
Spartina patens	Saltmeadow Cordgrass	Herb	Sandy, seasonally moist soils, salt marshes	Occasional
Sporobolus virginicus	Seashore Rush-grass	Herb	Beach foredune	Occasional
Uniola paniculata	Sea Oats	Herb	Beach foredune, sand dunes	Common
DICOTS				
AIZOACEAE				
Sesuvium portulacastrum	Pondweed, Sea purslane	Groundcover	Sandy beaches, saline flats, rocky areas	Common
ANACARDIACEAE				
Mangifera indica	Mango	Tree	Cultivated	Occasional
Metopium toxiferum	Poisonwood	Tree	Coppices, Scrublands	Common
APOCYNACEAE				
Nerium oleander	Oleander	Shrub	Ornamental - cultivated	Occasional
Plumeria obtusa	White Frangipani	Tree	Rocky scrublands, coppices	Occasional
Vallesia antillana	Pearl Berry	Shrub	Coppices, scrublands	Occasional
ASCLEPIADACEAE				
Cynanchum sp		Vine	Coppices	Occasional
ASTERACEAE				
Ambrosia hispida	Sweet Bay, Bay tansy, Soap-bu	Groundcover	Beach foredune, sandy shores	Occasional
Bidens alba	White Beggar-ticks	Herb	Variable habitats, esp. disturbed areas	Common
Borrichia arborescens	Lavender, Sea Marigold	Shrub	Coastal sands and rock, brackish margins	Occasional
Borrichia frutescens	Sea Ox-eye, Bay marigold	Shrub	Marshes and mud flats near brackish lakes	Common
Eupatorium lucayanum		Shrub	Thickets, dune coppices	Occasional
Salmea petrobioides	Shanks, Buchy Salmea	Shrub	Coastal rocks, dunes & coppices	Common
BIGNONIACEAE				

Williams Cay Plant List

Family/Scientific Name	Common Name	Life Form	Habitat	Abundance
Tabebuia heterophylla	Cedar	Tree	Thickets, Coppices	Common
Tecoma stans	Trumpet Flower, Yellow Elder	Shrub	Coppice edges, cultivated & disturbed areas	Occasional
BORAGINACEAE				
Argusia (Mallotonia) gnaphalodes	Wild Bay, Sea Lavender	Shrub	Sandy beaches, Foredunes	Occasional
Bourreria ovata	Strong-back	Shrub/Tree	Scrublands, Coppices	Occasional
BURSERACEAE				
Bursera simaruba	Gum-elemi, Gumbo Limbo	Tree	Coppices, Scrublands	Occasional
CASUARINACEAE				
Casuarina equisetifolia	Beefwood, Australian Pine	Tree	Sandy Shores, Disturbed coastal areas	Common
COMBRETACEAE				
Conocarpus erectus	Buttonwood	Shrub/Tree	Coastal wetlands, savannas, salina edges	Abundant
CONVOLVULACEAE				
Ipomoea indica	Morning Glory	Vine	Disturbed sites	Occasional
Ipomoea pes-caprae	Bay Hops, Bay Winders	Vine	Beaches & coastal rocks	Occasional
Ipomoea stolonifera	Morning Glory	Vine	Beaches, Coastal dunes	Occasional
Jacquemontia sp.	Jacquemontia	Vine	Coppices, pinelands	Occasional
EUPHORBIACEAE				
Ateramnus (Gymnanthes) lucida	Crabwood	Shrub	Coastal coppices	Occasional
Croton linearis	Granny-bush, Bay Wormwood	Shrub	Scrublands, rock formations, sandy areas	Occasional
Euphorbia mesembrianthemifoli	Coast spurge, Seaside spurge	Herb	Maritime sands, Beach dunes	Common
Phyllanthus epiphyllanthus	Abraham-bush, Hardhead	Herb	Rocky places, Whitelands	Common
GOODENACEAE				
Scaevola plumieri	Inkberry, Black-soap	Shrub	Coastal dunes	Common
Scaevola taccada	Ornamental Candlewood	Shrub	Beaches & coastal areas; non-native	Abundant
LAURACEAE				
Cassytha filiformis	Woe-vine, Love Vine	Vine	Beach backdune, coppices, disturbed areas	Common

Williams Cay Plant List

Family/Scientific Name	Common Name	Life Form	Habitat	Abundance
LEGUMINOSAE				
Acacia choriophylla	Cinnecord	Tree	Coppices	Common
Caesalpinia bonduc	Gray Nickers	Tree/Shrub	Coastal thickets, open, disturbed areas	Occasional
Caesalpinia major	Large Yellow Nicker	Vine	Coastal thickets, open, disturbed areas	Occasional
Canavalia rosea	Bay Bean, Beach Pea	Vine	Coastal sands, rocks, disturbed areas	Occasional
Delonix regia	Royal Poinciana	Tree	Cultivated	Occasional
Leucaena luecocephala	Jumbie Bean, Jumbay	Tree	Coppices, fields, thickets, disturbed areas	Common
Lysiloma latisiliquum	Wild Tamarind	Tree	Coppices, Scrublands, Open areas	Occasional
Pithecellobium keyense	Blackbead	Tree	Coppices	Occasional
Tamarindicus indica	Tamarind	Tree	Cultivated	Occasional
MALPIGHIACEAE				
Malpighia punicifolia	Barbados Cherry	Shrub	Cultivated fruit tree	Occasional
MALVACEAE				
Abutilon permolle	Velvety Abutilon	Shrub	Old field, coppices, disturbed areas	Occasional
Hibiscus rosa-sinensis	Hibiscus	Shrub	Cultivated	Occasional
Sida sp	Sida, Fanpetals	Herb	Disturbed soils, weedy areas	Occasional
MELIACEAE				
Azadirachta indica	Neem	Tree	Cultivated	Occasional
MORACEAE				
Artocarpus altilis	Breadfruit	Tree	Cultivated	Occasional
MYRTACEAE				
Callistemon viminalis	Weeping Bottlebrush	Shrub	Waste places,ornamental,cultivated areas	Occasional
Eugenia axillaris	White Stopper	Shrub	Coppices, Scrublands	Common
NYCTAGINACEAE				
Bougainvillea spectabilis	Bougainvillea	Shrub	Cultivated	Occasional
Guapira discolor	Blolly	Tree	Coppices, Scrublands, rock flats	Occasional

Williams Cay Plant List

Family/Scientific Name	Common Name	Life Form	Habitat	Abundance
PASSIFLORACEAE				
Passiflora pectinata	Wild Apricot	Vine	Littoral sands, coastal coppice, savannas	Occasional
PLUMBAGINACEAE				
Plumbago auriculata	Cape Leadwort	Shrub	Ornamental - cultivated areas	Occasional
POLYGONACEAE				
Coccoloba diversifolia	Pigeon-plum	Tree	Coppices, Scrubland	Common
Coccoloba krugii	Crabwood, wild grape	Shrub/Tree	Scrublands and Coppices	Occasional
Coccoloba uvifera	Seagrape	Tree	Coastal thickets, coastal coppices	Common
RHAMNACEAE				
Colubrina arborescens	Common Snake-bark, Bitters	Shrub	Coppices, dunes, rocky scrublands	Occasional
Reynosia septentrionalis	Darling Plum	Shrub	Coppices, scrublands, and rocky flats	Occasional
Ziziphus mauritiana	Ju Plum	Shrub	Coppices, scrublands, and rocky flats	Occasional
RHIZOPHORACEAE				
Rhizophora mangle	Red Mangrove	Tree	Muddy shores, estuarine swamps	Abundant
RUBIACEAE				
Casasia clusiifolia	Seven-year Apple	Shrub	Coastal Rocks, Coppices	Abundant
Erithalis fruticosa	Black Torch, Candlewood	Shrub	Beach dunes, coastal coppices, pinelands,	Common
Ernodea littoralis	Golden Creeper, Cough Bush	Shrub	Dunes, coastal coppices, disturbed areas	Common
Randia aculeata	Box briar	Shrub	Ubiquitous	Common
Rhachicallis americana	Hog-bush, Sandfly-bush	Shrub	Maritime rocks, coastal coppices	Common
Spermacoce sp.	Buttonweed	Groundcover	Disturbed areas, swales, depressions	Occasional
Strumpfia maritima	Rosemary, Mosquitobush	Shrub	Coastal rocks, rocky flats, Coastal coppices	Occasional
RUTACEAE				
Amyris elemifera	Torchwood	Tree	Thickets, rocky coppices and sandy soils	Occasional
Citrus x aurantium	Orange	Tree	Cultivated, may escape to coppices	Occasional
Citrus x aurantiifolia	Key lime	Tree	Cultivated	Occasional

