Environmental and Social Impact Assessment – Nikki Beach Resort

Prepared for Muqali Ltd

Prepared by Holly Trew Ph.D. (Project ESIA Lead)

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Jolly Harbour, Antigua

Prepared for Muqali Ltd

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DISCLAIMER: This document has been prepared based on the ToR provided to the preparers, and on several technical reports and information provided by the client's representatives including e.g., architectural, hydrodynamic, drainage and engineering. The preparers of the ESIA have taken this external information at face value, and against known factors and international standards where possible. The preparers of this ESIA are not responsible for the accuracy of the information provided by the client. The ESIA is organized into sections as outlined in the ToR and with the external consultants' reports attached as appendices.

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EXECUTIVE SUMMARY

Muqali Ltd submitted a G-application (#G12-2023) to the Development Control Authority (DCA) of Antigua and Barbuda for construction of the Nikki Beach Hotel. Based on a site visit by the Department of Environment (DoE), the DCA issued a Terms of Reference (ToR) for an Environmental and Social Impact Assessment (ESIA) on November 26, 2023. Deborah Brosnan & Associates was asked to complete this ESIA by Muqali Ltd. During the assessment, the DCA and DoE were consulted to understand the required scope and detail necessary for the ESIA document. The ESIA completed here follows the format and topics requested in the ToR provided.

Muqali Ltd proposes to build the Nikki Beach Hotel on Jolly Beach in the Jolly Harbour development. The development will be managed by North Sound Projects Ltd. The development will be constructed on a 16.4-acre plot, on a site currently occupied by the northern half of the Jolly Beach Resort and Spa (the southern half will remain separate and operational) and the Bodog Beach Club. It will include 184 residential units, 82 guest rooms, beach club, restaurants, a spa, and other amenities. The developers aim to create a luxury resort, spa and beach club that delivers an exquisite and unrivalled guest experience.

The developers propose to maintain an electrical service from the Antigua Power Utility Authority and all on-site electricity distribution will be underground. During the construction phase, potable water will be supplied by Jolly Harbour while the operational hotel will create potable water on site via reverse osmosis. All wastewater will be treated on site using a decentralised package membrane bioreactor treatment plant. Clear water effluent will be used on site for irrigation.

Direct benefits of the project will include increased high-end tourism within the Jolly Beach area, which will benefit local businesses including restaurants, vendors and taxi operators. The developers have committed to use locally sourced building material, purchase from Antiguan businesses, and employ Antiguan workers where possible. Up to 500 workers will be employed during construction and operational phases of the development and locals will be employed where possible. These local jobs will benefit the Antiguan economy and the wellbeing of Antiguan residents.

The ToR identified hydrology and drainage, storm surge and coastal flooding, and socio-economic concerns as the main factors to address in the assessment. A summary of the main impacts and mitigation measures is included in Table 0.1.

To minimise the impact of stormwater runoff, the development will construct an extensive drainage system with subsurface components (e.g. pipes) and surface components (e.g. gutters, drains, curbs). The land will also be graded and raised slightly to remove current low-lying areas where runoff accumulates. The current hydrology and drainage of the site was assessed by Harris Civil Engineers, and current drainage infrastructure and low-lying areas were identified. The drainage canal is degraded, closed off from the sea and contains stagnant water and garbage. The developers propose to close it up completely. The stormwater management assessment was completed by the Thompson Ehle Company. Based on a 50 year – 24 hour storm, they determined that a number of low impact development practices, such as swales, boreholes, and soakaways, should be constructed. The frequency of these structures and pipe widths were determined based on predicted runoff volumes for a 25 year 6 hour storm. Peak discharge was calculated for each sub-basin using the rational method model with the addition of a 10% increase in flow rate to account for climate change. Less frequent and more extreme rainfall events were not factored into the design.

Site-specific hydrodynamic modelling indicated that a finished floor elevation (FFE) of +2.4 m and a setback of 30 m from the Line of Permanent Vegetation are recommended based on a worst-scenario 100-year storm under present day conditions (sea level rise was not included, apparently per client request to ATM Engineers).

The current proposed FFE is +2.44 m, which is sufficient but does not include any factor of safety. The current site local survey datum (LSD) is +1-2 m and is vulnerable to storm surge, where present day 100-year storm surge was predicted at +1.34 LSD. Stabilizing vegetation should be planted to enhance sand dune systems and help reduce risks associated with coastal hazards.

The numerous stakeholders who currently use the development site include vendors selling souvenirs and food, taxis, locals and tourists to access the beach, and Sandra's Beach Shop, Bar and Grill. Sandra's Beach Shop, Bar and Grill is a semi-permanent structure that has been present on the beach in front of the development site for more than 10 years. The client informed us that they are in communication with the GoAB with regards to the relocation of this establishment. The socio-economic group specifically identified in the ToR are the vendors. The client informed us of significant and advanced discussions within the GoAB to create a vendor village to enhance tourism, provide greater economic opportunities for vendors and improve facilities. Because this is a separate and ongoing effort, we were informed by the client's representative that further activities and studies were not the responsibility of the client but involve the GoAB and the local community. Our baseline observations of beach user activities are reported and if vendors are provided with a new location, it should include additional amenities such as permanent, locking structures, dedicated running water and toilet facilities, and consistent and reliable access to the tourism market.

Table 0.1: Summary of main impacts and mitigation measures. These are detailed in Section 6.0.

Area	Description	Mitigation measures
Physical	Water quality	Minimise runoff; dust suppression; safe disposal of waste materials; regular water quality testing (in EMMP)
	Noise pollution	Construction restricted to daylight hours; music from Beach Club maintained at reasonable level; regular noise monitoring (in EMMP)
	Light pollution	Construction predominantly in daylight hours and operational hotel will be similar to the present site.
	Beach erosion	Prevent erosion by stabilizing the upper elevations of the beach with native, dune plans; protect topsoil and sand from wind/runoff erosion;
	Air quality	Dust suppression; haulage routes on sealed roads, cover truck loads; plant vegetation
Biological	Effects on native vegetation	No primary native assemblages present; preserve native tree and plant species protected under the EPMA (2019).
	Terrestrial wildlife	No protected species recorded; mobile wildlife will recolonize the area after construction
	Marine wildlife	Train workers to identify and report nesting Hawksbill sea turtles.
	Seagrass health	Control sediment and nutrient runoff
Socio-economic	Human health	Enforce health and safety protocols for construction crews; limit dust and noise as much as possible; precautions against mosquito breeding.
	Relocation of vendors	Proposed vendor village in collaboration with the GoAB; installation of permanent structures for vending.
	Public beach access	Public beach access to Jolly Beach will be maintained on the south end of the property.
	Housing for workers	Employ local workers where possible

No potentially significant ecological impacts of the development were identified, in part because the site contains a pre-existing hotel and restaurant, and Jolly Harbour itself is an extensive urban environment. The site itself is not environmentally pristine; it contains multiple buildings that are derelict or in need of repair, there is trash and garbage around the site and the drainage canal. Vegetation consists of ornamentals and several individual native (9 species) and protected species (5 species). The locations of individual plants were recorded and will be salvaged and/or preserved where possible. The nearshore habitat is comprised of sand and dynamic seagrass habitats. There will be minimal or no impact on these by controlling runoff and erosion from the site.

An Environmental Monitoring and Management Plan (EMMP) has been developed to ensure the proper procedures are in place for compliance with health and environmental standards and regulations. The EMMP outlines plans for biodiversity management, sewage treatment, stormwater runoff, socio-economic management, noise and air quality management, and disaster management.

1.0 INTRODUCTION

Nikki Beach Hotels (Muqali Ltd.) proposes to develop the existing Jolly Beach Resort and Bodog Beach Club into a Nikki Beach Hotel. The development will be managed by North Sound Projects Ltd.

The land area of the development is 16.4 acres in Jolly Harbour on the western coast of Antigua. The development will be situated on an area currently occupied by part of the Jolly Beach Resort and Spa, bordering both Jolly Harbour Marina and Jolly Beach. This area is zoned for tourism under the Sustainable Island Zoning Resource Management Plan (SIZRMP, 2011).

The proposed development will include 184 residential units, 82 guest rooms, beach club, restaurants, a spa, and other amenities. The development has committed to natural preservation and the design aims to draw from nature. As a luxury hotel brand, this Nikki Beach Hotel has state it will increase the high-end tourism with the Jolly Beach area, which will benefit local businesses including restaurants, vendors, and taxi operators.

Muqali Ltd. submitted Application G12-2023 to the Development Control Authority (DCA) for the project. Based on a review and site visit by the Department of the Environment, the DCA issued terms of reference (ToR) for an EIA. Muqali Ltd. requested Deborah Brosnan & Associates complete the EIA studies and report. This document fulfills the EIA requirement for the project and in accordance with the ToR.

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1.1. Environmental Legislation and Standards

Physical Planning Act (2003)

Under the Physical Planning Act of 2003, the Development Control Authority (DCA) is given the authority to approve applications for development and to manage the Environmental Impact Assessment (EIA) procedure.

Sustainable Island Resource Management Zoning Plan (2011)

The SIRZMP provides guidance to sound socio-economic and physical development in Antigua and Barbuda and provides guidelines to current and proposed zoning management plans for future tourism projects.

Environmental Protection and Management Act (2019)

The EPMA provides for sustainable environmental protection and management of natural resources, to allocate administrative responsibility for the management of environmental matters; to give effect to Antigua and Barbuda's treaty obligations with respect to the environment and to provide the framework financial mechanism to satisfy the requirements of the Act and for other related matters.

Beach Protection Act (1957) and Amendment (1993)

The Minister of Public Works is authorized under the Beach Protection Act to issue permits before the removal of any sand, shingle, or gravel from beaches.

Beach Control Act (1959)

The Government of Antigua and Barbuda Cabinet is granted the right to make decisions in the public interest with respect to the use of lands adjoining the foreshore for public recreational purposes.

Disaster Management Act (2002)

An Act to provide for the effective organisation of the preparedness, management, mitigation of, response to and recovery from emergencies and disasters natural and man-made in Antigua and Barbuda. Implemented by the Director of Disaster Preparedness and Response.

Public Health Act, CAP 353 (1957)

The Central Board of Health, Public Health Act CAP 353, has authority to regulate issues affecting public health, including operation of hotels and restaurants, storage and disposal of refuse, and discharge of treated effluent into marine water bodies.

Public Utilities Act (1973)

The Antigua Public Utility Authority (APUA), under the Public Utilities Act, has the authority to install and operate sewage treatment plants on behalf of the government, and the administration of potable water for government/private purposes.

Pesticide Control Act (1973)

The Pesticide Control Board is given authority to control the importation and use of chemicals for agriculture and landscaping. This includes storage of chemicals to protect workers as well as the application of chemicals for the interest of adjacent landowners.

Fisheries Act, CAP 173 (1984)

The Fisheries Division, under the Ministry of Agriculture and Fisheries, is responsible for the management of marine resources and commercial fisheries. This includes authority over established marine reserves to protect ecological integrity of flora and fauna, to promote scientific research, and preserve the natural beauty of marine areas.

Coastal Development Setback Guidelines in Antigua and Barbuda (1998)

Coastal setback guidelines for all construction in Antigua and Barbuda. This provides a standard framework to be applied by the planning authorities in Antigua and Barbuda with the aim of facilitating coastal development while reducing beach erosion.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1975)

An international agreement between governments with the aim to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species.

Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean (Escazú Agreement) (2018)

An international agreement among Latin American and Caribbean nations concerning the rights of access to information about the environment, public participation in environmental decision-making, environmental justice, and a healthy and sustainable environment for current and future generations.

2.0 PROJECT DESCRIPTION

Muqali Ltd. proposes the construction of a Nikki Beach Resort in Jolly Harbour, on the western coast of Antigua. It has been proposed as a luxury hotel that draws inspiration from the natural environment in its design and has committed to natural preservation and the design aims to draw from nature. As a luxury hotel brand, this Nikki Beach Hotel will increase the high-end tourism within the Jolly Beach area, which will benefit local businesses including restaurants, vendors, and taxi operators.

The proposed development will include a hotel, villas, beach club, a signature restaurant, a spa, and other amenities. Traditional hotel guestrooms will specifically include 20 standard rooms, 36 lux rooms, 18 signature rooms, 2 suites and 6 signature suites. Larger apartment-style rooms will include 16 studio units, 45 1-bedroom units, 74 2-bedroom apartments in three different styles, and 40 3-bedroom apartments in three different styles. There is also 1 3-bedroom villa and 4 4-bedroom villas planned for the southern side of the property. This breakdown is represented in Table 2.1.

Table 2.1: Proposed hotel room breakdown for the development

Description		**Rooms/Buildings**
	Studio	16
	1 Bedroom	45
	2 Bedroom, Style A	22
	2 Bedroom, Style B	12
Residences	2 Bedroom, Style C	40
	3 Bedroom, Style A	6
	3 Bedroom, Style B	20
	3 Bedroom, Style C	14
	Villas	5
	Lux	36
	Signature Room	18
Hotel	Signature Suite	6
	Standard Room	20
	Suite	2

The site is currently still operational as Jolly Beach Resort and Spa until March 2024. Once approval for the development is granted, all structures currently on site will be demolished. Construction of the proposed development is planned for early 2025 and aims for the hotel to be operational by 2028.

Figure 2.1: Model view of the proposed Nikki Beach Resort

Figure 2.2: Model view of the Beach Club

2.1. Project details

2.1.1 The initial state of the land

The project site includes land parcels 408, 410, 540, 541, 543, 544, 836, 837, 846 and 847, representing a total area of 16.4 acres on the western side of Jolly Harbour, Antigua, adjacent to Lignum Vitae Bay.

The land is currently occupied by the operational Jolly Beach Hotel and Spa. The Jolly Beach Hotel will continue to operate to the south of the development site. Several of the hotel buildings on the development site are currently derelict. All the current buildings on the site will be demolished except for one on the southern border that overlaps with the area of Jolly Beach Hotel, which will remain operational.

The objective of the project is to create a luxury resort, spa and beach club that delivers an exquisite and unrivalled guest experience and set a new standard of hospitality for Antigua. The goal of the developers is to design a development that will be more than just a destination; it will be an immersive experience that merges architecture with nature, while celebrating the essence of luxury, elegance, and authentic beauty. The design favours the sea view and direct access to the beach inside a generously planted space.

2.1.2 Demolition and land development

The construction phase of this development will require the initial demolition of all existing buildings and the removal of solid waste materials from the site. Existing below-ground infrastructure for plumbing and sewage may also be removed at this time. For the duration of the demolition and construction phases, construction hoardings should be erected around the perimeter of the property for the protection of the surrounding environment and persons, as well as general security.

During clearance of the land, site soil disturbance activities will be limited as much as practical to avoid generation of erosion and sediment transport. All clearing, grubbing and soil storage operations and areas will be delineated on the plans for limits of operation. An estimate of topsoil volume to be stockpiled will be coordinated with the Landscape Architect and shown on the plans.

The client independently decided to conduct an asbestos assessment on property. Green Engineering Limited (GE) was contracted by BCQS International (BCQS) to conduct presumptive asbestos sampling and analysis at the Jolly Beach Resort /Tranquillity Bay Resort. As additional information beyond the ToR, the report is included in Appendix 10. Of note, no asbestos was found in any of the property development buildings. However, there is asbestos in the roof of a building immediately adjacent to the property line and connected to one of the existing buildings within the property boundary. The client is addressing this matter separately with the neighbouring property and the government. The report identifies that any work with asbestos, regardless of who is conducting it, should be done by a certified asbestos abatement contractor.

2.1.3 Construction

The buildings are generally west facing within the site, taking advantage of the prevailing easterly winds for cooling.

All building foundations and pools rely on reinforced concrete and concrete. Concrete and other building materials will be locally sourced where possible. Local stone and wood building materials will be used where possible, but building materials will be imported if not available locally.

2.1.4 Landscaping

There are many opportunities to incorporate native plants into the landscaping design. These plants are adapted to the local environment and require less water and fertilizer to maintain. Along the beachfront, clusters of native vegetation can be planted to revegetate the top of the beach and provide sea turtle nesting habitat, which are discussed in detail in the Impacts and Mitigation sections.

A plant nursery should be started on site to provide a location for salvaged protected and local species to grow during the construction phase. This will also allow for easy landscaping when appropriate and save costs in purchasing plants.

2.1.5 Accesses to the property

Public access to the property by pedestrians will be maintained via a 5-foot-wide path at the southern end of the property.