Williams Cay Plant List

Family/Scientific Name	Common Name	Life Form	Habitat	Abundance
Citrus x tangelo	Tangelo	Tree	Cultivated	Occasional
Zanthoxylum flavum	Yellow-wood, Satin-wood	Tree	Coppices, hills, dunes, scrublands	Common
SAPINDACEAE				
Melicoccus bijugatus	Genip	Tree	Cultivated, waste places	Occasional
SAPOTACEAE				
Manilkara bahamensis	Wild Dilly	Tree	Coppices, Scrublands, Coastal areas	Common
Manilkara zapota	Sapodilla	Tree	Coppices, clearings, (cultivated)	Common
Mastichodendron foetidissium	Mastic, Ironwood	Tree	Hillsides, coastal coppices	Occasional
STERCULIACEAE				
Helicteres jamaicensis	Cow-bush, Blind Eye Bush	Shrub	Coppices, rock flats, saline fields	Occasional
Melochia tomentosa	Velvety Melochia	Shrub	Whitelands, Scrublands, Coppices	Occasional
SURIANACEAE				
Suriana maritima	Bay Cedar	Shrub	Beach mid-dune, Rocky shorelines	Common
THEOPHRASTACEAE				
Jacquinia keyensis	Joe-wood, Ironwood	Shrub	Coastal rocks, Coppices, Scrublands	Common
TURNERACEAE				
Turnera ulmifolia	Buttercups, Yellow Alder	Shrub	Beaches, Coastal dunes, Scrublands	Occasional
ZYGOPHYLLACEAE				
Guaiacum sanctum	Lignum vitae	Tree	Coastal coppices, coppices	Occasional

Appendix B

Williams Cay Landside Fauna List

The following species were observed during cursory landside field assessments conducted on Williams Cay, Bahamas during the week of April 5, 2015. This list should be considered preliminary, and that additional species would be identified if additional surveys were conducted, particularly during different times of the year.

Scientific Name	Common Name	Habitat	Abundance	Residential Status
CRUSTACEANS and ARTHROPODS				
Ocypode albicans	Ghost Crab	Sandy Shorelines	Uncommon	Resident
Cardisoma guanhumi	Land Crab	Coastal lowlands	Occasional	Resident
Coenobita clypeatus	Land Hermit Crab	Above mean high water, among plants	Uncommon	Resident
Percnon gibbesi	Nimble Spray Crab	Rocky intertidal	Uncommon	Resident
Uca minax	Fiddler Crab	Saline flats	Occasional	
MOLLUSKS				
Cerion sp.	Peanut snail	Herbaceous & other low-growing vegetation	Common	Resident
Tectarius muricatus	Beaded Periwinkle	Supra-tidal rocks	Common	Resident
BIRDS				
Larus atricilla	Laughing Gull	Shorelines, scavenger	Occasional	Resident
Sterna antiallarum	Least Tern	Nearshore open waters, roosts on beaches	Occasional	Summer resident
Sterna maxima	Royal Tern	Nearshore open waters, roosts on beaches	Occasional	Resident
Ardea alba	Great Egret	Shorelines & shallow inland wetlands		Resident
Butorides virescens	Green Heron	Shorelines & shallow inland wetlands	Occasional	Resident
Nyctanassa violacea	Yellow-crowned Night-heron	Shorelines & shallow inland wetlands	Occasional	Resident
Actitis macularia	Spotted Sandpiper	Shorelines	Occasional	

BIRDS, Continued				
Charadrius wilsonia	Wilson's Plover	Sandy beaches	Occasional	Resident
Pandion haliaetus	Osprey	Coastal areas, feeds on fish, nests nr water	Uncommon	Nests nearby
Columba leucocephala	White-crowned Pigeon	Coastal hammock, usu roosts & nests on islan	Uncommon	Resident
Columba passerina	Common Ground-dove	Sparsely-vegetated uplands	Common	Resident
Calliphlox evelynae	Bahama Woodstar	Coppice, typically nr nectar-producing flowers	Uncommon	Resident
Mimus gundlachii	Bahama Mockingbird	Coppice, Scrub, woodlands	Occasional	Resident
Vireo crassirostris	Thick-billed Vireo	Thick coppice, bushy forest edges	Occasional	Resident
Coerba flaveola	Bananaquit	Coppice, thicket & forest	Common	Resident
Loxigilla violacea violacea	Greater Antillean Bullfinch	Dense thickets, dense coppice	Occasional	Resident
REPTILES and AMPHIBIANS				
Anolis sagrei ordinatus	Bahamian Brown Anole	Semi-open uplands	Common	Resident
Epicrates striatus strigulatus	Bahama Boa [1]	Coppice, shed skin found in agricultural areas	Occasional	Resident

1 = Not observed during field assessment, but reported by residents to be year-round resident

Appendix C

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The National Invasive Species Strategy For The Bahamas

March 2003

Message from the Minister of Health and Environment

As the world becomes a global village, countries find it more and more difficult to isolate themselves from problems in other countries. The issue of biological invasion has become globally significant because no country is immune to the negative impacts it can cause.

Invasive species are typically defined as those organisms that negatively impact the environment, economy, human welfare and human health of a country. Invasives are thought to be one of the main causes of biodiversity loss worldwide. This problem is of sufficient significance to be addressed in the Convention on Biological Diversity, the international agreement on conservation, protection and sustainable use of biodiversity.

The National Invasive Species Strategy Project has afforded The Bahamas the opportunity to examine what invasive species occur in our country, which species need to be given priority and what mechanisms can be developed to address their introduction and spread. The project has involved a series of stakeholder workshops, public awareness campaigns and training. One of its objectives has been realized in the publication of this document, the National Invasive Species Strategy. It is hoped that various aspects of this Strategy will be implemented immediately and others in the near future.

Consultation has been an important aspect of this project as the Government recognizes that we cannot deal with issues of national significance without national discussions. Stakeholder workshops were carried out in several Bahamian islands, including Abaco, Andros, Grand Bahama and Eleuthera. All other islands were consulted through Local Government representatives. The result is a plan that encompasses as succinctly as possible the concerns expressed by all.

I encourage you to not only read this Strategy, but to also contribute to its implementation. If every citizen of The Bahamas can apply what is recommended, if only within their own homes, we will have achieved much in our efforts to address the invasive species problem.

On behalf of the Government, I wish to again express our gratitude to the British Government for their assistance in combating this global biological problem. This project represents the first joint effort between our two countries in addressing an environmental issue. It is our sincere hope that this is only the beginning of a fruitful cooperative relationship.

On behalf of the Ministry of Health and Environment and the BEST Commission, I wish to thank all who have participated in this worthy effort and have made this project a success.

Dr. Marcus C. Bethel
Minister of Health and Environment
The Commonwealth of The Bahamas

Message from the British High Commissioner

The National Invasive Species Strategy Project represents an important milestone in the cooperative relationship between the United Kingdom and the Commonwealth of The Bahamas. It is the first opportunity that my Government has been able to work jointly with the Government of the Commonwealth of The Bahamas on an issue of environmental concern.

Invasive species pose not only a threat to The Bahamas, but to the world. Everyday, native species and habitats are put at risk of displacement and extinction from invasion by non-native plants and animals. These invasions have increased globally due to expansion in the trade of goods and services, the increased mobility of people, the liberalization of markets and the use of exotic species in a wide range of activities.

This project has enabled The Bahamas to begin to assess the impact of invasive species nationally and develop a strategy to combat invasion and protect its native species and habitats. The British Government is proud to be able to contribute to such a worthwhile activity and to aid in the conservation and protection of the biological diversity of these islands.

Funding for this project has been made possible through the Environment Project Fund of the Foreign and Commonwealth Office (FCO) of the British Government. The FCO works to protect and improve the quality of the global environment as a foundation for sustainable development. It is committed to addressing critical environmental issues, such as biodiversity, biotechnology, energy, resource supply and climate change.

The FCO accomplishes its tasks through a global network of missions, and the Environment Fund aims to utilise this network in association with governments, NGOs and institutions to support a range of focused, high quality environment projects, such as the Bahamian invasive species project.

It is our hope that this is only the beginning of joint efforts between the United Kingdom and The Bahamas to address environmental issues and concerns to the betterment of all humankind.

His Excellency Peter Heigl
British High Commissioner
Nassau, The Bahamas
15th February 2003

Message from the Ambassador for the Environment

The National Invasive Species Strategy Project represents the second phase in a national effort to address the issue of biological invasion. This project builds on the work completed under the Inter-American Biodiversity Information Network Invasives Information (I3N) Project, which enabled the development of databases of invasive species found in The Bahamas. While we realize these databases are not complete, they provided a starting point for work to begin on dealing with this problem.

Both projects have provided The Bahamas the opportunity to work cooperatively with foreign Governments and organizations. The information project was made possible through assistance from the United States Geological Survey and the current strategy project, through the Environment Project Fund of the British Government's Foreign and Commonwealth Office. The willingness of these agencies to work cooperatively with The Bahamas, a small islands developing State, speaks to the global concern on this issue.

Invasive species are not just an ecological problem. They are also an economic one. Worldwide, millions of dollars are spent every year to control invasive species and to repair the damage they cause. As we experience trying economic times globally, we must strive to ensure that issues that may further impact us negatively are adequately addressed. Biological invasion is one such issue.

Island states, like The Bahamas, are generally considered highly susceptible to invasions because of their particularly vulnerable native biodiversity and predominantly import driven economies.

The recommendations contained within this Strategy represent The Bahamas' initial effort to deal with invasive species nationally. It is our intent to continue to build on this initial work towards achieving implementation and instituting effective management mechanisms.

On behalf of the BEST Commission, I thank the British High Commission and all persons involved for their invaluable assistance in this project, and making the publication of this document possible through their contributions of knowledge, expertise, insights and opinions.

His Excellency Keod M. Smith
Ambassador for the Environment
The Commonwealth of The Bahamas

Preface

The National Invasive Species Strategy (NISS) project was developed in 2002 and jointly funded by The Bahamas Government and the Environment Project Fund of the Foreign and Commonwealth Office of the British Government.

The project facilitates the assessment of the current mechanisms existing in The Bahamas to address the invasive species issue while enabling increased public awareness and involvement in the process. There have been numerous stakeholder and public exercises during the project over the past few months. The project has resulted in the development of awareness materials that will hopefully be of benefit, not only to The Bahamas, but also to other Small Island Developing States (SIDS).

The NISS project has also afforded The Bahamas the opportunity to begin to build partnerships with international organizations, such as the Global Invasive Species Programme (GISP), Invasive Species Specialist Group (ISSG), Islands Initiative and The Nature Conservancy (TNC).

This project builds on initial work completed under the Inter-American Biodiversity Information Network (IABIN) Invasives Information Network Project in which databases on invasives species, expertise and programmes were developed and made accessible on the Worldwide Web. This phased approach has been very successful and it is intended that the work on this issue will continue, resulting in the development of a comprehensive infrastructure that will prevent the entry and establishment of unwanted invasive species and other biological threats to the biodiversity of the Bahamian islands.

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Stacey Wells-Moultrie
Project Coordinator
BEST Commission
Ministry of Health and Environment

Nassau, March 2003

Table of Contents

1.0 Abbreviations and Acronyms

BEST	Bahamas Environment, Science and Technology
CAB International	Successor of a number agencies including the Commonwealth Agricultural Bureau initially existing in the United Kingdom and other parts of the Commonwealth
CBD	Convention on Biological Diversity
FAO	United Nations Food and Agriculture Organization
FCO	Foreign and Commonwealth Office
GISP	Global Invasive Species Programme
I3N	IABIN Invasives Information Network
IABIN	Inter-American Biodiversity Information Network
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
IPPC	International Plant Protection Convention
ISSG	Invasive Species Specialist Group
IUCN	World Conservation Union
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-Governmental Organization
NISS	National Invasive Species Strategy
OIE	Office International des Epizooties
Ramsar	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971)
SIDS	Small Island Developing States
SPS	Agreement on the Application of Sanitary and Phytosanitary Measures
TNC	The Nature Conservancy
UNCLOS	United Nations Convention on Law of the Sea (Montego Bay, 1982)
UNCED	United Nations Conference on Environment and Development (Rio de Janeiro, 1992)
WHO	World Health Organization
WTO	World Trade Organization

2.0 Glossary of Terms

Aggressive species – Those species (plants, animals, micro-organisms) that overwhelm the landscape whether they are native or introduced.

Alien species – non-native, non-indigenous, foreign, exotic species occurring outside of their natural range and dispersal potential, and includes any part, such as seeds and larvae, that might survive and subsequently reproduce.

Biodiversity – The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Short for biological diversity.

Conservation of biodiversity - The management of human interactions with genes, species, and ecosystems so as to provide the maximum benefit to the present generation while maintaining their potential to meet the needs and aspirations of future generations; encompasses elements of saving, studying, and using biodiversity.

Domesticated or cultivated species - Species in which the evolutionary process has been influenced by humans to meet their needs.

Ecology - A branch of science concerned with the interrelationship of organisms and their environment.

Ecosystem - A dynamic complex of plant, animal, fungal, and microorganism communities and their associated non- living environment interacting as an ecological unit.

Endemic species – A species restricted to a specified region or locality.

Harmful or dangerous – Plants and animals that sting, prickle, cause allergies, are poisonous to humans or other organisms or exclude other organisms from an ecosystem or habitat.

Feral animals – Animals that are untamed or wild.

Historic – Those plants and animals that were introduced long ago but now are accepted by most persons as “native”.

Intentional introduction – An introduction made deliberately by humans, involving the purposeful movement of a species outside of its natural range and dispersal potential. Such introductions may be done legally or illegally.

Introduction – The movement by human agency of a species, subspecies or lower taxon outside its natural range. This movement can be either within a country or between countries.

Invasive alien species - Alien species that become established in a new environment, then proliferate and spread in ways that are destructive to native ecosystems, human health, and ultimately human welfare.

Native species – A species occurring within its natural range and dispersal potential, i.e. within the range it occupies naturally or could occupy without direct or indirect introduction or by care of humans. Those plants and animals that occurred when Columbus arrived.

Naturalized – Plants and animals that have been introduced and now propagate on their own.

Unintentional introduction – An unintended introduction made as a result of a species utilizing humans or human delivery systems as vectors for dispersal outside its natural range.

3.0 Introduction: An Overview of Invasive Alien Species

Invasive alien species may be defined as:
Alien species that become established in a new environment, then proliferate and spread in ways that are destructive to native ecosystems, human health, and ultimately human welfare.

Invasive species spread because the natural controls that keep them in check in their native homelands, such as disease and predators, do not exist when they introduced into a new habitat.

Invasive species occur globally and are represented in every taxonomic group. They can be:

- micro-organisms, such as bacteria and plankton;
- plants, such as trees, shrubs and vines; or
- animals, such as insects, reptiles, amphibians and mammals

Invasive species have negative economic and environmental impacts. Some of these negative impacts include:

- loss of genetic diversity, i.e. they dilute the gene pool through hybridization;
- competition with native species, resulting in their loss or displacement;
- introduction of diseases; and
- change in the physical properties of the environment, e.g. decrease amount of dissolved oxygen in water, decrease the amount of sunlight reaching an area.

The direct economic costs of invasive alien species run into many billions of dollars annually. A recent effort by United States ecologists to calculate the annual costs of all alien invasives in the United States concluded that invasive weeds cost US agriculture about $27 billion per year. The total costs to the United States of all non-indigenous species (plants, animals, and microorganisms) were estimated at over $138 billion per year.