2.2. Resource use and waste products

2.2.1 Electricity

New primary electrical service will be obtained from Antigua Power Utility Authority (APUA) via new overhead primary feeder which will be transitioned into an underground service at a new utility pole located within the site. The APUA primary line voltage will be 11kV and terminated at the main electrical room at the back-of-house building. The 11kV primary feeders will then be distributed to the villas, hotels, apartments, beach club, spa, and parking garage buildings creating a loop. On a development of this type, overhead electricity cables are aesthetically unappealing, so the electricity distribution system within the development is consisted of buried cables installed within PVC pipes. Manholes will be constructed in this system to facilitate the installation of cables and to allow access to the cables for maintenance or repair. Due to frequent power outages on this site, an emergency power system will be provided using multiple diesel generators running in parallel.

2.2.2 Water

During the construction phase, water will be supplied to the site by Jolly Harbour. A meter will be installed, and all water will be paid for.

For the operational hotel, potable water will be created on site via reverse osmosis, and there will be no draw on the mains water supply. It is proposed that water will be supplied to the site from deep-water wells and deep-water injection wells. Storage of enough potable water for two days and a fire cistern reserve is planned. The potable water supply shall be designed to supply the peak domestic demand and consider the entire build-out in accordance with the approved Site Plan for development.

2.2.3 Sewage

In Antigua, water and sewage responsibilities are outlined in the 1973 Public Utilities Act. A sewer system will be built across the extent of the development in accordance with national standards. Wastewater will be treated on site using a decentralised package membrane bioreactor (MBR) treatment plant. MBRs utilize a specifically designed chamber to support a biologically active environment where bacteria and protozoa grow and consume substances in raw wastewater. Membranes act as a solid-liquid separation device to retain biomass within the bioreactor while treated effluent is released. Overall, MBR systems are very efficient, and produce a high-quality effluent widely acknowledged to surpass environmental standards.

The sewer peak load will be 116,000 GPD. Clear water effluent will be stored on site in a proposed grey water tank and used for irrigation of green areas. The effluent treatment level shall be compatible for unrestricted landscape irrigation or street cleaning with a minimum of 10 mg/l BOD and 10 mg/l TSS. To control algae formation in the reused water, treatment will also need to meet a phosphorus effluent limit of 0.3 mg/l. It is currently understood that sludge will be disposed of offsite, but this is still to be determined.

Typically, the client would provide additional information including the estimated daily wastewater production at full occupancy, as well as the volume of sludge produced by the treatment plant. However, at the time of writing, this information is not yet available from the client. The client has requested that this ESIA be completed in a timely manner, based on their own schedule. Consequently, we are completing this ESIA with information that has been provided to us and identifying those areas which have yet to be determined. Should any of the additional information be made available, it can be submitted as an annex or DoE/DCA can request the information from the client.

2.2.4 Roadways and parking

The main entrance to the current resort will be maintained in the new design. Roads and parking areas will be excavated to subgrade elevations as indicated on the grading plans and as defined by the thicknesses indicated on the paving details. Subgrade will be prepared and compacted according to the geotechnical report recommendations. Aggregate base will be placed and compacted. Asphaltic binder course and surface course will be placed and compacted. Pavement thicknesses will be as recommended for heavy duty and light duty traffic areas. Materials specifications will be based on local standards and available materials.

There will be approximately 150 parking spaces to accommodate guests and staff members, both on ground level and in a basement parking garage.

2.3. Essential maps to be provided with the application

Figure 2.3: Master plan of the proposed Nikki Beach Hotel development.

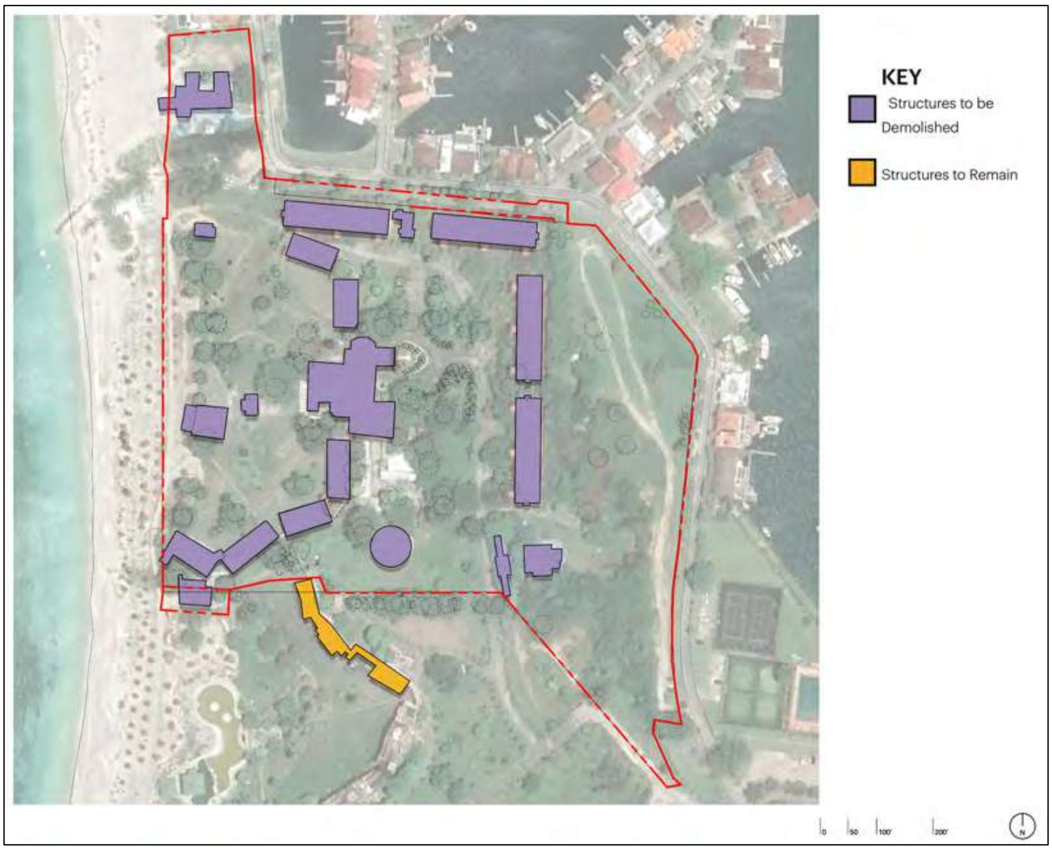

Figure 2.4: Map of existing structures to be demolished.

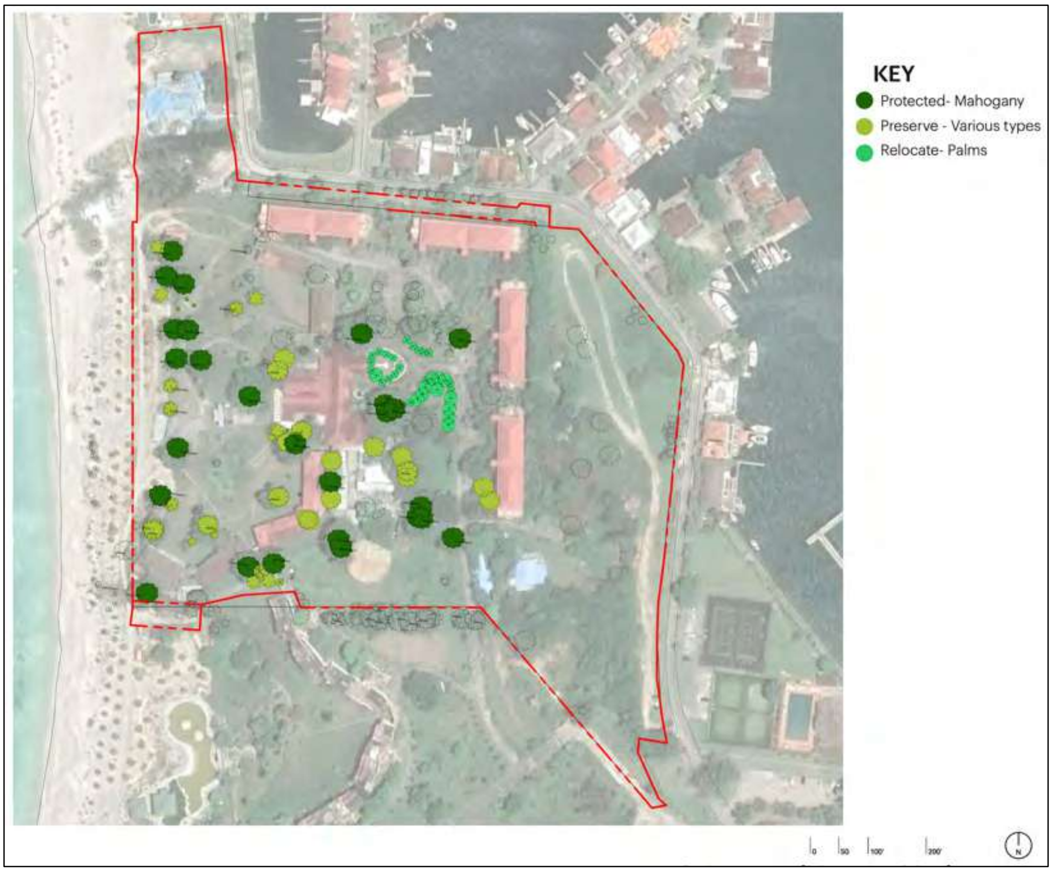

Figure 2.5: Map of trees to be preserved during the development.

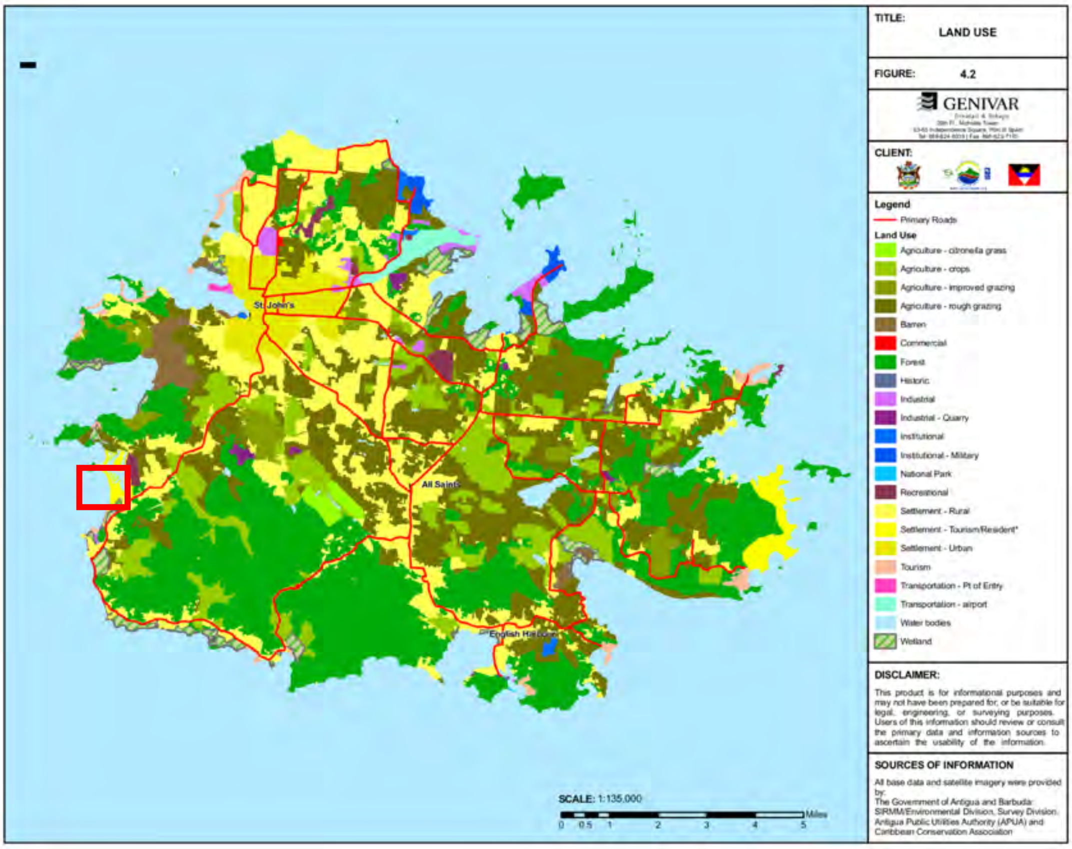

Figure 2.6: Current Land Use in Antigua showing the project area in the red box.

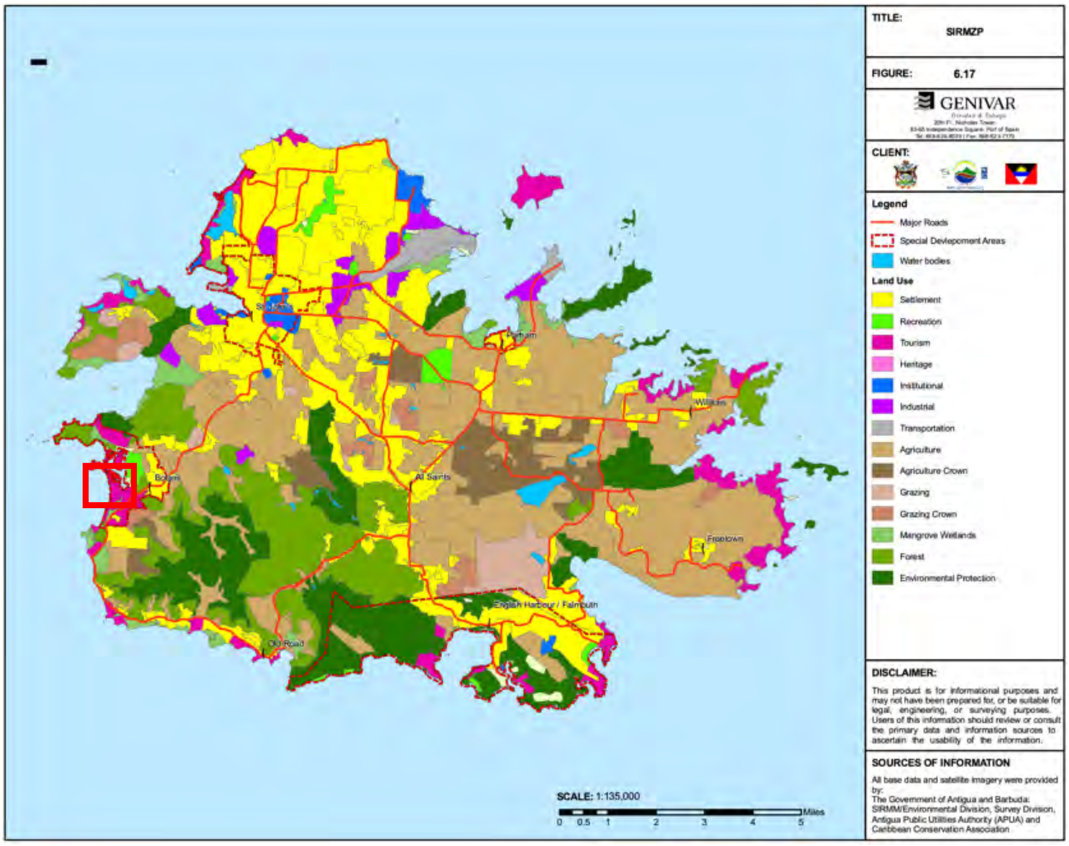

Figure 2.7: Sustainable Island Resource Management Zoning Plan for Antigua showing the project area in the red box.

2.4. Project benefits

There has been an increasing focus on sustainable development in Antigua over the past fifteen years. Sustainable practices have been incorporated into the Nikki Beach Resort design via the use of passive solar protection and re-use of treated wastewater for irrigation.

Jolly Harbour is a highly developed area comprised of the Jolly Harbour development, which includes a marina, numerous homes, and public areas with shops and restaurants. There are currently two hotels within Jolly Harbour and several other hotels and many private homes within 5 km.

The current hotel is regarded as being in poor condition and detracting from the aesthetics. The addition of a luxury hotel like Nikki Beach Hotel will provide increased revenue for Jolly Harbour overall. The hotel can provide employment for local Antiguans and will require suppliers of high-end products imported or provided by local businesses. The hotel appeals to wealthy clientele and all businesses in Jolly Harbour can benefit from this higher earning potential.

A large hotel development such as this one also provides many jobs for workers of different skills, both in the construction and operational phases. The developers estimate that up to 500 workers will be employed in both stages. Antiguans will be employed to fill these positions where possible.

2.5. Analysis of alternatives (technology & sites)

There were no alternatives considered for the Nikki Beach Resort development. The site is already in use as a hotel, and the land usage remains the same.

A variable primary chilled water system will be utilized to serve the cooling needs to buildings and will include three 400 tonne water-cooled chillers and cooling towers. A geothermal system has been considered as an alternative system and will be utilized if site suitability has been verified. Tonnages would be the same as above.