Increasing globalization of markets and rises in global trade, transport, travel and tourism mean that more and more species from all parts of the world are moving to new habitats, enhancing the possibility of invasion in all ecosystems all over the world.

The degradation of natural habitats globally has made it easier for alien species to establish and become invasive. Global climate change is also a factor assisting the spread and establishment of invasive alien species. For example, increased temperatures may enable alien, disease-carrying mosquitoes to extend their range.

There are three categories of activities that can result in alien species becoming invasive:

1. Intentional introduction of species for use in biological production systems, i.e. agriculture, forestry, fisheries and landscaping, as well as recreational and ornamental purposes and for biological control of pests;

2. Intentional introduction of species as a commodity for uses where there is a known risk of escape or release to the wild, i.e. zoos, aquaculture, mariculture, aquariums, horticulture, pet trade, etc.; and
3. Unintentional introduction of species through pathways involving transport, trade, travel or tourism.

With unintentional introductions, alien species can be present in bilge and ballast water of ships, airplane wheel wells, tourists' shoes, as well as gut and hooves of imported livestock. Absent bioterrorism, the spread of disease by international travelers or freight, is also an unintentional introduction, e.g., West Nile virus.

Studies have shown that islands, like those of The Bahamas, are especially vulnerable to invasions. Island species often have small populations and are unique when compared to continental species due to the isolation of islands throughout prehistoric times. This isolation has been provided by the natural barriers of oceans, mountains, rivers and deserts that have enabled these unique species and ecosystems to evolve. Most island species are ill-equipped to defend against aggressive invading species and fare poorly in the face of competitors, predators, pathogens and parasites from other areas.

While the isolation of islands has proved to be a weakness in the ability of island species and ecosystems to be resilient against biological invasion, it can be used as an advantage by improvement of the capacity of governments of Island States to prevent the arrival of invasive alien species with better knowledge, improved legislation and greater management capacity, supported by quarantine and customs systems that are capable of identifying and intercepting invasive alien species.

4.0 Mechanisms to Manage and Control Invasive Species

Measures that can be taken to address invasion by alien species include:

- Prevention
- Early detection and response
- Eradication
- Control

Prevention of the entry and establishment of unwanted invasive species will require a comprehensive infrastructure that includes a national inspection system, training of human resources, and funding. Public education and awareness is also an important part of prevention (see also Appendix I).

Prevention also involves reduction or elimination of those activities that make invasion possible, i.e. clear-cutting, pollution and other forms of habitat degradation.

An early detection system was previously used in The Bahamas for the Pink Hibiscus mealy bug (*Maconellicoccus hirsutus*). Early detection and response involves inventory and mapping of species, a rapid-response plan, public notification, and the resources to act quickly when a new invader is discovered. This system is the same as would be employed by a public health agency in the event of a new disease outbreak. A system for addressing invasive species would include components for:

1. Raising public awareness;
2. Generating support and funds for quality programs;
3. Developing effective integrated management plans with specific control actions; and
4. Assessing the economic and social impact of invasives.

An important component of an early detection system is monitoring. Monitoring of species must occur on a regular basis.

Early detection is facilitated by collaboration within the country to maximize human and financial resources with monitoring being carried out by those who are regularly in the field, i.e. birdwatchers, landscape crews and researchers.

Out of all possible management strategies of invasive species, eradication (removal of the entire population) is the most suited as a means for restoration of native biological diversity, although it is also the most difficult and expensive strategy to employ. Whether or not eradication can be accomplished is affected by whether it is feasible and if it can be carried out early enough in an invasion to be successful. Eradication of established populations of invasive species requires significant resources and years of committed action to accomplish. It is important to note that the most successful examples of eradication are from small islands.

Control of invasive species requires initial treatment followed by maintenance control. Maintenance control involves use of techniques in a coordinated manner on a continuous basis in order to maintain invasive populations at the lowest acceptable level. Options for control include prohibition and restriction with conditions. Control also involves ensuring the use of proper disposal methods and areas, especially with respect to invasive plant material. Control methods should be socially, culturally and ethically acceptable as well as efficient and non-polluting. Methods employed should minimize adverse affects on native flora and fauna, human health and well-being or agricultural stocks.

In exploring all the options available for addressing the invasive species problem, we must recognize the role that human habits and behaviours play in the introduction and spread of invasives and work to modify or change these. For example, in management of dogs, we must also focus on fostering responsible care of owned dogs, implementation of current and new legislation to achieve this and enforcement of legislation.

Human decisions and human activities not only affect the introduction and spread of invasive species, but also affect the resilience of ecosystems and the possibility of timely policy responses to deal with invasions. Degraded habitat, such as land that has been clear-cut, is prime habitat for invasion. If policy responses are slow, the risk of invasive species becoming established is increased and the success of preventive or control measures is negatively affected.

Any meaningful prevention and control strategy has a cost. Given budget constraints, any decision-making on what measures to apply will inevitably involve setting priorities and accepting trade-offs. In consequence, the determination of costs and benefits of invasive alien species control and the related options for prevention, control and management becomes vital.

There are a number of reasons why it may be economically worthwhile to protect native biological diversity. These include protecting:

- human health and safety - invasive species that introduce disease can impact directly on human well-being through sickness, debilitation and death.
- production standards - invasive species may disrupt production processes by reducing the productivity of pasture, plants and livestock. Such incursions of invasive species may impact on production through increased costs, reduced output volumes or lower prices from products perceived as of inferior quality.
- access to overseas markets - other countries may use the presence of potentially damaging invasive species in The Bahamas as a reason to erect trade barriers against Bahamian seafood and produce exports. These barriers can impact the prices for exports, and in the long term, may also lead to changes in the volume of products sent to export.
- a sense of security and cultural identity - such impacts are difficult to quantify, but there can be a real reduction in well-being for the population at large from introduction of invasive species which damage parts of the environment significant for national or cultural identity, such as traditional use beaches and fisheries.

5.0 Recommendations

It must be clarified that actions recommended under this strategy are specific to invasive plants and animals. It is hoped that at a later stage micro-organisms and diseases will be addressed.

Stakeholders consulted during the project have recommended the following:

1. There should be building of awareness through the development of a database on invasive species to include:
- Information on risks associated with each species;
- All characteristics of each species (e.g. breeding habits. migration patterns, physical description;
- Management mechanisms and
- Visual representation.

2. Training should occur in the following areas:
- Customs officers in the identification, safe handling, holding and transfer of invasive species; and
- Agricultural and fisheries officers in the identification, safe handling, holding, transfer and disposal of invasive species as well as methods of risk assessment and management.
- Enforcement officers in the identification, safe handling, holding and transfer of invasive species.

3. All officers should be trained in a national mechanism that would coordinate action in the field with respect to invasive species. This mechanism would set up clear powers and responsibilities between the agencies concerned.

4. As monitoring cannot be achieved for the entire archipelago, it is recommended that specific sites be identified for regular monitoring, such as:
- All public areas
- National parks
- Protected areas
- Freshwater sources (groundwater and well fields)
- Field stations

5. Existing legislation related to management and control of alien species should be enforced and where deficient, be amended. There will also be the need to draft and amend new legislation specific to management and control of invasive alien species.

6. There should be a sequenced approach to invasive species control:
   i. Preventing entry of potential invasives from other countries and other Bahamian islands;
   ii. If entry has already occurred, preventing the establishment and spread of invasives, i.e. rapid response;

iii. Eradication of invasives at the earliest possible stage is preferred. Methods of eradication should be as ethical and humane as possible;
iv. If eradication is not feasible or cost-effective, containment and long-term control measures should be considered.

7. Priority species should be listed for eradication and control. These lists therefore would not include all known invasives for The Bahamas. The latter list can be found at Appendix XVI and is the most current list to date. It should also be noted that species on the eradication and control lists would be reviewed on a regular basis with the result that current species may be deleted and new species added.