No other sustainability measures, e.g. photovoltaic panels, solar water heaters, or green roofs have been considered.

3.0 METHODOLOGY

Conditions of the Nikki Beach Resort site were assessed using a variety of methods. Desktop analysis of existing published and historical information about Antigua and Jolly Harbour provided context for the project and data for specific analyses.

Data was also collected on site to assess baseline vegetation, water quality and noise levels. The vegetation assemblages and plant diversity, specifically of protected or sensitive plants, was recorded during *in situ* surveys. Any native birds or wildlife were also recorded at this time. Water samples were collected from the marina, drainage canal and sea to assess quality of the water in these zones.

Information about the development and drawings were provided by the developers.

Presumptive bulk asbestos sampling and analysis of the Jolly Beach Resort was performed by Green Engineering Limited. The on-site asbestos materials survey was conducted in accordance with the asbestos standards: (1) ASTM E2356 – Standard Practice for Comprehensive Building Asbestos Surveys, and (2) OSHA Construction Industry Standard 29CFR 1926.1101. Laboratory PLM analysis was conducted by an accredited laboratory (EMSL Analytical Inc.). The test procedure was in accordance with USEPA's method 40CFR 763, Subpart F, Appendix EPA/600/R-93/116 and is described in the Construction Industry Standard 29CFR 1926.1101. The investigation focused on the inspection of building materials that may be presumed to be asbestos containing including: roof sheeting, interior/ exterior ceiling tiles, vinyl floor tiles and mastic cement, siding panels/ partitions, HVAC ducting insulation, air handler rooms, and other miscellaneous construction materials.

The analysis of current drainage infrastructure for this development and ESIA were performed by Harris Civil Engineers. The work consisted of a site visit to describe the existing infrastructure and on- and off-site drainage conditions under the current state of the site.

Hydrological assessment of the site and analysis of drainage pre- and post-development was performed by the Thompson Ehle Company, a civil engineering company. The application Hydraflow Extensions and The Urban Hydrology for Small Watersheds TR-55 Method were utilized to assess the site's topography, drainage systems, and roadways to calculate peak discharge rates pre- and post-development. Peak discharge was compared pre- and post-development and drainage structures were designed and sized to accommodate the runoff predicted by these rates. All calculations were produced following the Antigua and Barbuda Drainage Code and Guidelines dated November 2022 methodology for a Type A -Stormwater Management Approval.

The coastal hazard analysis and hydrodynamic study for this development and ESIA were performed by Applied Technology & Management (ATM), a Geosyntec company. The work consisted of site visits and onsite data gathering, as well as external data sources, which include satellite and Esri ArcGIS data. All modelling undertaken simulated a 100-year storm under current, present day conditions and without including SLR. Offshore wave conditions were assessed from NOAA's WaveWatchIII Model (WW3) hindcast, a model that has been thoroughly tested worldwide. The CEDAS SBEACH numerical model was used to determine maximum wave crest elevations, runup, and resulting base flood elevations (BFEs) at the site. The SBEACH model was used to simulate storm waves, water levels (including wave setup), and cross-shore beach and dune erosion along two (2) selected transects at the project site.

4.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

This Environmental and Social Impact Assessment is required by the Physical Planning Act (PPA) (2003). The project is required to follow environmental regulations including those under the Environmental Management and Protection Act (EMPA) (2019) and the Sustainable Island Resources Zoning Management Plan (SIRZMP) (2011), as well as regulations governing protected wetlands and mangroves. In addition, because of the DoE and DCA's stated focus on climate resilience including in relation to sea level rise and storm surge (and as communicated to us by DoE), determining appropriate and risk-managed setback and elevations are an important consideration.

5.0 ENVIRONMENTAL BASELINE

Antigua is an island located in the Leeward Islands on the Barbuda Bank. It has an area of 281 km^2 with 87 km of coastline. The climate is tropical-maritime, with a mean annual temperature of 26°C, ranging between 16.7 to 28.3°C (WorldBank, n.d.-b). Annual precipitation is approximately 1100 mm but is variable throughout the year. The main rainy season is between October and November annually. Antigua is an above-water limestone “cap” of a now inactive volcano and has a karst limestone landscape. The west and southwest of the island is comprised of volcanic mountains rising to 402 m above sea level, the highest elevation on the island. Ecologically, the island is surrounded by scattered coral reef and seagrass ecosystems (Figure 5.27).

Jolly Harbour marina and adjoining lands were created by the dredging and landfilling of 53 acres of mangroves and wetlands, including Jolly Hill and Yorks salt ponds and mangrove swamps. Construction began in 1988 and Jolly Harbour was completed in 1992. The area now includes an all-inclusive hotel, many high-density apartments and villas oriented towards tourists and non-residents, as well as a golf course, shopping centre and marina. The large white sand beach of Jolly Beach made the area appealing for development, but the removal of the salt pond and wetland and subsequent construction of the marina had extensive environmental impacts. High turbidity, coral mortality and sedimentation of seagrass and algal beds were all noted (Baldwin, 2000; de Albuquerque 1991). Visibility in Lignum Vitae Bay was reduced to 2-4 m from previously clear water and sediment from the construction was identified as the source of mortality of the reef in Mosquito Cove and Reeds Point. By 1995, the terrestrial and marine environment of Lignum Vitae Bay was significantly degraded (de Albuquerque & McElroy, 1995).

Currently, Jolly Harbour is a hub of tourism. Jolly Beach is a large white-sand beach with calm waters that are popular for swimming. The beach is used both by the local community and by tourists and non-residents especially those staying in Jolly Beach Hotel and private houses within the Jolly Harbour community. The marina is also well used for permanent and transient boats and yachts, and the haul out facility for dry storage attracts many boaters

The area has limited space for expansion due to geographical constraints.

5.1. Physical Environment

5.1.1 Geomorphology

The west and south of the island is characterised by the rock unit known as the Basal Volcanic Suite (BVS). This was formed 33-23 million years ago and is comprised of lava flows and pyroclastic rocks, primarily characterized by calc-alkaline volcanic rock such as dacite and quartz basalt or andesite, as well as limestone lenses, agglomerate and tuff (Donovan et al., 2014). This substrate is represented as ‘Sandstone, Conglomerate & Shale’ in Figure 5.1.

The development site is a flat shoreline area that falls entirely between the 1 m and 2 m topographic contours (full topographic survey diagram in Appendix 1).

Soil observed at the site contained many shell fragments (Figure 5.2).

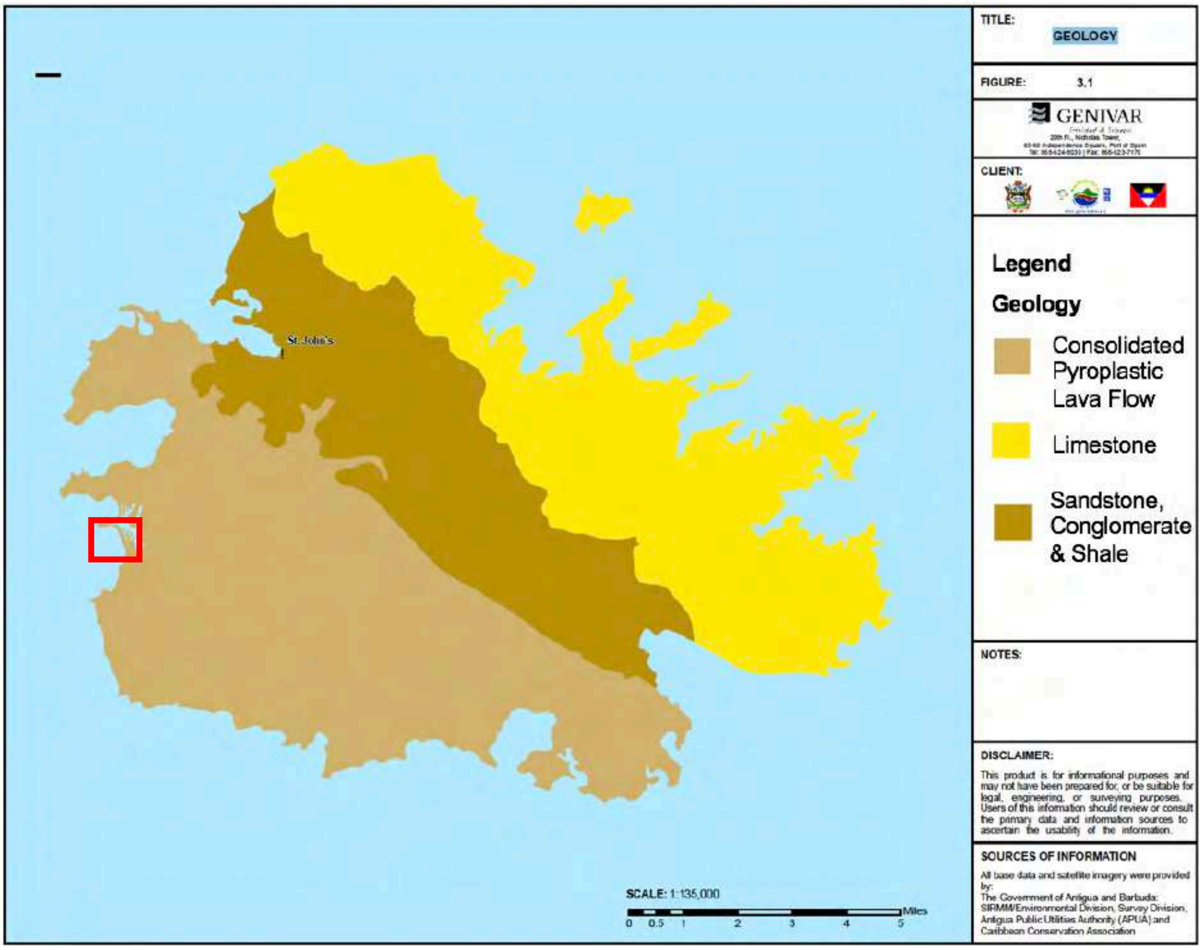

Figure 5.1: SIRMZP Geology Map of Antigua where showing the project area delineated in red.

Figure 5.2: Shell soil observed in the meadow on the eastern side of the site

5.1.2 Meteorology (rainfall, wind, waves, and tides)

Antigua has a tropical climate that is hot year-round. Average daily temperature in Antigua and Barbuda averaged 26.41°C from 1901 until 2021, reaching an all-time high of 27.5°C in 2010 and a record low of 25.2°C in 1913. (WorldBank, n.d.-b).The prevailing winds are from the east with average wind speeds of 20 km/h.

Precipitation in Antigua and Barbuda averaged 1048.83 mm from 1901 until 2021, reaching an all-time high of 1361.70 mm in 2008 and a record low of 666.20 mm in 2015 (WorldBank, n.d.-a). Most recent data showed 880.90 mm of rainfall in 2021, and 1003.80 mm in 2020. The wet season is officially between June and November annually, although this may vary inter-annually.

The Caribbean Sea, including Antigua, has a micro-tidal range, which mostly varies between 10-20 cm. The tide is primarily mixed semidiurnal or mixed diurnal.

5.1.3 Sea currents and bathymetry

Antigua is an island located on the Barbuda Bank and is surrounded by waters shallower than 20 m (Figure 5.3). At the edge of the Bank, the bathymetry steeply slopes away to more than 500 m depth. Jolly Harbour and Lignum Vitae Bay are characterized by the shallow waters and flat bottom of the top of the Bank.

Figure 5.3: Bathymetric map of Antigua's waters (ArcGIS Online)

5.1.4 Surface hydrology and drainage

For this development and ESIA, Harris Civil Engineers (HCE) were contracted by Muqali Ltd to perform an evaluation of the existing drainage infrastructure on site (pre-development), while Thompson Ehle Company (TEC) were contracted to assess and analyse existing and proposed drainage patterns and identify specific drainage infrastructure to be implemented.

The report by HCE records observations from a site visit and delineates the existing development infrastructure and drainage areas. These are identified in Figure 5.4. Field observations were visual in nature and did not include any testing, underground excavations, or other invasive means and methods of evaluation. HCE found that there were a variety of drainage-related structures present on the site in various states of functionality. Stormwater runoff was found to accumulate in low-lying green areas. Ultimately, the developers plan to demolish all existing buildings and associated infrastructure and utilities on the site. The new resort concept will grade the site and install and route applicable utilities to service the proposed development.

The full technical report and recommendations are summarised in Sections 5.1.4.1-5.1.4.3 below and presented in Appendix 3.

The report by TEC presents the site drainage evaluation based on the site's topography, drainage systems, roadways and the existing and proposed development. Based on a 50 year – 24 hour storm, TEC showed an increase in peak flow of less than 5% between pre- and post-development conditions, and no SWM Detention facilities are required. Thus, low impact development (LID) practices were designed to manage stormwater by minimizing impervious cover and by using natural or man-made systems to filter and recharge stormwater into the ground. These LID structures include naturally shaped swales with minimum slopes and filtration strips, soakaway inlet structures to promote infiltration and ground water recharge, and borehole structures connected to impervious structures to inject runoff to the water table, reducing peak flows and recharging the groundwater levels. Erosion will be controlled using best management practices (BMPs), which will be implemented during the construction phase.

The full technical report and recommendations are summarised in Sections 5.1.4.4-5.1.4.6 below and presented in Appendix 4.

Based on the information that has been shared with us, we provide the details on the current and planned site drainage below.

5.1.4.1. HCE – Existing site infrastructure observations

All observations were made during the site visit on March 26, 2024. The following infrastructure features were present at the time of the survey:

- **4 large, 3-story buildings** along the eastern and northern boundaries that were dilapidated, overgrown and no longer in use.

- **Utility piping and a water meter** near the current guard house at the property entrance.

- **Concrete roadways and pathways, as well as paver walkways** were present throughout the property. The roadways had curbs to help direct runoff, and these commonly had purpose-built cut marks and/or holes to convey drainage to landscaped areas. The concrete walkways showed evidence of cracking and patching, as well as washout and undermining due to erosion.

- **An above-ground water tank** which contained water at the time of the site visit but was not in use. There was some overgrowth by vegetation observed. The tank was connected by a pipe to an above-ground cistern, but this cistern was not assessed and it is unknown if it was in use. HCE did not confirm the operation of any pumping systems.

- **A sanitary lift station** was located near the gazebo. Another lift station was located at the northeastern corner of the property, but the Site Representative relayed that said lift station does not service the property but instead services the surrounding marina development.

- **An elevated electrical substation** was located in the northwest corner of the property.

- **Several above-ground concrete structures/vaults** were located around the site. Many were inaccessible and HCE did not determine the nature of said vaults or if they contained operating utilities.

- **A short rock wall** to delineate the property from the public beach along the western boundary line. The wall appeared aesthetic rather than as a functional retaining wall.

- **A 6-foot block wall** on the north side of the property adjacent to the public beach access.

5.1.4.2. HCE – Drainage evaluation for existing conditions and on-site drainage

Several drainage infrastructure features were documented during the site visit, including stormwater inlets, roof gutters, above-ground header pipes, a flushing channel, as well as vaults and stormwater pumps.

Stormwater inlets were located within the roads and/or drive aisles. Many of these were filled with sediment and debris. HCE was unable to determine if the structures were connected via piping system, if the inlets acted as exfiltration boxes, or if they were connected to a larger stormwater system.

The buildings had roof gutters and above-ground header pipes for roof drainage. These were in varying conditions where some were operational, and others had large sections of damage, loss or overgrowth by vegetation. The downspouts of the gutters did not appear to tie into a larger drainage system. Where the gutters were damaged, stormwater sheeted off the roof directly to the ground, in some cases causing erosion of walkways. Some gutters connected to header pipes, but it was not clear where these pipes route or discharge to.

A flushing channel connected to Jolly Harbour Marina was present at the northwestern corner of the property via concrete culverts. Its intended purpose was to connect the marina to the ocean, but as the area has been dammed by sand it no longer performs this function.

No defined stormwater pond or runoff attenuation area was present, but runoff appeared to accumulate in low-lying grassed or landscaped areas. The low-lying areas appeared to be intentional to allow stormwater to collect and percolate into the ground. All structures and beach frontage are elevated higher than these areas, effectively containing the runoff.

One vault on the southern property boundary appeared to be used for pumping stormwater. It was positions at the bottom elevation of a low-lying area. HCE was not able to determine if the pump was operational. There was visible piping from the vault, but it was not clear where the water was ultimately discharged.

5.1.4.3. HCE – Drainage evaluation for off-site drainage

There are additional drainage systems on Palm Beach Drive road on the north and east of the property boundary. These consisted of an above-ground, concrete lined swale and grated inlets which seemed to convey water to the marina. HCE did not evaluate any offsite drainage systems.