Species recommended for eradication are:

Casuarina glauca	Suckering Australian Pine
Melaleuca quinquenervia	Melaleuca, (paper bark)
Mucuna pruriens	Monkey Tamarind
Scaevola taccada	Asian Scaevola, White Inkberry, (Hawaiian Seagrape)
Schinus terebinthifolius	Brazilian Pepper, Bahamian Holly
Molothrus bonariensis	Shiny Cowbird
Procyon lotor	Raccoon (for all islands except New Providence and Grand Bahama)

Species recommended for control are:

Albizia lebbeck	Woman's Tongue
Antigonon leptopus	Coral Vine
Bauhinia variegata	Poor Man's Orchid
Casuarina equisetifolia	Casuarina, Australian Pine, (beefwood)
Delonix spp.	Poinciana
Eichhornia crassipes	Water Hyacinth
Haematoxylon campeachianum	Logwood
Impomoea purpurea	Morning Glory
Leucaena glauca	Jumbey
Pimenta racemosa	Bay Rum
Prunus amygdalus	Almond
Ricinus communis	Castor Bean
Spathodea campanulata	African Tulip Tree, Flame of the Forest
Schefflera actinophylla	Schefflera, Queensland Umbrella Tree
Trachelosperumum jasminoides	Star Jasmine
Wedelia trilobata	Wedelia, (carpet daisy)
Columba livia	Rock Dove
Passer domesticus	House Sparrow
Streptopelia decaocta	Eurasian Collared Dove

Canine	Dogs
Felis catus	Cats
Procyon lotor	Raccoon (for New Providence and Grand Bahama)

8. The Government accept and implement an Invasive Species Policy as outlined in the draft at Appendix IV

9. Specific actions should be taken by the Government as given in the Code of Conduct in Appendix V.

10. Specific actions should be taken by sectors as identified in the Voluntary Codes of Conduct in Appendices VI through XIV.

11. The Government commit to give and seek funding for a sustained management program of invasive species and explore the option of maintaining a contingency fund specifically for emergency response purposes. Determining the size of such a fund would involve estimating the risk of an invasion emergency and the likely magnitude of such an event.

12. The Bahamas seeks to establish a comprehensive infrastructure for the management of invasive alien species in compliance with its international obligations under the following international agreements and organizations:
    i. 1992 Convention on Biological Diversity, Article 8(h) and the Interim Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species
    ii. 1971 Ramsar Convention, Resolution VII/14 on Invasive Species and Wetlands;
    iii. 1995 FAO Code of Conduct for Responsible Fisheries and Code of Conduct for the Import and Release of Exotic Biological Control Agents
    iv. 1994 World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)
    v. International Plant Protection Convention (IPPC)
    vi. World Health Organization (WHO)
    vii. Codex Alimentarius Commission for Food Safety and Human Health
    viii. Office International des Epizooties (OIE) for Animal Health
    ix. 1982 United Nations Convention of the Law of the Sea (UNCLOS), Article 196
    x. 1997 IMO Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens
    xi. 1998 International Civil Aviation Organization (ICAO) Assembly Resolution A-32-9 on preventing the Introduction of Alien Invasive Species
    xii. Agenda 21, United Nations Conference on Environment and Development (UNCED), 1992

xiii. 1994 Barbados Programme of Action for the Sustainable Development of Small Islands Developing States (SIDS)

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Appendices
I. The Public and Implementation of the Strategy

Public education and awareness must occur at all levels and we define public to include the following:

Cabinet Ministers
Policy makers
Judiciary
Government Ministries and officials
Local Government
Technical Officers
Enforcement agencies
Churches
Media
Youth
NGOs
Farmers
Fishermen
Tourism sector (including hotels and tourists)

Contractors (i.e. landscapers, architects and construction industry)
Schools and colleges
Importers and exporters
Airline companies
Shipping companies
Horticulturists
Plant nurseries
Botanical gardens
Homeowners
Gardeners/gardening enthusiasts
Gardening clubs
Pet stores
Pet breeders and dealers
Pet owners

Public education should involve utilization of the media in the promotion of information on invasive species and their management.

1I. Plant and Animal Species Recommended for Eradication

Casuarina glauca	Suckering Australian Pine
Melaleuca quinquenervia	Melaleuca, (paper bark)
Mucuna pruriens	Monkey Tamarind
Scaevola taccada	Asian Scaevola, White Inkberry, (Hawaiian Seagrape)
Schinus terebinthifolius	Brazilian Pepper, Bahamian Holly
Molothrus bonariensis	Shiny Cowbird
Procyon lotor	Raccoon (for all islands except New Providence and Grand Bahama)

III. Plant and Animal Species Recommended for Control

Albizia lebbeck	Woman's Tongue
Antigonon leptopus	Coral Vine
Bauhinia variegata	Poor Man's Orchid
Casuarina equisetifolia	Casuarina, Australian Pine, (beefwood)
Delonix spp.	Poinciana
Eichhornia crassipes	Water Hyacinth
Haematoxylon campeachianum	Logwood
Impomoea purpurea	Morning Glory
Leucaena glauca	Jumbey
Pimenta racemosa	Bay Rum
Prunus amygdalus	Almond
Ricinus communis	Castor Bean
Spathodea campanulata	African Tulip Tree, Flame of the Forest
Schefflera actinophylla	Schefflera, Queensland Umbrella Tree
Trachelosperumum jasminoides	Star Jasmine
Wedelia trilobata	Wedelia, (carpet daisy)
Columba livia	Rock Dove
Passer domesticus	House Sparrow
Streptopelia decaocta	Eurasian Collared Dove
Canine	Dogs
Felis catus	Cats
Procyon lotor	Raccoon (for New Providence and Grand Bahama)

IV. Draft Policy on Invasive Species

The Commonwealth of The Bahamas

Draft National Invasive Species Policy

The Government of the Commonwealth of The Bahamas,

Recognizing its obligation as a Party under Article 8(h) of the Convention on Biological Diversity to "prevent the introduction of, to control or to eradicate those alien species, which threaten ecosystems, habitats or species",

Acknowledging that scientists and governments throughout the world recognize that biological invasions by alien species pose serious threats to native biological diversity,

Noting that invasive alien species are found in all taxonomic groups: plants, animals and microorganisms,

Noting that invasive alien species are as damaging to native species and biological diversity as the loss and degradation of habitat,

Recognizing that, globally, hundreds of species extinctions have already resulted from invasive alien species,

Noting that the natural barriers to the movement of species - oceans, rivers, mountains and deserts - that provided the isolation essential for the evolution of unique and endemic species, have become increasingly ineffective,

Acknowledging that globalization, and the emphasis on free trade, provide even greater opportunities than hitherto for species to be introduced, either deliberately or accidentally, to new habitats, with the opportunity to become invasive,

Aware that small islands developing states are particularly vulnerable to the impacts of seemingly innocuous invasions, and The Bahamas perhaps especially so, given its archipelagic nature and many ports of entry,

Aware that the impacts of alien invasive species are immense, insidious, and often irreversible and that the costs due to their damage on a global scale are enormous, both in ecological and economic terms, and in terms of human welfare,

Recognizing that The Bahamas relies heavily on its natural resources, and has an open economy heavily dependent on imports,

Recognizing that the cost of allowing the introduction of invasive alien species is the irretrievable loss of endemic species and of unique ecosystems,

Recognizing also that there are direct economic costs of control of alien animals and plants, disease and pests, *Noting* that introduced alien diseases and parasites of humankind not only result in suffering, and perhaps death, but also have economic costs of medical treatments and the loss of productivity,

Noting that global climate change is also a significant factor in facilitating the establishment of many alien species, and

Determined to conserve and sustainably manage the biological diversity of The Bahamas for the benefit of present and future Bahamians,

Has decided to adopt the following Policy:

- To enact legislation to prevent the introduction of, to control and to eradicate those alien invasive species which threaten the ecosystems, habitats, endemic species and the human health and welfare of The Bahamas, in support of the Convention on Biological Diversity;

- To prepare a National Invasive Species Strategy for The Bahamas, which lists and prioritizes in order of significant impact those invasive species present in The Bahamas;

- To prepare Strategic Management Plans for individual species of high priority as identified under the National Invasive Species Strategy;

- To facilitate research on the occurrence, distribution and impacts of invasive alien species and invasive native species in The Bahamas;

- To prevent the introduction of invasive alien species into The Bahamas by regulatory and other relevant means;

- To monitor invasive species populations in The Bahamas by the conduct of surveys and risk assessments;

- To undertake control and management activities in an environmentally and cost-effective manner;

- To monitor potentially invasive alien species not yet established in The Bahamas;

- To promote, undertake and facilitate the reestablishment of native species, where appropriate, and the restoration of invaded and damaged habitats;

- To conduct and facilitate research into the best management and control practices for individual species, including plants, animals and microorganisms, using chemical, physical and biological methods that are environmentally sound;

- To promote public education and outreach on invasive alien species at all levels of society by appropriate methods;

- To promote international and regional cooperation which would aid in the fulfillment of this policy and implementation of the National Invasive Species Strategy;

- To mandate such cooperation between Government Ministries, Departments and other Agencies including Non-Governmental Organizations and the Private Sector, as necessary, to implement this policy and to carry out the Strategy.

- To promote and facilitate such infrastructural development as is necessary to enable Ministries, Departments, and other Agencies, to implement this Policy and the National Invasive Species Strategy.

V. Code of Conduct for Government

Require risk assessment for Government-led or financed plant and animal introductions to ensure that no new harmful species are introduced, intentionally or unintentionally.

Do not distribute existing holdings of invasive plant and animal species to areas where they can potentially do harm.

Coordinate and facilitate collaboration in databases, early warning systems, monitoring and other means of preventing invasive plant species problems.

Lead and fund the development of environmentally sound methods to control harmful invasive plant species, seek control of such species on Crown and other public lands and promote their control on adjacent private lands.

Develop and promote the use of non-invasive plant species within all Government agencies and to the public.

Facilitate, lead, coordinate and evaluate public outreach and education on harmful invasive species.

Encourage public servants and managers to participate in ongoing training programmes on invasive species.

Foster international and regional cooperation to minimize the risk of import and export of potentially invasive species.

Develop partnerships and incentive programmes to lessen the impact of invasive species and provide non-invasive restoration materials.

Provide a forum for regular evaluation of the effectiveness of these voluntary codes of conduct towards preventing the invasive species problem.

Enforce existing invasive species legislation at all levels, and enact new legislation where deficiencies occur in existing legislation.

VI. Voluntary Code of Conduct for Botanical Gardens

Conduct an internal review examining all activities that provide an opportunity to prevent the spread of invasive species and to inform visitors on this issue.

Avoid introducing invasive plants by establishing an invasive plant assessment procedure. This procedure should involve responsible and regular monitoring of the garden site.

Remove invasive species from plant collections. If for any reason the decision is made to retain an invasive species, ensure its control and provide strong interpretation to the public explaining the risk of the species and its function in the garden.

Seek to control harmful invasive species in natural areas managed by the garden and assist others in controlling them on their property, whenever possible.

Promote non-invasive alternative plants or help develop non-invasive alternatives through plant selection or breeding.

If your institution participates in seed or plant distribution, do not distribute known invasive plants except for bona fide research purposes and consider the consequences of distribution outside your biogeographic region. Consider attaching a statement of caution to species that appear to be potentially invasive but have not been fully evaluated.

Increase public awareness about invasive plants. Provide information on why they are a problem, their origin, mechanisms of harm and need for prevention and control. Work with local nurseries and seed industries to assist the public in environmentally safe gardening and sales.

Participate in developing, implementing or supporting regional, national or local early warning systems for immediate reporting and control.

Participate in the creation of regional lists of concern.

Become informed about the invasiveness of species within your institution in other biogeographic regions. Compile and share this information in a manner accessible to all.

Become partners with other organizations in the management of harmful invasive species.

Follow all laws on importation, exportation, quarantine and distribution of plant materials across political boundaries. Be sensitive to conventions and treaties that deal with this issue and encourage affiliated organizations (plant societies, garden clubs, etc.) to do the same.

VII. Voluntary Code of Conduct for Landscape Architects

Work with local plant ecologists, horticulturists, nurseries, botanic gardens, conservation organizations and others to determine what species in your region either are currently highly invasive or show aggressive potential.

Increase interaction with other professionals and non-professionals to identify alternative plant material and other solutions to problems caused by harmful invasive plants.

Take advantage of continuing education opportunities to learn more about the invasive species issue.

Identify and specify non-invasive species that are aesthetically and horticulturally suitable alternatives to invasive species in your region.

Eliminate specification of species that are invasive in your region.

Be aware of potential environmental impacts beyond the designed and managed area of the landscape plan (for example, plants may spread to adjacent natural areas or cropland).

Encourage nurseries and other suppliers to provide landscape contractors and the public with non-invasive plants.

Collaborate with other local experts and agencies in the development and revision of local landscape ordinances. Promote inclusion of invasive species issues in these ordinances.

VIII. Voluntary Code of Conduct for the Gardening Public

Ask for only non-invasive species when you purchase plants. Plant only environmentally safe species in your gardens. Work towards and promote new landscape design that is friendly to local ecosystems.

Seek the best information on which species are invasive in your area. Sources could include botanical gardens, nurseries, horticulturists, conservationists and Government agencies.

Remove invasive species from your property and replace them with non-invasive species suited to your site and needs.

Do not trade plants with other gardeners if you know they are species with invasive characteristics.

Request that botanical gardens and nurseries promote, display and sell only non-invasive species.

Help educate your community and other gardeners in your area through personal contact and in such settings as garden clubs and other civic groups.

Ask garden writers and other media to emphasize the problem of invasive species and provide information. Request that garden writers promote only non-invasive species.

Invite speakers knowledgeable on the invasive species issue to speak to garden clubs, schools and other community groups.
Seek the best information on control of invasive plant species and organize neighbourhood work groups to remove invasive plant species under the guidance of knowledgeable professionals.

Volunteer at botanical gardens and natural areas to assist ongoing efforts to diminish the threat of invasive plants.

Participate in early warning systems by reporting invasive species you observe in your area to the relevant authority, i.e. the BEST Commission, Department of Agriculture or the Botanical Gardens.

Assist garden clubs to create policies regarding the use of invasive species not only in horticulture, but in activities such as flower shows.

Urge florists and other to eliminate the use of invasive plant material.

IX. Voluntary Code of Conduct for Nursery Professionals

Ensure that the invasive potential of plants is assessed prior to introducing and marketing a plant species new to The Bahamas. Invasive potential should be assessed by the introducer or qualified experts using risk assessment methods that consider plant characteristics and prior observations or experience with the plant elsewhere in the world.

Additional insights may be gained through extensive monitoring on the nursery site prior to distribution.

Work with local experts and stakeholders to determine which species are either currently invasive or will become invasive. Identify plants that could be suitable alternatives in your area.

Develop and promote alternative plant material through plant selection and breeding.

Where agreement has been reached among nursery associations, Government, academia and ecology and conservation organizations, phase out existing stocks of invasive species in areas where they are considered to be a threat.

Follow all laws on importation and quarantine of plant materials across political boundaries.

Encourage customers to use non-invasive plants.

X. Voluntary Code of Conduct for Zoos and Aquaria

Conduct an internal review examining all activities that provide an opportunity to prevent the spread of invasive species and to inform visitors on the issue.

Avoid introducing invasive animals by establishing an invasive animal assessment procedure. This procedure should involve responsible and regular monitoring of the facility.

Take due care to prevent the release or escape of animals that are known to cause damage as invasives or may be potential invasives.

Remove invasive species from exhibits or displays. If the decision is made to retain an invasive species, ensure its control and containment and provide strong interpretation to the public explaining the risk associated with the species and its function in the facility.

If your institution participates in breed stock exchange, do not distribute known invasive animals except for bona fide research purposes and consider the consequence of distribution outside your biogeographic region. Consider attaching a statement of caution to species that appear to be potentially invasive but have not been fully evaluated.

Increase public awareness about invasive animals. Provide information on why they are a problem, their origin, mechanisms of harm and need for prevention and control.

Participate in developing, implementing or supporting regional, national or local early warning systems for immediate reporting and control.

Participate in the creation of regional lists of concern.

Become informed about the invasiveness of species within your facility in other biogeographic regions. Compile and share this information in a manner accessible to all.