Figure 5.4: Jolly Beach Resort site observations exhibit (Appendix A, HCE Report)

5.1.4.4. TEC Stormwater management – Data sources and methodology

The calculations in this drainage report were produced following the Antigua and Barbuda Drainage Code and Guidelines dated November 2022 methodology for a Type A -Stormwater Management Approval.

The property is located at Jolly Harbor/ Mosquito Cove west of Palm Beach Drive. By graphical plotting only the site is on Flood Zone 1 with an annual probability of Flooding (F) less or equal to 0.001, low classification. Refer to Figure 1.1 in Appendix 4 for the Antigua Flood Zone Map and Figure 1.2 in Appendix 4 for site aerial photo.

The total drainage area for the existing and proposed development is approximately 16.43 acres. This contributing drainage area was delineated with consideration of the site's topography, drainage systems, roadways, existing and proposed development (Figure 5.5, Figure 5.6). It was then divided into sub-basins based on the same considerations as the original delineation to calculate more accurate peak discharged and isolate components contributing to the drainage structure (Figure 5.7). Within each sub-basin, design criteria were identified to satisfy the components of the USDA Urban Hydrology for Small Watersheds TR 55. The model described in TR-55 requires a rainfall amount to be uniformly imposed on the watershed over a specified time distribution. Mass rainfall is then converted to mass runoff using a runoff curve number (CN), and mass runoff is transformed into a hydrograph using unit hydrograph theory. The specific criteria required are:

1. **Hydrological soil group** – Group "C", determined from the map presented in Figure 3.1 in Appendix 4;
2. **Run-off curve numbers** – established runoff coefficients for Antigua based on hydrological soil group, land slope, vegetation and impervious surfaces are presented in Table 3.3 in Appendix 4;
3. **Surface run-off area** (A, in acres) – determined digitally for both pre-development and post-development conditions; and
4. **Time parameters based on velocities of flow** (Tc, minutes) – Rainfall intensity and distribution data was obtained from the NOAA ATLAS 14 Rainfall Data with a Type II distribution for PR and USVI.

Peak discharge rates for the site were calculated based on the design criteria using Hydraflow Extensions, which analyses the hydrologic properties of simple and complex watersheds and models entire drainage basins and detention ponds. Pre-development and post-development peak flows were compared to determine if on site detention or storage facilities were required.

The Antigua and Barbuda Drainage Code and Guidelines (November 2022) performance standard in Section 2.1.7.1 requires SWM Detention facilities to be included if the predevelopment flows are exceeded by the post development flows by 5% margin.

Drainage structures were designed and sized to accommodate the peak discharge rates calculated for the design storm per Antigua and Barbuda Drainage Code and Guidelines dated November 2022 performance standard in section 3.1.1 Figure 3.1 in Appendix 4. Peak flows for each drainage system were calculated using the rational method, which represents a steady inflow-outflow condition of the watershed during the peak intensity, where the runoff coefficient (C), or "coefficient of imperviousness", represents the ratio of runoff to rainfall. A 10% adjustment for the effects of climate change on flow was incorporated into the rational method calculation. This accounts for storm intensity that is 10% higher than present day.

Autodesk Storm and Sanitary Analysis Model was used to produce pipe sizing and profiles.

Figure 5.5: Basin delineation pre-development (Figure 2.1 in Appendix 4)

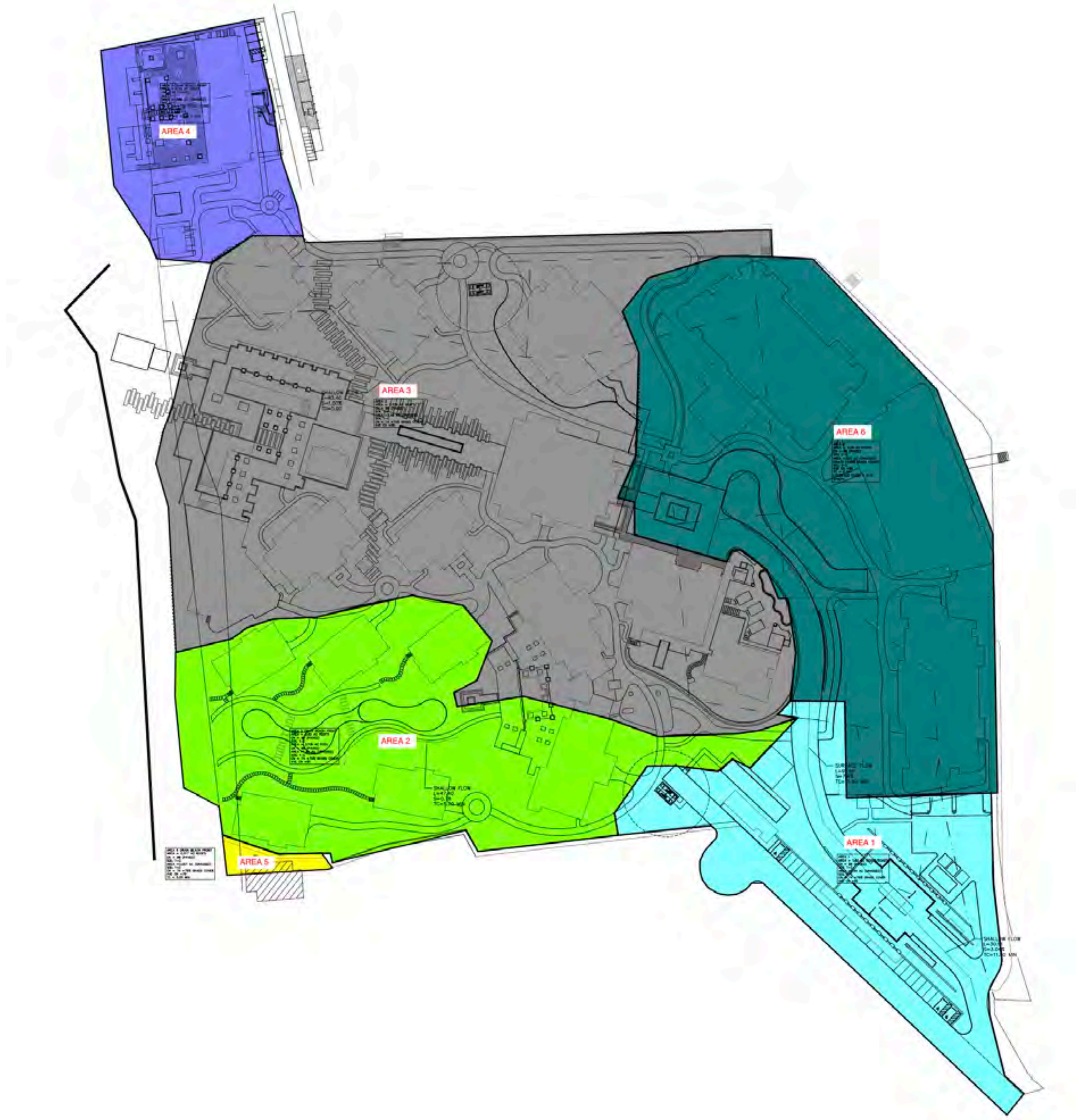

Figure 5.6: Basin delineation post-development (Figure 2.1 in Appendix 4)

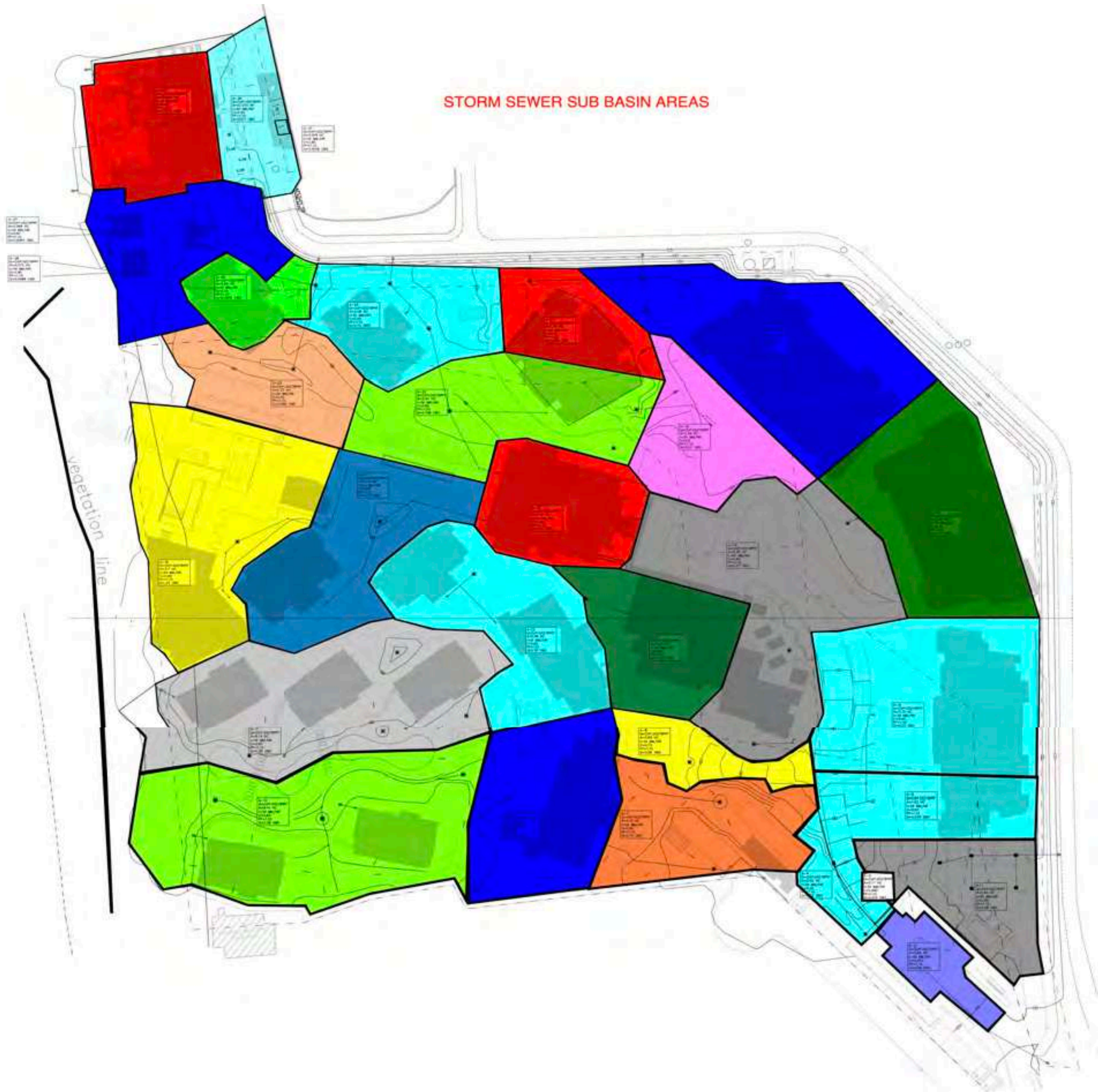

Figure 5.7: Sub-basins to inlets (Figure 4.2 in Appendix 4)

5.1.4.5. TEC Stormwater management – Hydrology calculations and analyses

The design criteria identified were used to calculate peak discharges per basin for the design storm using Hydraflow Extensions. The jurisdictional design storm for the stormwater management mitigation for the site (Flood Zone 1) was determined to be a 50 year – 24 hour storm. This hydrological analysis showed an increase in peak flow of 4.75% between pre- and post-development conditions. Since this increase is less than 5%, no SWM Detention facilities are required. The complete Civil 3DHydraflow Extensions report is presented in Appendix A of the full report (Appendix 4).

The design of all drainage system components on site was completed using the rational method model in Autodesk Storm and Sanitary Analysis Model to produce pipe sizes and profiles. Here, the jurisdictional design storm for stormwater management mitigation for the site (Flood Zone 1) was determined to be a 25 yr – 6 hour storm. A 25 year storm is a relatively low risk event, although it is the level of analysis required by the Antigua and Barbuda Drainage Code and Guidelines. Less frequent and more intense rainfall events were not included in the analysis, i.e. the 1 in 50 or 1 in 100 year storm, and as these events are expected to increase, the development needs to ensure the infrastructure can handle such events.

Peak discharge was calculated for each sub-basin using the rational method model with the addition of a 10% increase in flow rate to account for climate change. The average velocity in open channels with gravity flow was calculated using Manning's equation. The relationship between model channel parameters and peak flow was modelled using the continuity equation. These equations described in further detail in Section 5.1 of Appendix 4.

Additional design constraints specified in Autodesk Storm and Sanitary Analysis were:

1. Lateral Pipes 300 mm minimum, V = 1.5 m/s maximum
2. Trunk Pipes 450 mm minimum, V= 2.4 m/s maximum.
3. Inspection holes every 30 mts on pipes.
4. Gravity flowing pipes flowing half full.

The parameters and velocities for each system are outlined in Appendix 4 (Section 5.2 and Appendix B).

5.1.4.6. TEC Stormwater management – Stormwater and erosion control strategies

The stormwater management strategy for the proposed Nikki Beach Resort will focus on low impact development (LID) practices. The goals of LID practices are to reduce runoff and mimic a site's pre-development hydrology by minimizing disturbed areas and impervious cover (e.g. roads and parking lots) and infiltrating, filtering, storing, evaporating and detaining stormwater runoff close to its source. LID practices at the proposed Nikki Beach Resort will include:

1. **Swales** – Rip Rap Lined swale with 0.5% slopes designed to reduce velocities allow runoff to slowly move along the swales, promoting filtration and infiltration into the subsoil. The installation of an infiltration trench with a perforated pipe will increase the runoff capture volume preventing surface ponding for extended periods of time.

2. **Catch basin soakaway type** – Located in landscape and grassed areas, the soakaway structures allow portions of the runoff captured by conventional drainage systems to percolate to the sub-soil by providing a bottomless structure followed by an inverted stone filtering system.

3. **Boreholes** – These form the core of the proposed stormwater management system, allowing the reduction of peak runoff volumes generated on impervious surfaces, from roofs to roads, by injection of runoff water back to the ground.

4. **Outlet protection** – This will be provided at the end of every daylighted storm pipe to ensure outlet velocities stay below 1.5 m/s to prevent erosion and transportation of sediments downstream.

The proposed locations of these structures are mapped in Figure 5.8.

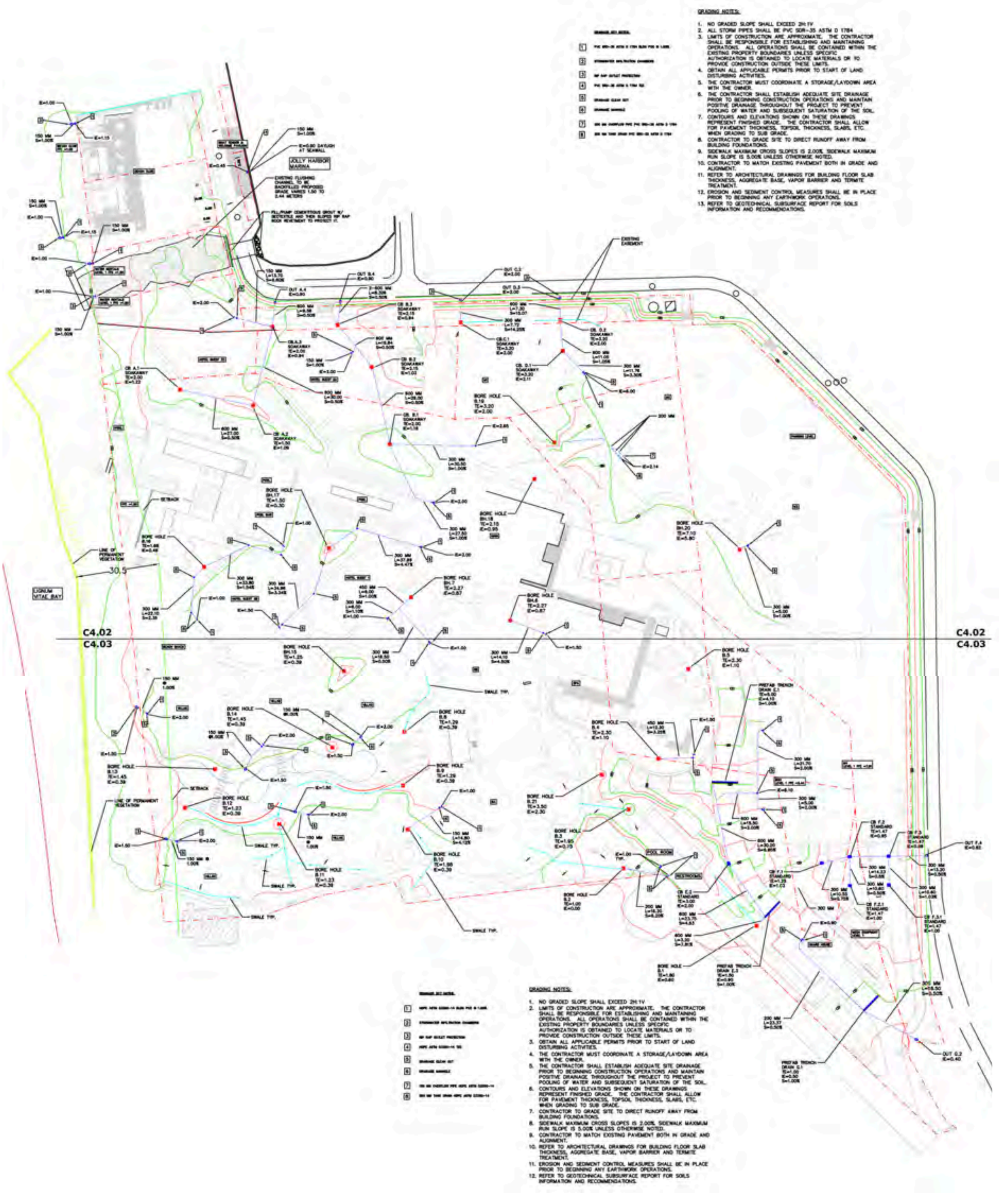

Figure 5.8: Drainage plan post-development

Erosion control BMPs will be established during the construction phase by the design documentation and will require the general contractor to establish these controls prior to the demolition, clearing and grubbing, and mass grading works. The perimeter BMPs will follow the phase I ESPC requirements established by the State of Georgia and identified in the 2016 Field Manual for Erosion and Sediment Control in Georgia. The BMPs included on the design documents are:

1. Du – Dust control on disturbed areas by installing a dust tarp around the perimeter construction fence.
2. Ds1 – Disturb area stabilization with mulch – Apply to all areas disturbed and idle for 7 days
3. Ds 2 – Disturbed area stabilization with temporary seeding – All areas disturbed and idle for more than 14.
4. Ds3 – Permanent vegetation following the landscape plan and the ESPC – All areas disturbed and idle for more than 30 days as well as all final grade areas.
5. SS – Slope stabilization mats using a biodegradable mat with seeding on all slopes 2(H):1(V).
6. Cd Check Dams – Hay Bale Dams along the perimeter silt fence to reduce runoff velocities and storage sediments preventing them to migrate the from site.
7. Co Construction Entrance – stone revetment area to clean vehicle tires prior leaving the construction site.
8. Sd1 – Sediment barrier along the perimeter of the site.

The proposed locations of these BMP measures are mapped in Figure 5.9.

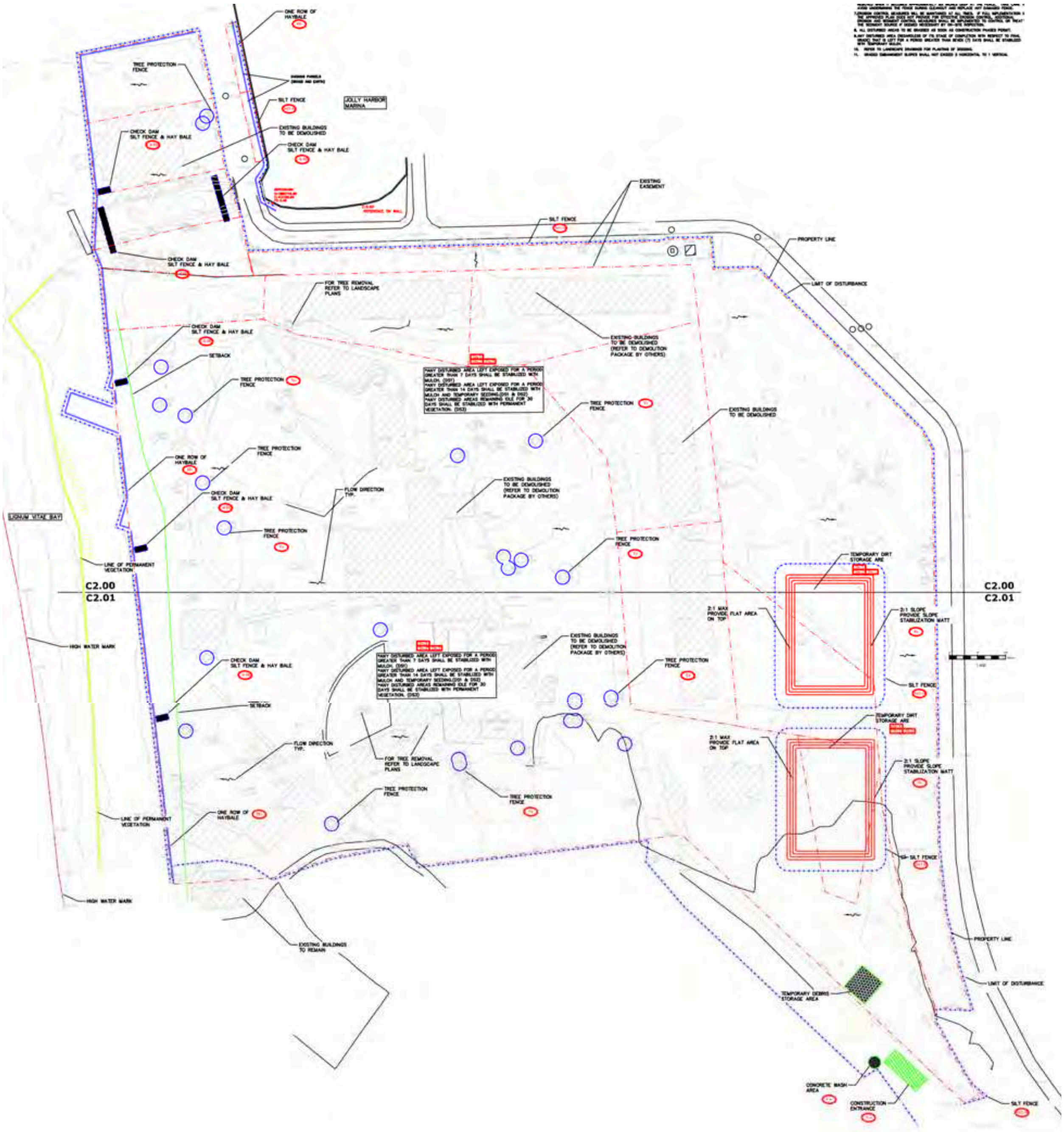

Figure 5.9: Erosion control plan

5.1.5 Coastal engineering assessment and hazard analysis

For this development and ESIA, Applied Technology & Management (ATM), a Geosyntec company, was contracted by Muqali Ltd to provide coastal engineering consultancy services for the redevelopment of a site on the south side of Jolly Harbour into a Nikki Beach Resort. In addition to hydrodynamic assessments, their analysis also addressed setback and elevations associated with the redevelopment of this beachfront property in Jolly Harbour Antigua.

In the scope of work to ATM, the developer requested that ATM provide a hydrodynamic assessment that included development planning and design recommendations. In the hydrodynamic analysis and coastal hazard modeling, ATM evaluated the effects of a present day 1:100 year storm and under current sea level conditions as the most extreme event. The findings were used to assess and provide recommendations for the finished floor elevations (FFE) and design flood elevations (DFE).

The study specifically excluded any analysis that incorporated sea level rise, which the ATM coastal engineers indicated was at the client's request. This is unusual as the standard analysis today is to incorporate sea level rise scenarios because of their impact on storm damage, resilience and erosion. ESIA terms of reference request climate change assessments. Therefore, the results must be interpreted within the framework of this limitation. The developer must understand and accept the associated elevated risks and any potential resulting associated direct or indirect costs to the development

The full technical report and recommendations are summarised in Sections 5.1.5.1-5.1.5.4 below and presented in Appendix 5.

5.1.5.1. Data Sources

The ATM team conducted an in-depth analysis of coastal hazards and hydrodynamics. The work consisted of site visits and onsite data gathering, as well as external data sources, including satellite and Esri ArcGIS data.

The primary environmental forces with the potential to affect the project site include wind, waves, and elevated water levels. The project location on the leeward / western side of Antigua is generally well protected from the prevailing easterly trade wind and waves which dominate the region.

Tidal range is based on NOAA (US National Oceanic and Atmospheric Administration) tide station (#9761115, Barbuda), located ~35 miles north of the project site. Typical of this region of the Caribbean, the tidal range at the site is minor, less than 0.3 m between Mean Lower Low Water (MLLW) and Mean Higher High Water (MHHW). This is considered to be representative of local site conditions in Lignum Vitae Bay, although minor deviations would be expected.

Upland topographic and nearshore bathymetric survey data for the site was provided by the Client. Upland elevations are generally within +1 to 2 m local survey datum (LSD) across the site. Offshore bathymetry was obtained from local nautical charts and Esri ArcGIS bathymetric layer services datasets, which primarily consists of the GEBCO (General Bathymetric Chart of the Oceans) 2019 grid dataset for the local and surrounding offshore site bathymetry. Depths in the immediate nearshore are shallow, less than 3.5 m (~12 ft), and mildly slope on the wide surrounding bank, which exhibits intermediate depths typically between 10 to 20 m (30 to 100 ft) for approximately 11 km (~7 miles) offshore from the site shoreline before drastically dropping off to deep water with depths greater than 300 m (1,000 ft).

Shoreline change data, specifically beach width, was obtained from James (2008), which used data collected by Antigua's Fisheries Division, and digitization of satellite imagery. This allowed for assessment of erosion and accretion, where the general trend in Lignum Vitae Bay was for stability and accretion.

A wind rose summarizing windspeed and direction from 2011 to 2023 at V.C. Bird Airport, located ~ 7 miles northeast of the site. The average wind speed is 10.3 miles per hour (mph) and predominantly from the east-southeast to east-northeast. The project site is generally well sheltered from the prevailing easterly trade winds and waves, however, less frequent / more extreme events (e.g., tropical storms, hurricanes) can bring damaging windspeeds and large waves from various directions.

The North Equatorial Current turns into the Antilles Current as soon as it reaches the Leeward Islands. The Antilles Current runs generally toward the NW, on both sides of Antigua in deep waters. On a regional scale, this current is typically ~ 0.5 knots (0.25 m/s). However, more variable and stronger currents may occur closer to shore and where local wind and bathymetric effects will control currents.

Antigua is susceptible to tropical storms and hurricanes between June and November annually. On average, the island is affected by a storm about every 3 years, as 24 storms passed within 50 miles of the island between 1950-2023. About half of these storms were major hurricanes (Category 3 or above), which translates to a hurricane every 6 years and a major hurricane every 12 years. Hurricane duration and direction play an important role in surge and other impacts that are discussed in this study.

Storm surge values were evaluated from several regional sources, past regional projects by ATM, as well as Antigua-specific studies by other authors. Based on the data analysed, the governing 100-year surge condition for the site is recommended as 1.34 m above LSD (or ~1.7 m above MSL).

Seismic and underwater volcanic threats were mentioned as hydrodynamic based risks, but were not analyzed in the study.

5.1.5.2. Models and Analyses

Offshore wave conditions were assessed from NOAA's WaveWatchIII Model (WW3) hindcast - a model that has been thoroughly tested worldwide. Three representative sites were selected (see Figure 2.11 in Appendix 5). Return times for waves at different heights at these sites was estimated (see Table 2.3 in Appendix 5). These offshore waves were then propagated into the nearshore of the project location within site specific models. The CMS-Wave model was used to transform the offshore wave data to the project shoreline. This methodology and analysis is discussed in detail in Appendix 5. The CMS-Wave model was used over the entire project region out to deep water utilizing a 50-meter cell resolution. 100-year wave conditions were conservatively defined as: Hs = 7.3 m, Tp = 12 seconds, and were input for various critical directions (ranging from south-southwest to north-northwest incident conditions) at the CMS-Wave model boundary. Graphical outputs of wave vectors and wave heights (in meters) of select model runs are presented on Appendix 5 while outputs of all model simulations are provided in the appendix of the full report.

Based on the CMS-Wave modeling, governing 100-year nearshore wave conditions in this location at the center of the bay and approximately 1.6 km (~1 mile) offshore are Hs = 4 m, Tp = 12 s, generally from the west direction, but have the potential to approach from varying directions (these can be assumed to act shore perpendicular along the site coastline). ATM utilized these results as inputs into the CEDAS SBEACH model.

The CEDAS SBEACH numerical model was used to determine maximum wave crest elevations, runup, and resulting base flood elevations at the site. The SBEACH model was used to simulate storm waves, water levels (including wave setup), and cross-shore beach and dune erosion along two (2) selected transects at the project site as shown in plan view on Figure 5.10 (Figure 4-3 in Appendix 5). During existing 100-year storm conditions, peak storm surge along the western coast of Antigua in Lignum Vitae Bay and Jolly Beach would be 1.34 m (4.4 ft). SBEACH simulations were run for a 12-hr duration, 100-year storm with a peak surge level of 1.34 m (4.4 ft) LSD and constant initial wave conditions (Hs = 4 m [13 ft] and Tp = 12 sec).

SBEACH simulations also estimate additional water level increases along the shoreline due to wave setup (breaking waves pushing water up against the shoreline to locally increase water levels further) on the order of 1.5 ft (~0.5 m) or more. Present-day 100-year storm conditions for both the existing site and the proposed development using grading plans were assessed. The line of permanent vegetation (LPV) was provided by the clients and was used to assess the setback of the property, which is greater than the 30 m (100 ft) recommended for Jolly Beach.

Based on the analysis, a 1:100 year storm results in a run up elevation from 2.1-2.4 m, which is greater than the current site elevation (+1-2 m), and equal to the finished floor elevation (FFE) (2.44 m) for the habitable buildings closest to the beach. The results for the existing site condition in the 1:100 year event (no SLR) and for the proposed development in the 1:100 year event (no SLR) are presented in Appendix 5 Figures 4-5 through 4-7. Overall the flood elevations presented for the present-day 100-year scenario are comparable to the minimum requirements by the US Federal Emergency Management Agency (FEMA) as a basis for flood risk management, which recommend that the FFE or LHME is typically greater or equal to the DFE elevation. If the client accepts the risk of flooding for beachfront residences, it is strongly recommended that a shelter-in-place location is established to shelter the guests that will be displaced from these residences in the event of a 100-year storm or other natural disaster.

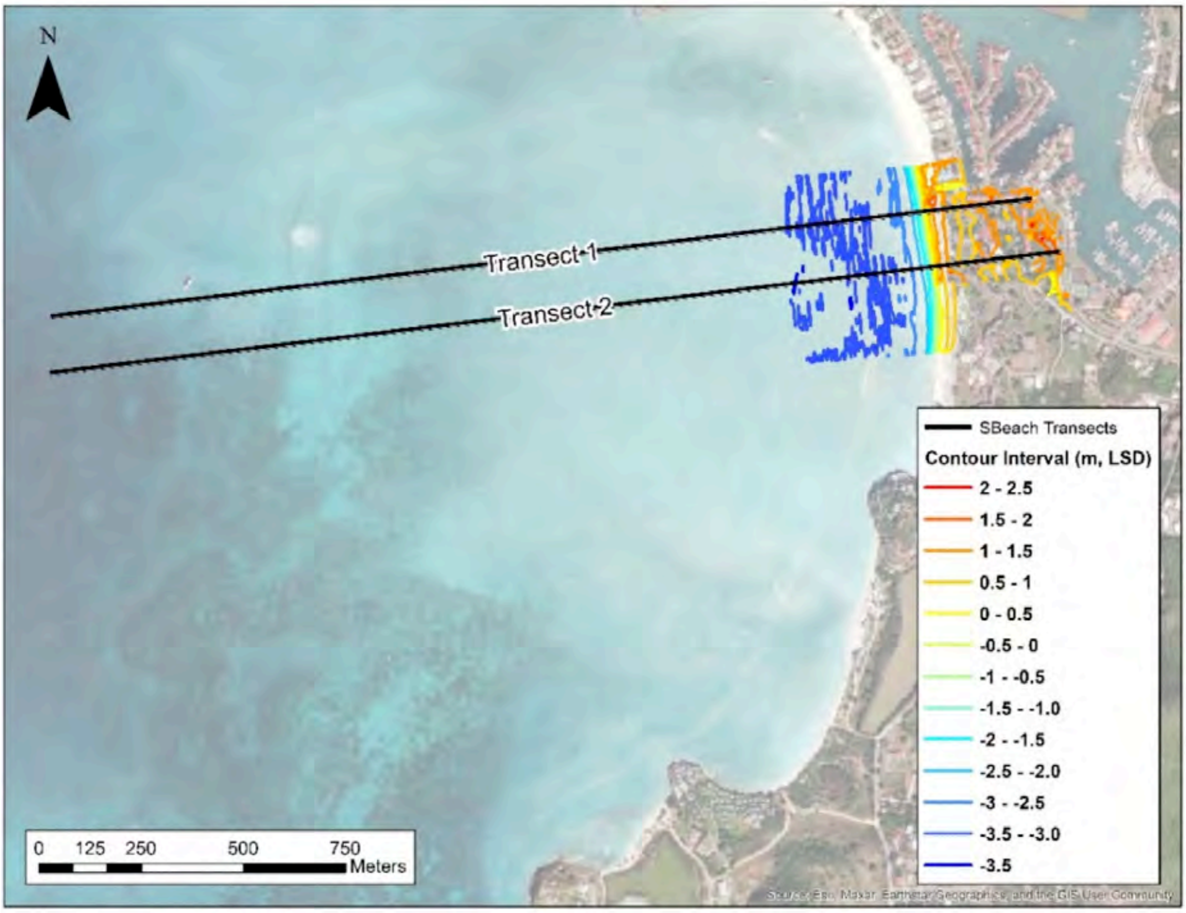

Figure 5.10: SBEACH Transect Locations Overlaid on Existing Topographic Contours (Figure 4-3 in Appendix 5).