Become partners with other organizations in the management of harmful invasive species.

Follow all laws on importation, exportation, quarantine and distribution of animals across political boundaries. Be sensitive to conventions and treaties that deal with this issue and encourage affiliated organizations to do the same.

XI. Voluntary Code of Conduct for Farms (Agricultural and Aquacultural)

Ask for only non-invasive species when you purchase livestock or fish stock. If for any reason, the decision is taken to farm invasive species, ensure that they are controlled and contained through appropriate mechanisms, e.g. fencing to prevent escape or breeding with native species.

Take due care to prevent the release or escape of domestic animals that are known to cause damage as feral animals, e.g. pigs and goats.

Take due care to prevent the release or escape of livestock or fish stock that are known to cause damage due to their invasive characteristics or potential.

Seek information on which species are invasive in your area. Sources could include breeders, veterinarians, conservationists and Government agencies.

Do not trade stock with other farmers if you know that they are species with invasive characteristics.

Request that breeders and dealers promote and sell non-invasive species.

Help educate your community and other farmers in your area through personal contact and in such settings as farmers' association meetings.

Ask writers and other media to emphasize the problem of invasive species and be willing to provide information.

Invite speakers knowledgeable on the invasive species issue to speak to farmers' association meetings, schools and other community groups.

Seek the best information on control of invasive animal species.

Participate in early warning systems by reporting invasive species you observe in your area to the relevant authority, i.e. the BEST Commission, Department of Agriculture or Department of Fisheries.

Assist farmers' associations to create policies regarding the use of invasive species in agriculture and aquaculture.

XII. Voluntary Code of Conduct for Pet Stores, Breeders and Dealers

Ensure that the invasive potential of animals is assessed prior to introducing and marketing an animal species new to The Bahamas. Invasive potential should be assessed by the introducer or qualified experts using risk assessment methods that consider animal characteristics and prior observations or experience with the animal elsewhere in the world.

Additional insights may be gained through extensive monitoring at your facility prior to distribution.

Work with local experts and stakeholders to determine which species are either currently invasive or will become invasive. Identify animals that could be suitable alternatives in your area.

Where agreement has been reached among associations, Government, academia and ecology and conservation organizations, phase out existing stocks of invasive species in areas where they are considered to be a threat.

Follow all laws on importation and quarantine of animals across political boundaries.

Encourage customers to purchase non-invasive pets or livestock.

XIII. Voluntary Code of Conduct for Pet Owners

Ask for non-invasive species when you purchase pets. If the decision is taken to own an invasive species, ensure that it is contained and controlled through confinement to your property and reproductive control (e.g. spaying and neutering).

Seek information on which species are invasive in your country. Sources could include zoos, aquaria, pet stores, ecologists, conservationists and Government agencies.

Do not trade pets with other pet owners if you know they are species with invasive characteristics.

Request that pet stores and breeders promote, display and sell non-invasive species.

Help educate your community and other pet owners in your area through personal contact and in such settings as pet shows, training sessions, visits to the vet and other gatherings involving activities with pets.

Ask writers and other media to emphasize the problem of invasive species and provide information.

Invite speakers knowledgeable on the invasive species issue to speak to associations, clubs, schools and other community groups.

Seek the best information on control of invasive animal species and work with other like-minded individuals to remove these species from your area in an ethical and humane manner under the guidance of knowledgeable professionals.

Volunteer at zoos, aquaria, national parks and other natural areas to assist ongoing efforts to diminish the threat of invasive animals.

Participate in early warning systems by reporting invasive species you observe in your area to the relevant authority, i.e. the BEST Commission, Department of Agriculture or the Animal Control Unit.

XIV. Voluntary Code of Conduct for Veterinarians

Work with local ecologists, breeders, pet stores, conservation organizations and others to determine what species in your region either are currently highly invasive or show aggressive potential.

Increase interaction with other professionals and non-professionals to identify non-invasive animals and other solutions to problems caused by harmful invasive animals.

Take advantage of continuing education opportunities to learn more about the invasive species issue.

Identify and specify non-invasive species that are aesthetically and ecologically suitable alternatives to invasive species in your region.

Eliminate specification of species that are invasive in your region.

Encourage breeders and pet stores to provide farmers, private firms and the public with non-invasive animals.

XV. Stakeholder Participant List

Abaco

David Knowles
Anita Rolle
Beatrice Moxey
Derrick Bailey
Michael Albury
A.J. Wells
Mel Wells
Don Cornish
Eric Collie
Ed Newell
Brickell Brennen
John Hedden
Moxey Williams
A.L. Knowles
John Bethell
Doug Evans
Lisa Evans
Cleveland Banks

Molly Roberts
Chris Roberts
Mimi Rehor
Dave Ralph
Kathy Ralph
Erin Pagliaro
Ron Pagliaro
Jack Hardy
Bobby Jones
Kendy Anderson
Wayne Cornish
H.B. Pinder
Paul Pinder
Chris Bergh

Andros

Donald Cash
Fred Pyfrom
Mary Wilson
Margo Blackwell
Dewitt Edgecombe
Deon Sweeting
Peter Douglas
Bill Adderley
Donna McQueen
Theresa Minnis
Reverend N.W. Hamilton

Eleuthera

Rufus E. Johnson
Lionel Fernander
Lloyd C. Johnson III
Michael C. M. Culmer
Robert Patterson
Lawrence Griffin
Bessie Culmer
Branka Hanford
Kevin Joseph Jr.
Manon Tousignant
Kingsley A. Bethel
Drexel Boothe
Kendal Sands
Sally Chisholm

Grand Bahama
Please call Nakira for these names

New Providence

Eugene Torchon-Newry
Lester Gittens
Timothy Bethel
Carol Albury
Dr. E. McPhee
Dr. Maurice Isaacs
Nehemiah Francis
Timothy Johnson
Gwen Hammerton
Dr. John Hammerton
S.J. Miller
Robert Myers
Stephen Bethel
Paul Dean
Earl Seymour
Pastor James Redmon
Marian Rolle
William Fielding
Robin Wright
Eric Rose
Derek Smith
Earlston McPhee
Daniel Drost
Eric Carey
Eleanor Phillips
Casuarina McKinney
Stephen Bellot
Stephan Moss
Sharrah Moss
Nakira Wilchcombe
Deon Stewart
Stacey Wells-Moultrie

Acklins & Crooked Island
Berry Islands
Bimini
Exuma & Ragged Island
Inagua
Long Island
Mayaguana
Run Cay & San Salvador

Still awaiting response for above islands;
will forward by Monday.

XVI. List of Known Invasive Alien Species in The Bahamas

Plant Species

Abrus precatorius	Rosary pea
Alibiza lebbeck	Woman's tongue
Antigonon leptopus	Coral vine
Asparagus densiflorus	Asparagus fern
Bauhinia variegata	Poor man's Orchid, Orchid tree
Casuarina equisetifolia	Australian Pine, Beefwood
Casuarina glauca	suckering Australian pine
Cestrum diurnum	Day jessamine
Colubrina asiatica	Lather leaf
Dioscorea alata	Winged yam
Dioscorea bulbifera	Air potato
Eichhornia crassipes	Water hyacinth
Eugenia uniflora	Surinam cherry
Haematoxylon campeachianum	Logwood
Impomoea purpurea	Morning Glory
Jasminum fluminense	Azores jasmine, Brazilian jasmine
Lantana camara	Lantana, Shrub verbena, angel lips, big sage, black sage, white sage, prickly lantana
Leucaena glauca	Jumbey
Melaleuca quinquenervia	Melaleuca, paper bark
Nephrolepis multifora	Asian sword fern
Panicum repens	Torpedo grass
Pennisetum purpureum	Napier grass
Pimenta racemosa	Bay Rum
Prunus amygdalus	Almond
Ricinus communis	Castor Bean
Ruellia brittoniana	Mexican petunia
Scaevola taccada	Asian Scaevola, Hawaiian seagrape, White inkberry
Schefflera actinophylla	Schefflera, Queensland umbrella tree
Schinus terebinthifolius	Brazilian pepper, Bahamian holly
Spathodea campanulata	African tulip tree, flame of the forest
Syngonium podophyllum	Arrow head vine
Thespesia populnea	Seaside mahoe, cork tree, Spanish cork
Trachelosperumum jasminoides	Star Jasmine
Wedelia trilobata	Wedelia, carpet daisy