5.1.5.3. Summary and Recommendations

This coastal analysis provides a site-specific shoreline change assessment, storm surge and wave height estimates, and recommended construction setback and building elevations of major and/or habitable structures elevations for the Nikki Beach Hotel project site based on the 1:100 year storm event. Key recommendations and observations are summarized below.

Long-term shoreline assessment suggests the site shoreline has experienced net accretion over the past ~20 years and is currently relatively stable. A Beach Monitoring Plan is proposed to assess overall health and determine when future maintenance renourishment may be needed. No new shoreline stabilization structures (e.g., groynes, breakwaters) are suggested at this time, however, it is recommended that the existing rock structures on the property shoreline be left in place. These can also potentially be rehabilitated to improve functionality in the future, if necessary.

Short-term (episodic) shoreline changes from an extreme storm event at the site and Base Flood elevations (utilizing a 100-year return period storm event as the base flood, following FEMA methodology) were assessed using the SBEACH model.

- The SBEACH 100-year model simulations suggest minimum setbacks of ~ 30 m (100 ft) from the existing approximate permanent vegetation line on the beach (delineation provided by Client) for the proposed development, which aligns with the DoE recommended setback.
    - Erosion was observed landward of this setback under proposed conditions scenarios in areas where no retaining wall will be located, however, this is relatively minor and no buildings or habitable structures are proposed in these areas.
    - Planting stabilizing vegetation, and/or enhancing the dune system will help to mitigate erosional damage along the site's shoreline/upland transition. ATM engineers included hardscaping as an option, but we caution that this should be used sparingly and in conjunction with nature-based solutions, e.g. dunes, because of risks of erosion and other factors.
- It is recommended that any habitable and permanent structures developed at the minimum setback limits are founded on piles or other foundation which can accommodate the anticipated potential storm scour/erosion and wave/over wash loads. Construction in front of setback limits is not permitted.
- Model results for Existing and Proposed Conditions under 100-year storm conditions (no SLR), suggest a BFE of +2.4 m, LSD for the seaward-most areas of planned development near the 30 m LPV setback. Model BFEs farther inland reduce to +2.1 m under present-day and proposed (no SLR) conditions.
- Explicit consideration of future SLR would result in higher BFEs for the proposed project.
- Design flood elevations (DFEs) typically include a minimum additional 0.3 m (1 ft) factor of safety (i.e., freeboard) on top of modeled BFEs to conservatively account for uncertainty in the analysis. Alternatively, the BFEs resulting from "future" 100-year storm scenarios which include SLR may be considered an acceptable DFE. These

values would be a minimum target elevation for lowest horizontal structural members and/or finished floor to reduce loading on the buildings. Due to increased awareness of future SLR, many communities now require a minimum 0.6 m (2 ft) freeboard above BFE.

- Coordination with the Client after initial analysis, based on Client accepted balance of acceptable risk versus project economics and other factors, resulted in a Client directive to not explicitly include SLR or additional freeboard in the flood hazard analysis. Therefore, only present day 100- year storm event scenarios (i.e., without SLR) are presented.

Based on the 100-year results (without SLR), a minimum DFE of +2.4 m LSD was calculated for the planned buildings/amenities, noting that this value does not include a freeboard/factor-of-safety.

The client indicated to the engineers that they do not wish to use seafront retaining walls. However, ATM analyzed such a scenario in their scope of work, as such we are reporting the findings here. We note however that using such an option would result in changes to DFEs (ATM pers comm). In areas where the client may choose to use oceanfront retaining walls, DFEs for planned buildings/amenities within 9.1 m inland from the wall are suggested to be established based on the following:

- As significant wave runup/overtopping is anticipated and following FEMA guidance, it is recommended DFE's within the 9.1 m splash distance be set to at least 1 m above the wall crest elevation — meaning for areas where an oceanfront retaining wall with a crest elevation of +2.4 m LSD is proposed, a DFE of +3.4 m LSD is recommended for anything planned to be built within a 9.1 m splash zone landward of the retaining wall. A recurved profile at the retaining wall crest could be considered to remove this requirement.

- Any habitable or non-expendable structures planned within 9.1 m inland of an oceanfront retaining wall should be pile supported with the lowest horizontal member elevation (LHME) set above the DFE or to at least 1 m above the retaining wall elevation, whichever is higher.

Stem walls are recommended at a minimum (as opposed to simple slab on grade) for all structures that are not required to be founded on piles to protect the foundation from scour/erosion from sheet flow (e.g., overtopped flowing water, return flow as flood waters recede) adjacent to buildings.

The above recommendations are based on the 100-year design condition (1% chance of occurring in any given year). We understand from the client and engineers that this is the standard they will use and this has been discussed previously along with any caveats

Maintaining a healthy beach and vegetated dune system will also help reduce risks associated with coastal hazards. Setbacks are meant to protect the stability of the beach and the existing vegetation (dune and coastal strand systems) from development as well as protect potential development from severe wave impacts near the shoreline. Less severe wave effects are possible beyond this setback but are generally limited to shallow flooding and less severe over wash.

While less critical and non-permanent infrastructure such as walking paths may potentially be placed seaward of the setback line, all infrastructure with foundations, including permanent pools with foundations must be located within the designated development area and comply with setbacks.

Note that if/where retaining walls, bulkheads or other shore parallel structures are sited – there is potential for increased erosion and the need for a scientifically designed and planned beach/dune rehabilitation and restoration to avoid impacts to the native beach. In addition, siting of a building within 9.1 m (30 ft) of a retaining wall or other coastal armoring structure may result in overtopping splash and runup which can damage windows, foundations, decks, etc.

Proper coastal construction methods (FEMA 55, ASCE 24) are recommended whenever possible in order to reduce risks. (see ATM full report for details).

5.1.5.4. Coastal Development Risk Potential

While the recommendations for coastal development setbacks, base flood elevations, etc. described herein are based on reasonably conservative values and according to standard coastal engineering practice, the forecasted conditions described herein are by no means absolute. The data provided herein are minimum recommendations based on the best available information and methods at this time. The predicted water level elevations are not absolute; extreme storms may cause conditions which exceed those forecasted at any time during the lifespan of the facility.

Such an occurrence can cause partial or even complete destruction of the facility, and the owner/developer and operator must realize and accept this fact. In addition, the owner/developer must consider insurance requirements and adopt facility design and operational procedures to address the risks associated with facility siting within a coastal zone influenced by tropical storms.

There is always some risk of damage and even total loss of a coastal facility, which can be estimated by the following equation:

$$R = 1 – (1 – 1/Tr)n$$

where R is the probability or risk that an event with a return period of Tr years will occur at least once during a time period (project life) of n years.

This means that statistically, there is roughly a 1-in-4 (26%) chance of at least one 100-year design condition (1% chance of occurrence in any year, on average) occurring over a consecutive 30-year period, which is the length of a typical mortgage in the US. Similarly, there is a 9.6% chance of the 100-year design condition occurring during a consecutive 10-year period. Decreasing the return period of the design condition increases the risk as discussed in the previous section.

Table 5.1: Theoretical Occurrence Percentages for Varying Time Spans (Table 4-2 in Appendix 5).

Event Return Period (Years)	Theoretical Occurrence over 1 Year	Theoretical Occurrence over 5 Years	Theoretical Occurrence over 10 Years	Theoretical Occurrence over 25 Years	Theoretical Occurrence over 50 Years	Theoretical Occurrence over 100 Years
10	10%	41%	65%	93%	99%	100%
25	4%	18%	34%	64%	87%	98%
50	2%	10%	18%	40%	64%	87%
100	1%	5%	10%	22%	39%	63%

The Developer/Owner of the facility must consider and balance these risks with insurance premiums, available coverage, design life, risk of life/safety, project requirements, and capital costs so that an informed decision can be made regarding the required robustness of the final design.

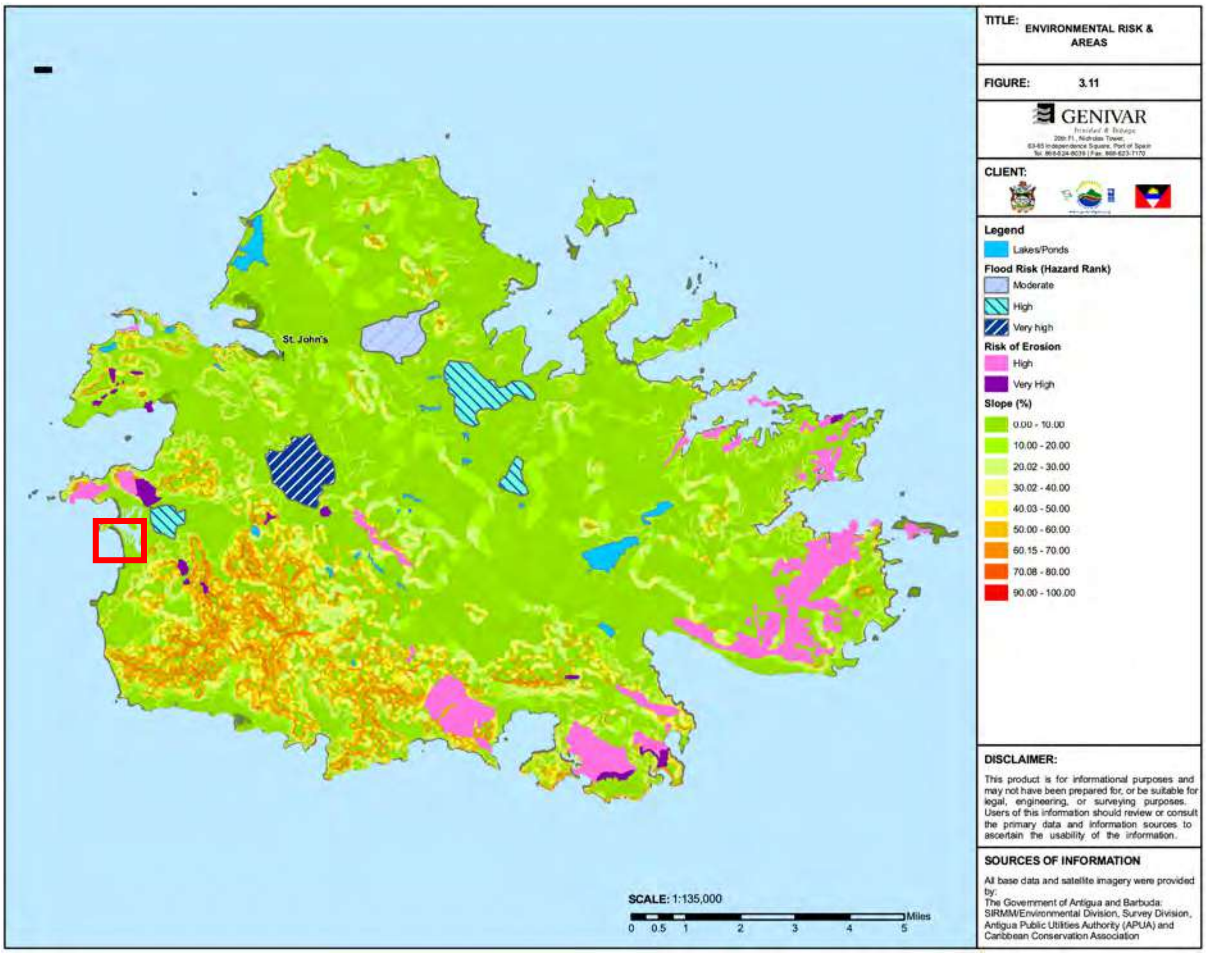

Figure 5.11: Environmental risk zones, including flooding and erosion showing the project area delineated in red.

5.1.6 Estuarine/marine receiving water quality

The proposed site for the Nikki Beach Hotel borders the internal waters of Jolly Harbour marina, as well as the coastal waters of Lignum Vitae Bay. A human-made flushing canal within the development site (adjacent to the BoDog restaurant) once connected a channel in the marina to the Bay. But the canal has been blocked by sand for many years, and now contains areas of stagnant water (Figure 5.12). A previous flushing study of Jolly Harbour marina showed that permanent closure of the canal would have no material impact on flow or flushing of the marina (Deborah Brosnan & Associates, 2021).

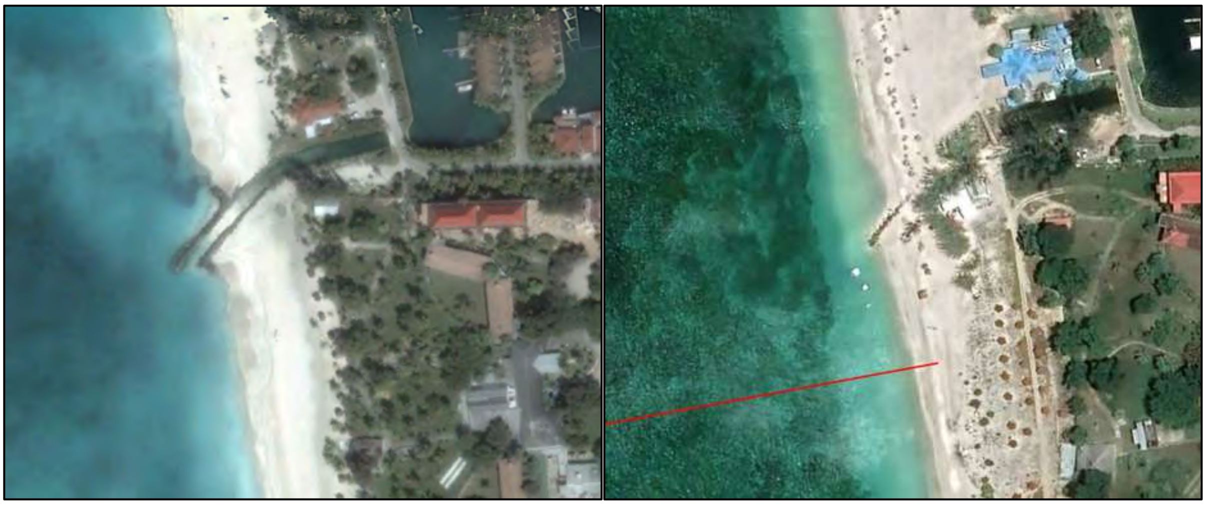
Figure 5.12: Aerial imagery of the flushing canal (a) open in April 2012 and (b) closed in July 2022.

The DoE communicated that to establish the baseline water quality of the site and that one set of water quality samples would be required for the purposes of this ESIA. Water samples were collected on November 20, 2023 from 9 monitoring sites, specifically 3 from the marina, 3 from the flushing canal and 3 from the sea, between 9:15 and 10:00 am (Table 5.2, Figure 5.13). Samples were put on ice and transported and delivered to the Department of Analytical Services Laboratory the same day.

Analyses were conducted by the Analytical Services Laboratory (ASL), in Antigua and as per the request of DoE. Water samples were tested for nitrate, phosphate, salinity, pH, turbidity, Enterococci, and fecal coliform to align with the capabilities of the laboratory and the parameters agreed upon with DoE. Temperature and dissolved oxygen were measured in situ with a YSI probe by the science team. All water measurement reporting measurements and standards were provided by the DoE. These standards require that phosphates and nitrate results be reported in mg/mL, and since the ASL reports these metrics in ppm, the results were converted from ppm to mg/mL.

Both ASL certified data and *in situ* raw data are reported in Appendix 2, and a summary of both sets of results and the converted values are presented in Table 5.2.

Water quality at 6 out of 9 sites samples met good quality standards based on the analysis conducted by ASL and the *in situ* measurements made by the science team. Temperature, turbidity, and salinity were all within acceptable limits under the EPMA 2019. No nutrients exceeded threshold standard levels per the DOE standards, and fecal coliform and enterococci concentrations were within acceptable limits. The main findings are:

On November 20, 2023, nutrient concentrations (phosphate and nitrate) at all 9 sites sampled were within the acceptable threshold standards provided by DoE. Phosphate concentrations were within acceptable threshold limits (<0.025 mg/mL) and the nitrate concentrations were within acceptable threshold limits (<0.4 mg/mL) per the DoE standards at all sites for this sampling event.

Enterococci concentrations were within acceptable EPMA (2019) threshold limits for all 9 sites (threshold <60 cfu/100 mL for a single sample). Fecal coliform concentrations were also within acceptable limits under the EPMA (2019) at all 9 sites for the sampling event (threshold standard is < 400/100 mL for a single sample).

We report DO standards based on those provided in the EPMA. These thresholds apply to marine coastal waters; Lagoonal or wetland water quality thresholds have yet to be legally defined, but the EPMA values are useful as a benchmark to assess fluctuations, trends, and can help to identify concerns. Dissolved oxygen (DO) levels were >5.0mg/L (the EMPA (2019) threshold for recreational coastal waters) for the six marina and beach sites. However, samples from the flushing canal had dissolved oxygen levels of 4.44-4.78 mg/L (Table 5.2, Figure 5.13), which is lower than the DoE required threshold. This is likely due to water stagnation and lack of circulation in the flushing canal (Figure 5.14a).

The pH of the 9 sites sampled fell within the EPMA (2019) range for marine/coastal waters of 7.7-8.5. Coastal samples showed relatively high turbidity consistent with the poor visibility observed (<0.5 m) (Table 5.2).

DoE has instructed that water quality should be monitored every 3 months during the construction phase of the hotel. Once Nikki Beach Resort is operational, water quality will be measured every 6 months. This will ensure early detection and rapid response if there are development related impacts to the water quality of Lignum Vitae Bay, and mitigation measures can be implemented to address the water quality concerns. We do not anticipate any cumulative impact from water discharge into the Bay during construction or operations.

Table 5.2: Water quality sampling locations and results. Site locations are shown in Figure 5.13.

Sample ID	Description	Temp (ºC)	DO	Salinity (g/100 ml)	Enterococci (cfu/100ml)	Faecal coliform (MPN/100ml)	pH	Turbidity (NTU)	Nitrate (mg/mL)	Phosphate (mg/mL)
M1	Marina 1	28.6	6.01	28	3	<20	8	2.45	0.00001	0.0004
M2	Marina 2	28.6	5.75	32	1	<20	8	2.50	0.00001	0.0004
M3	Marina 3	28.8	5.89	31	1	<20	8.2	1.60	0.00001	0.0002
C1	Canal 1	28.5	4.44	30	ND	<20	8	5.71	0.00001	0.0004
C2	Canal 2	28.3	4.43	29	9	<20	8	4.94	0.00001	0.0004
C3	Canal 3	27.6	4.78	28	ND	<20	7.8	29.30	0.00676	0.0006
B1	Beach 1	28.3	7.19	32	ND	<20	8	43.50	0.00001	0.0002
B2	Beach 2	28.4	7.51	33	13	<20	8.1	40.40	0.00001	0.0002
B3	Beach 3	28.5	7.47	33	ND	<20	8.1	54.60	0.00001	0.0002

Figure 5.13: Map of water sampling locations


Figure 5.14: (a) The end of the flushing canal, where water stagnates (water sample ‘Channel 3’), and (b) the beach side of the flushing channel, fully blocked by sand.

5.1.7 *Ambient noise*

Any noise quality impacts are expected to be largely temporary and mostly during the construction phase. The specific noise risks during construction include construction workers working with loud machinery. These noise impacts may be considerable on the neighbouring residential and commercial properties as the development site is fully embedded within the Jolly Harbour community. Ongoing noise risks during the operational phase are from music from the Beach Club and may impact properties immediately adjacent to the northern end of the development site.

Noise levels are measured in decibels (dB), which are described using an adjustment for human hearing and are called decibels A (dBA). Normal, ambient noise levels fall within the 50-65 dBA range, up to 70 dBA without causing damage after exposure over long periods. Construction noises may be up to 120 dBA from, for example, hammer drills, and much construction activity is around 80-90 dBA. According to the U.S. Occupational Safety and Health Act (OSHA), average noise exposure should not be more than 90 dBA over an 8-hour period, and worker should not be exposed to levels of more than 115 dBA for more than 15 minutes (Table 5.3). Therefore, construction noise exposure should be limited, and hearing protection devices should be provided to workers when needed.

Table 5.3: U.S. Occupational Safety and Health Act of 1970 (OSHA) standards & OSHA Hearing Conservation Program Amendment (Occupational noise exposure - 1910.95)

Duration per day (hours)	< ¼	1	1 ½	2	3	4	6	8	16	32
Sound level (dBA) Slow Response	115	110	105	102	97	95	92	90	85	80

During the construction phase of this development, daily activities will take place from Monday to Friday between 08:00-16:30, and on Saturdays between 08:00-15:00. Night shifts may be required and will only be undertaken with prior approval from the DCA/DoE. When the hotel is operational, high noise levels are not anticipated except for the beach club. Depending on operating hours, music from the beach club may occur throughout the day and evening.

Baseline noise monitoring was completed on March 6, 2024, using standard noise monitoring methodologies based on established noise monitoring standards for development (The National Academy of Sciences, 1977) and recent noise monitoring studies (Golder Associates Ltd, 2018; Kerr et al., 2002; Ove Arup & Partners Hong Kong Ltd, 2001; Ramboll, 2018). Depending on their purpose, varying sampling interval, total sampling time, and microphone sensitivity were used. For this assessment, sampling was completed throughout the day (08:00-19:00) with high sampling interval (2 seconds) to capture a thorough understanding of noise on the site, including short, high-level noises.

Baseline noise data were collected using a R8070SD Data Logging Sound Level Meter (REED Instruments) using a wind diffuser ball. Prior to use, the sound level meter was calibrated using the R8090 Sound Level Calibrator. Measurements were taken at 3 locations as described in Table 5.4 and shown on Figure 5.15. Each location was selected near the boundary of the development site, in an open area more than 1.5 m away from hard surfaces, in accordance with recommended noise monitoring protocols and data logger specifications. The deployed noise meters are pictured in Figure 5.16.

Table 5.4: Noise sampling sites

Site no	Description	Latitude	Longitude
1	Meadow to the east of the site, close to access road and residential properties	17.066320°	-61.885917°
2	Northern end of the beach by the current Pop-Up Bar and car park	17.067607°	-61.888667°
3	Southern end of the beach, near the boundary of the Jolly Beach Resort and Spa	17.065712°	-61.888272°
Additional data of opportunity	Next to Sandra's Beach Shop and Bar to record nighttime music and karaoke	17.067068°	-61.888550°

At each of the three sampling sites, continuous recording at 2 second intervals were completed for 1 hour in the morning (8:00-11:00 am), midday (11:30 am – 3:00 pm), and afternoon (3:30-7:00 pm). This resulted in 3 hours of data and 5,400 data points for each site. In addition to the plan sampling regime, an additional 10 minutes of data was recorded, as there was an opportunity to collect additional noise data next to Sandra's Beach Shop and Bar from music and karaoke to evaluate the noise levels associated with these types of activities. These data provide a baseline for nighttime music and activity that will be useful when evaluating the noise levels associated with the planned Nikki Beach Club.

The data collected was used to calculate the equivalent noise level over each 1-hour sampling period ($L_{eq,\ 1\ hour}$), the maximum and minimum noise levels recorded in each sampling period (L_{max}, L_{min}), and the 10th and 90th percentiles of noise level readings (L_{90} and L_{10}). L_{10} is the noise level exceeded 10% of the sampling time and includes noise peaks probably due to sporadic or intermittent events, such as traffic or construction noise. L90 is the level exceeded for 90% of the sampling time and is considered to represent the ambient noise level of an environment. It is used to quantify the background noise level.

The results of this study indicated that noise levels around the Nikki Beach Resort site currently range between 34 and 78 dBA but averaged between 43 and 54 dBA between 08:00 and 19:00 ($L_{eq,\ 1\ hour}$ in Table 5.4). The data collected at each sampling site for each time period are displayed in Figure 5.18, Figure 5.19, and Figure 5.20, and additional data from Sandra's Beach Shop and Bar is displayed in Figure 5.21. The data and *in situ* observations indicate that the noise data were affected by:

- Traffic, particularly at Site 1, including cars and some heavy machinery for road repairs occurring that day near the public access.
- A lawnmower at Site 2 in the morning sampling period between 00:00 and 12:52 minutes (Figure 5.19)
- People and music at Sites 2 and 3 throughout the day.

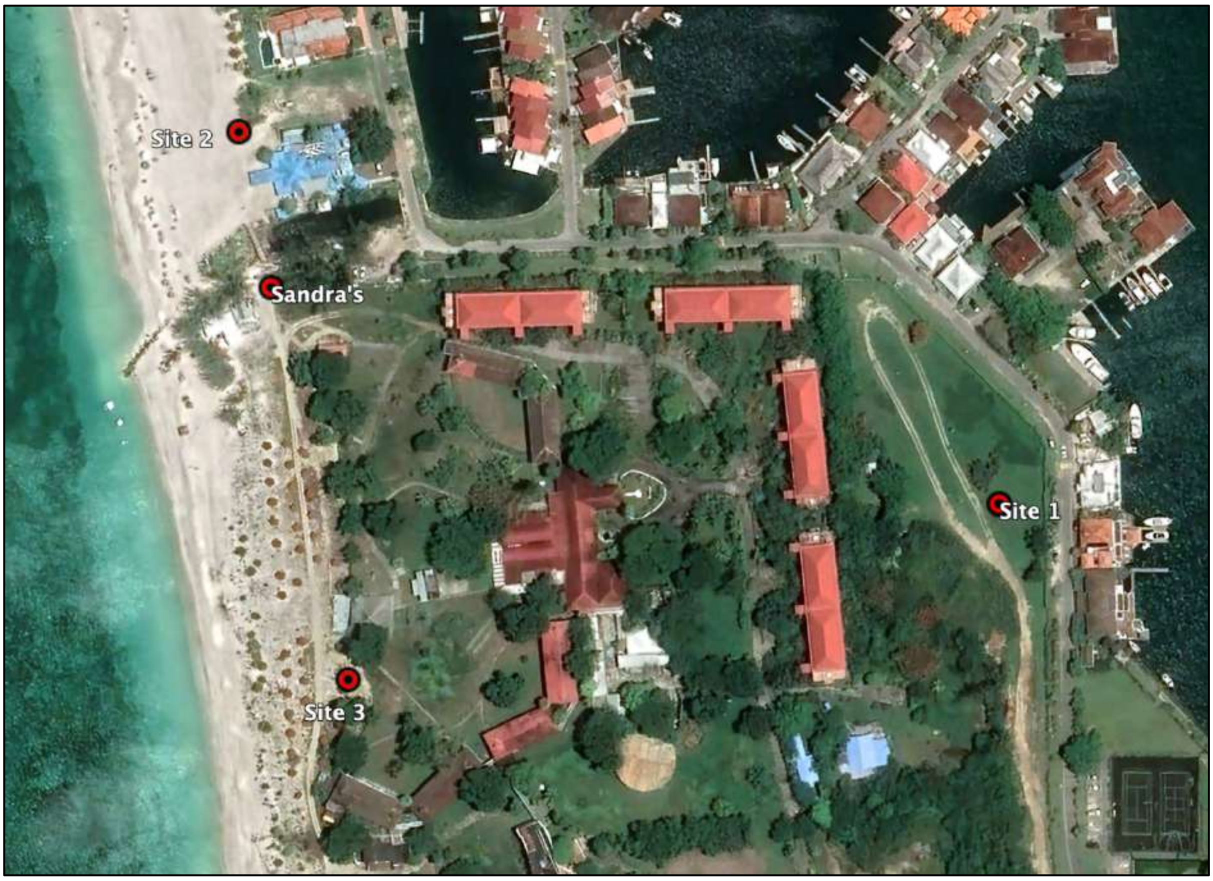

Figure 5.15: Map of the sites where noise monitoring data were collected.

Figure 5.16: Sound level meter deployed at (a) Site 1 (Meadow), (b) Site 2 (North Beach), (c) Site 3 (South Beach), and (d) adjacent to Sandra's Beach Shop and Bar.

Figure 5.17: Noise level monitoring summary statistics in dBA for each of the 3 sampling sites for each of the three time periods, indicating sampling start time.

	Meadow			**North Beach**			**South Beach**			
	Morning (07:54)	Midday (11:29)	Afternoon (15:44)	Morning (09:02)	Midday (12:45)	Afternoon (16:52)	Morning (10:08)	Midday (13:50)	Afternoon (17:56)	Sandra's (19:00)
$L_{eq, 1hour}$	43	46	47	47	51	47	54	44	44	67*
L_{max}	64	68	72	71	72	73	73	62	63	78
L_{min}	34	37	36	43	45	42	40	40	39	62
L_{10}	38	40	40	44	47	44	47	42	41	63
L_{90}	50	53	54	51	58	52	61	47	47	73

* Noise data at Sandra's Beach Shop and Bar was only recorded for 10 minutes so equivalent noise data was calculated for that period ($L_{eq, 10\ min}$)

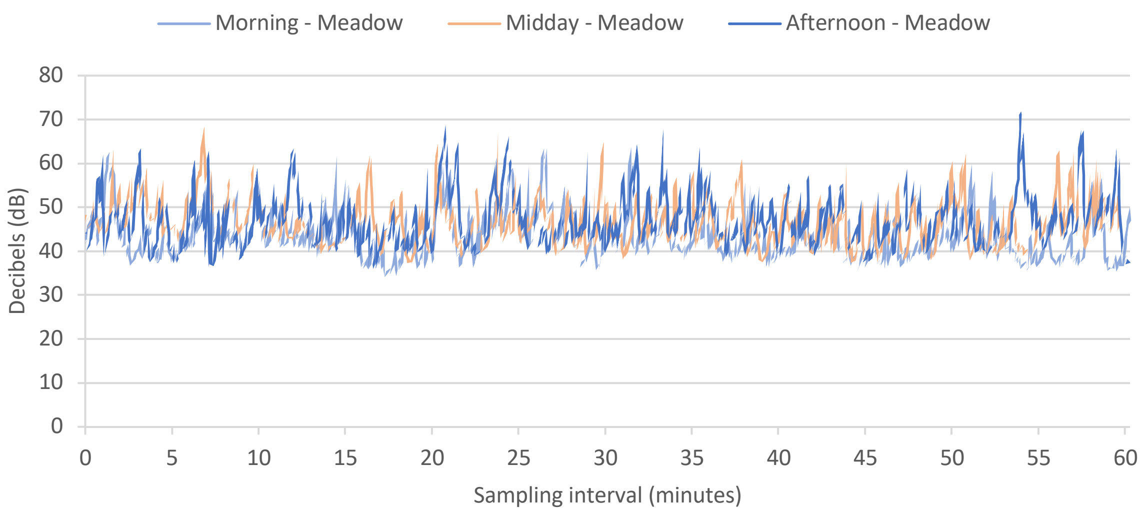

Figure 5.18: Noise data recorded at Site 1 (Meadow) over 3 1-hour periods. $L_{eq, 1\ hour}$ for these sampling periods were 46, 46 and 47 dBA.

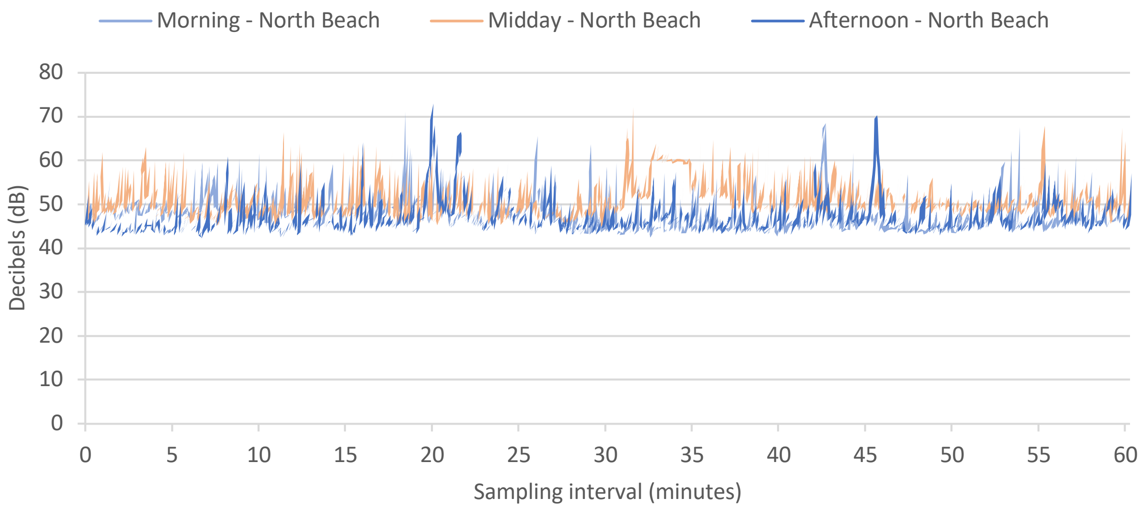

Figure 5.19: Noise data recorded at Site 2 (North Beach) over 3 1-hour periods. $L_{eq,\ 1\ hour}$ for these sampling periods were 47, 51 and 47 dBA.