Bird Species

Columba livia	Rock Dove
Molothrus bonariensis	Shiny Cowbird

Passer domesticus	House Sparrow
Streptopelia decaocta	Eurasian Collared Dove

Terrestrial Animals Species

Bos taurus	Holstein
Canine	Dogs (all breeds and types)
Capra hicus	Goat
Elaphe guttata	Corn snake
Eleutherodactylus coqui	Caribbean tree frog, common coqui
Equus asinus	Donkey
Felis catus	Cats (all breeds and types)
Mus musculus	Mouse
Ovis aries	Sheep
Procyon lotor	Racoon
Rattus norvegicus	Norway rat
Rattus rattus	Ship rat
Solenopsis invicta	Red imported fire ant
Sus scrofa	Pig
Trachemys scripta	Red-eared slider
Loxosceles reclusa	Brown recluse spider
Wasmannia auropunctatus	Little fire ant

Aquatic Species

Amphiprion sp	Clown fish
Artemia cysts	Brine shrimp
Callinectes sapidus	Blue crab
Callionymus lyra	Dragonet
Cherax quadricarinatus	Red claw
Chiloscyllium punctatum	Banded shark
Chkosoyllium piunctatum	Brown Bamboo shark
Chrysoara quinquechirra	Sea nettle
Family Cichlidae	Cichlid fish
Crassostrea virgnica	American oyster
Dunaliella sp.	Green algae
Epinephelus lanceolatus	Queenland grouper
Euxiophipops navarchis	Blue-girded angelfish
Euxiophipops xanthometapm	Yellow-faced angelfish
Hemiscylliidae	Bamboo shark
Heterodontus zebras	Zebra Bullhead shark
Nannochloropsis oculata	Algae
Oreochrommis ureblepis	Tilapia
Radianthus	Sea anemone

Appendix D

Literature Summary for Lee Stocking Island, Williams Cay, and Lee Stocking Island

John Perry purchased Lee Stocking Island in 1957 and established the Perry Institute for Marine Science (PIMS) and the Research Center in 1970. In 1984, the Caribbean Marine Research Center (CMRC) took over the Research Center as part of the United States National Ocean and Atmospheric Administration's (NOAA) National Undersea Research Program (NURP). Operations of PIMS on Lee Stocking Island ceased around 2010.

During its operation, PIMS was dedicated to ocean research and public education to advance conservation management. A voluntary no-take zone was promoted around Lee Stocking Island to enable long-term monitoring and research projects. The island hosted visiting scientists, graduate students and touring school groups to generate awareness for the marine environment. The Research Center and later CMRC, supported technology advances to marine submersibles and technical dives.

PIMS in-house research scientists focused on four (4) areas:

- Fisheries
- Ecosystems
- Coral Reefs
- Marine Biodiversity

CMRC NOAA's NURP focused on four (4) key areas:

- Building Sustainable Fisheries
- Maintaining Healthy Coastal Ecosystems
- Predicting Environmental Change
- Gaining New Biological and Economical Value from the Sea

With relation to the development, the following research topics are of relevance to Children's Bay Cay and Williams Cay.

Stromatolites. Stromatolites are composed of layers of cyanobacteria colonies. Cyanobacteria are able to photosynthesize which produces oxygen and allowed for the evolution of complex life. Stromatolites have been on earth for 3.5 billion years and provide a modern viewing of ancient life processes. With relation to Lee Stocking Island, two areas of stromatolites formations are growing in the channel between Norman's Pond Cay and the northwestern tip of Lee Stocking Island. The stromatolites here are considered modern giant stromatolites growing in a subtidal marine environment.

Selective Literature - Stromatolites

Dill, R.F., Kendall, C.G.St.C., & Shinn, E.A. (1989). *Giant subtidal stromatolites and related sedimentary features: field trip guidebook T373*. Washington, D.C.: American Geophysical Union.

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Riding, Robert; Awramik, Stanley M.; Winsborough, Barbara M.; Griffin, Karen M.; and Robert F. Dill. (1991) Bahamian giant stromatolites; microbial composition of surface mats. Geol. Mag 128(3) 227-234.

Coral Research. PIMS and CMRC created a Coral Research Program in 2000 to focus on the long-term study of shallow and deep coral reef systems. Scientists studied coral health an diseases, seawater temperatures, tides and currents, coral reef ecology, genetic diversity, and the like.

Selected Literature – Coral Research

Voss, Joshua D. and Laurie L. Richardson. (2006) Coral diseases near Lee Stocking Island, Bahamas, patterns and potential drivers. Diseases of Aquatic Organisms. Vol 69 (33-40).

Studies of trophic ecology on coral reef ecosystems (Steele and Forrester 2002, Webster 2002, 2003, 2004, Almany 2004, Almany and Webster 2004, Lesser et al. 2004)

Life history studies of economically and ecologically important taxa associated with coral reefs (Dahlgren and Eggleston 2000, Gutierrez-Rodriguez and Lasker 2004b)

Elucidation of coral reef ecosystem functions as well as the interrelationships between and among neighboring (estuaries, and back reef habitats) and distant ecosystems (Sahara Desert)(Garrison et al. 2003, Smith et al. 2004)

Identification of threats that degrade coral reefs and contribute to the incidence of coral disease (Fitt et al. 2000, 2001, Smith 2001, Denner et al. 2003, Lasker 2003, 2005, Duval et al. 2004)

Development of coral culture and storage in order to promote restoration of damaged coral reefs as well as establishing corals as "model" systems for biological and physiological study (Becker and Mueller 2001)

Using advanced diving techniques, to study caves and the deep fore reef (Iliffe and Bowen 2001, Lombardi 2004)

Determination of genetic diversity of and reproductive isolation among corals (Sanchez et al. 2003, Gutierrez-Rodriguez and Lasker 2004a, Levitan et al. 2004)

Long-term environmental monitoring to provide critical data that can be used to develop models to predict environmental change and associated impacts of such change (Powell et al. 2002)

Fisheries. CMRC conducted research on economically important Bahamian fisheries including the Nassau Grouper, Conch, and Caribbean Spiny Lobster. Research at Lee Stocking Island focused on life-cycles, recruitment, population dynamics, and fisheries management.

Selected Literature - Fisheries

Stoner, Allan; Davis, Martha; and Catherine Booker. (2011). Surveys of Queen Conch Populations and Reproductive Biology at Lee Stocking Island and the Exuma Cays Land and Sea Park, The Bahamas. Community Conch. www.communityconch.org

Mechanisms that regulate spatial and temporal patterns of biodiversity in various marine habitats, such as coral reefs, seagrasses, and mangroves (Dahlgren and Eggleston 2000, Hixon et al. 2002, Steele and Forrester 2002, Webster and Almany 2002, Almany 2003, Almany and Webster 2004)

Understanding of ecosystem function (Wellington et al. 2001, Smith 2004)

Effects of anthropogenic activities, including fishing, on fish populations and critical habitats (de Sylva et al. 2000, Crowder et al. 2000, Stockhausen et al. 2000, Lipcius et al. 2001, Choat et al. 2003)

Critical fish habitat, with particular emphasis on habitats that influence recruitment (Dahlgren and Eggleston 2000, Hixon et al. 2002, Serafy et al. 2003, Adam and Ebersole 2004)

Long-term oceanographic and climactic conditions, which are critical in the development of realistic simulation models that will predict future conditions (Wellington et al. 2001)

Life histories and associated requirements of economically and ecologically important species (Dahlgren and Eggleston 2000, 2001, Wilson and Meekan 2001)

Effects of fishing on trophic interactions (Adam and Ebersole 2004, Almany 2004, Almany and Webster 2004)

NOAA Miami Regional Library
Selective Bibliography: Lee Stocking Island, Exuma, Bahamas

The NOAA Miami Regional Library has a selective list of research available public viewing on its website: http://www.aoml.noaa.gov/general/lib/CREWS/cmrc3.htm. The list of publications is provided below.

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