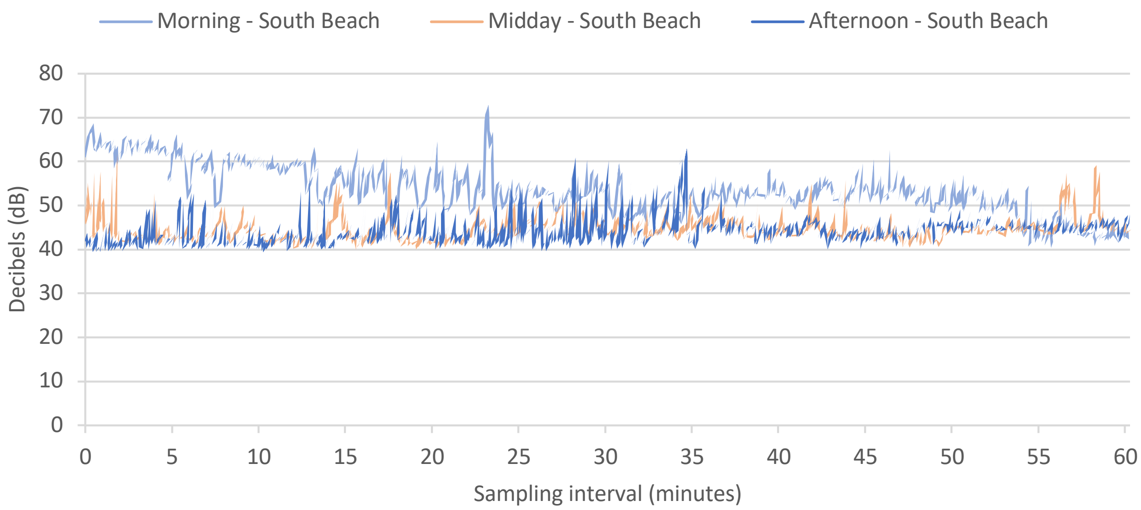

Figure 5.20: Noise data recorded at Site 3 (South Beach) over 3 1-hour periods. $L_{eq,\ 1\ hour}$ for these sampling periods were 54, 44 and 44 dBA.

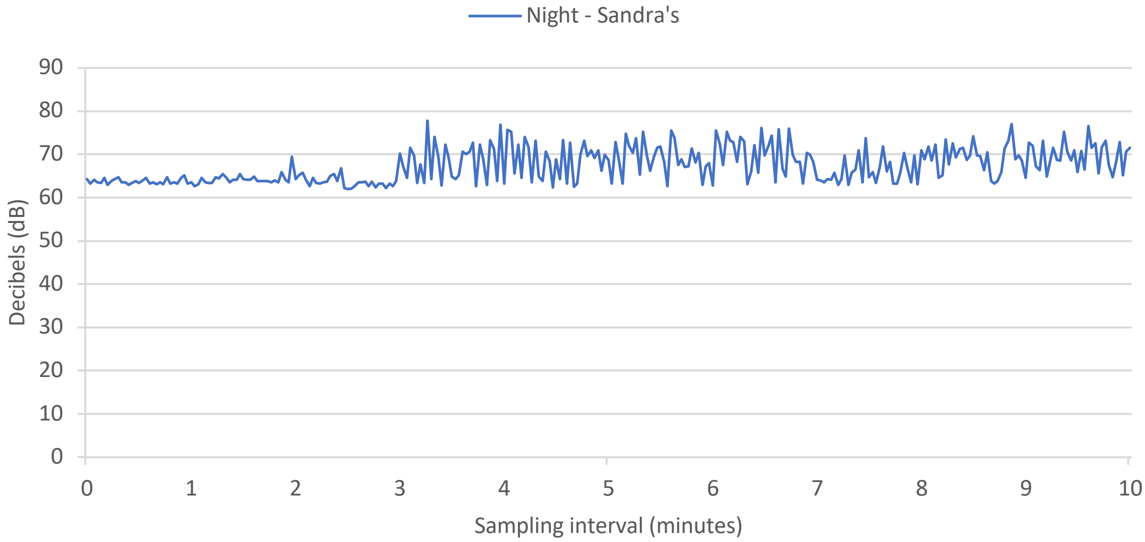

Figure 5.21: Additional noise data recorded at Sandra's Beach Shop and Bar. $L_{eq,\ 10\ min}$ for this sampling period was 67 dBA.

These data will serve as a baseline for the site when comparing to the operational phase of the project.

5.2. Biological environment

5.2.1 Terrestrial vegetation and fauna

The terrestrial ecosystems of Antigua are highly variable, ranging from evergreen woodlands, xerophytic woodlands, scrublands, grasslands to mangrove forests, herbaceous swamps, salt ponds, sandy beaches, rocky shores, coastal lagoons, sea grass beds, coral reefs, coral reef outcrops and oceanic islands and rocks (CARICOM/FAO/ODA, 1993). Assessments of the vegetation on the study site were conducted on November 19, 2023 with the intent to identify the plant species present, wildlife use of the habitat, and current land use. The site was surveyed on foot and GPS points were taken for all large trees and plants of interest. specifically, species considered sensitive. Sensitive vegetation are those species that are listed as threatened or endangered (IUCN Red List), protected under the Environmental Protection and Management Act (EPMA) 2019, are regionally endemic (as determined by Pratt et al., 1997) or have cultural value to Antigua and Barbuda. Trees that are healthy and mature add both aesthetic value to the site and soil stabilization, and it would be beneficial to incorporate them into the design of the development. A map was created using the field data to identify notable existing vegetation and large trees for preservation.

A total of 36 plant species were recorded during this survey (Table 5.5). Of these, 28 were trees, 6 were shrubs, 1 was an herb and 1 was a succulent. Two species were invasive, 5 were regionally endemic, and 5 are protected under the EPMA (2019). Wildlife observed during the survey included a mongoose, butterflies, land crabs, and lizards. Burrows were observed on the southeast corner of the site which are believed to be from mongoose given that mongoose typically live in underground burrows.

Table 5.5: All plant species recorded on the development site.

Scientific name	Common name	Protection status
Agave karatto	Agave	EPMA (2019) protected
Terminalia catappa	Almond	
Casuarina equisetifolia	Australian pine	Invasive
Musa sp.	Banana	
Bougainvillea sp.	Bougainvillea	
Pithecellobium unguis-cati	Bread and Cheese	
Chamaecrista glandulosa	Broom	Regional Endemic per Pratt et al. (1997)
Conocarpus erectus	Buttonwood	EPMA (2019) protected
Roystonea aleracea	Cabbage/Imperial Palm	EPMA (2019) protected
Erithalis fruticosa	Candlewood	
Cocos nucifera	Coconut Palm	
Phoenix dactylifera	Date Palm	
Solanum racemosum	Dolly Tomato	
Caryota sp.	Fishtail Palm	
Delonix regia	Flamboyant	
Cordia sebestena	Geranium Tree	Regional Endemic per Pratt et al. (1997)
Gliricidia sepium	Gliricidia	
Hibiscus sp.	Hibiscus	
Coccothrinax barbadensis	Palmetto/ Thatch Palm	EPMA (2019) protected, Regional Endemic per Pratt et al. (1997)
Mangifera indica	Mango	
Azadirachta indica	Neem	
Morinda citrifolia	Noni	
Nerium oleander	Oleander	
Bauhinia variegata	Poor Man's Orchid	
Ficus elastica	Rubber Tree	
Lantana camara	Sage	
Coccoloba uvifera	Sea Grape	
Thespesia populnea	Seaside Mahoe	
Albizia lebbeck	Shak-Shak	
Conocarpus erectus var. sericeus	Silver Buttonwood	
Jacquinia arborea	Torchwood	Regional Endemic per Pratt et al. (1997)
Vachellia tortuosa	Twisted Acacia	Invasive
Ficus benjamina	Weeping fig	
Swietenia mahagoni	West Indian Mahogany	EPMA (2019) protected
Tabebuia heterophylla	White Cedar	Regional Endemic per Pratt et al. (1997)
Yucca sp.	Yucca	

Figure 5.22: Map showing GPS locations of large trees and protected plant species on the development site.

Table 5.6: Tree species and the waypoints showing their locations

Scientific name	Common name	GPS field location	Notes
Agave karatto	Agave	1313, 1314	
Terminalia catappa	Almond	1316, 1317	Both large
Conocarpus erectus	Buttonwood	1313	
Phoenix dactylifera	Date Palm	1324	Low-lying wetland area by entrance gate
Caryota sp.	Fishtail Palm	1344, 1346	
Delonix regia	Flamboyant	1318, 1342, 1343	
Gliricidia sepium	Gliricidia	1319, 1320	
Coccothrinax barbadensis	Palmetto/ Thatch Palm	1331	Located in a low-lying damp area
Mangifera indica	Mango	1316	
Azadirachta indica	Neem	1328, 1333, 1335	
	Palms	1313, 1318, 1319, 1320, 1322, 1324, 1328, 1337, 1339, 1341, 1346	Various species of small trees
Coccoloba uvifera	Sea Grape	1318, 1320, 1339	
Ficus benjamina	Weeping fig	1318, 1346	Row of large trees along the border of the

			meadow to the east of the site
Swietenia mahagoni	West Indian Mahogany	1310, 1329, 1331, 1332, 1334, 1335, 1337, 1339, 1343, 1344	
Tabebuia heterophylla	White Cedar	1311, 1312, 1313, 1314, 1315, 1321, 1323, 1324, 1326, 1327, 1328, 1331, 1334, 1340, 1341, 1342, 1345	#1315-1317 Row along the northern fence line. #1324 and 1340 is a grove of juvenile plants ideal for salvage.

Figure 5.23: (a) 1313, Australian pine and Imperial Palms on the beach at the mouth of the flushing canal, (b) 1318, row of large weeping fig trees bordering the meadow to the east of the site, (c) 1324, large date palm by the entry gate, and (d) 1344, large West Indian mahogany trees by the main entrance of the hotel.

The current development plan identifies several trees that will be preserved (Figure 2.5), however, there are species onsite protected under the EPMA (2019) and should be preserved where possible (Figure 5.24). Large trees with girth greater than 180 cm are also protected under this Act. The EMMP in Section 8.4.2 of the ESIA details the recommended, site-specific, sensitive vegetation environmental process, management, and mitigation actions. However, in summary, there are protected species onsite that are not marked on the current development plan, which include:

- Agave is protected under the EPMA (2019), and there are several large individuals along the flushing canal. These should be salvaged and relocated.
- Buttonwood is protected under the EPMA (2019), and one individual is located on the bank of the flushing canal.

- Weeping Fig is not a protected species, however, there is an entire row of large individuals between 1317 and 1318, with one particularly large one at 1318.
- A West Indian Mahogany tree at GPS location 1310 should be preserved, but all other mahoganies on the development site were marked for preservation.
- Many White Cedars, a regionally endemic species, that were not identified for preservation, were located at 1311, 1312, 1313, 1321, 1323, 1324, 1326, 1327, 1328, 1342 and 1345 (Figure 5.24). An entire row of large White Cedar trees extends along the northern border of the property between 1314 and 1317, and there are several groves of juvenile trees that could be salvaged and used in the new landscaping at 1324 and 1340.

Once removed, it will take many years for these mature trees to functionally be replaced. Their value to the development is high and they should be incorporated into the landscaping plan where possible.

Figure 5.24: Overlay of trees planned for preservation in the development on the GPS locations of large trees and protected species from vegetation surveys.

5.2.2 Rare or endangered species

Endangered wildlife species in Antigua and Barbuda include several bird species including the West Indian Whistling-Duck and White-crowned Pigeon; reptiles including the Lesser Antillean Iguana (*Iguana delicatissima*) and the Antigua ground snake (*Alsophis antillensis antiguae*) (SIRMZP, 2011). These are unlikely to exist in the Jolly Harbour area as it is already highly developed with few natural areas.

Four endangered sea turtle species are also found in Antigua. At least one species, the critically endangered hawksbill turtle (*Eretmochelys imbricata*) is found in Lignum Vitae Bay (Figure 5.25). Ten hawksbill sea turtle nests were laid on Lignum Vitae beach between 2015-2020 (Deborah Brosnan & Associates, 2020; Eckert & Eckert, 2019). Sea turtles require specific conditions and vegetation for nesting, which no longer occur on Jolly Beach. The development has the opportunity to create habitat more suitable to sea turtle nesting via landscaping.

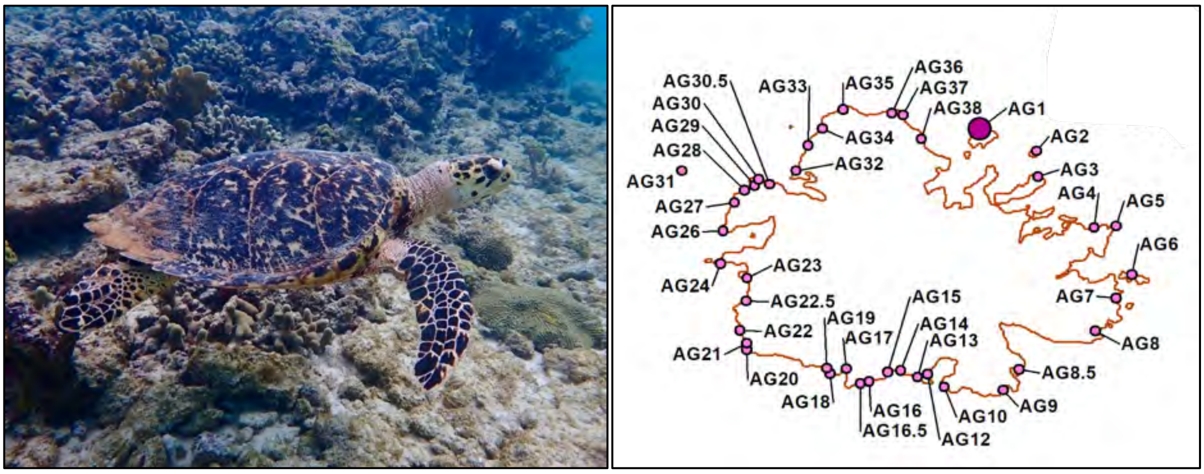

Figure 5.25: (a) A hawksbill turtle and (b) map of Antigua's hawksbill nesting beaches, where AG23 represents Jolly Beach (Eckert & Eckert, 2019).

5.2.3 Sensitive marine habitats

Lignum Vitae Bay is located on the western coast of Antigua and is not classified as a critical environmental area under SIRZMP (2011), although at the time, it was shown to be surrounded by critical seagrass habitat (Figure 5.27). Under the Physical Planning Act (2003), seagrass ecosystem habitat function must be maintained during any development.

During the period this EIA was completed, it was not possible to conduct *in situ* marine surveys due to the high turbidity of the nearshore waters. During site visits in November and December 2023, and January and March 2024 visibility was less than 0.5 m and it was not possible to see the seafloor. This type of high turbidity is visible in satellite imagery from December 2019 and November 2021 (Google Earth, Figure 5.28). However, in March 2024, seagrass samples were collected between the shoreline and 100 m offshore by freediving. This indicated that seagrass beds nearer shore were composed of *Syringodium filiforme* (manatee grass) and *Halodule wrightii* (shoal grass) and transitioned to include *Thalassia testudinum* (turtle grass) from approximately 50 m from shore (Figure 5.26). No individuals of the non-native paddle grass (*Halophila stipulacea)* were observed. It has been previously reported that the seagrass meadows are predominantly composed of *Thalassia testudinum* and associated green algae species (Deborah Brosnan & Associates, 2020). The composition of the seagrass beds with the three predominant species present in Antigua and Barbuda is indicative of a healthy seagrass system.

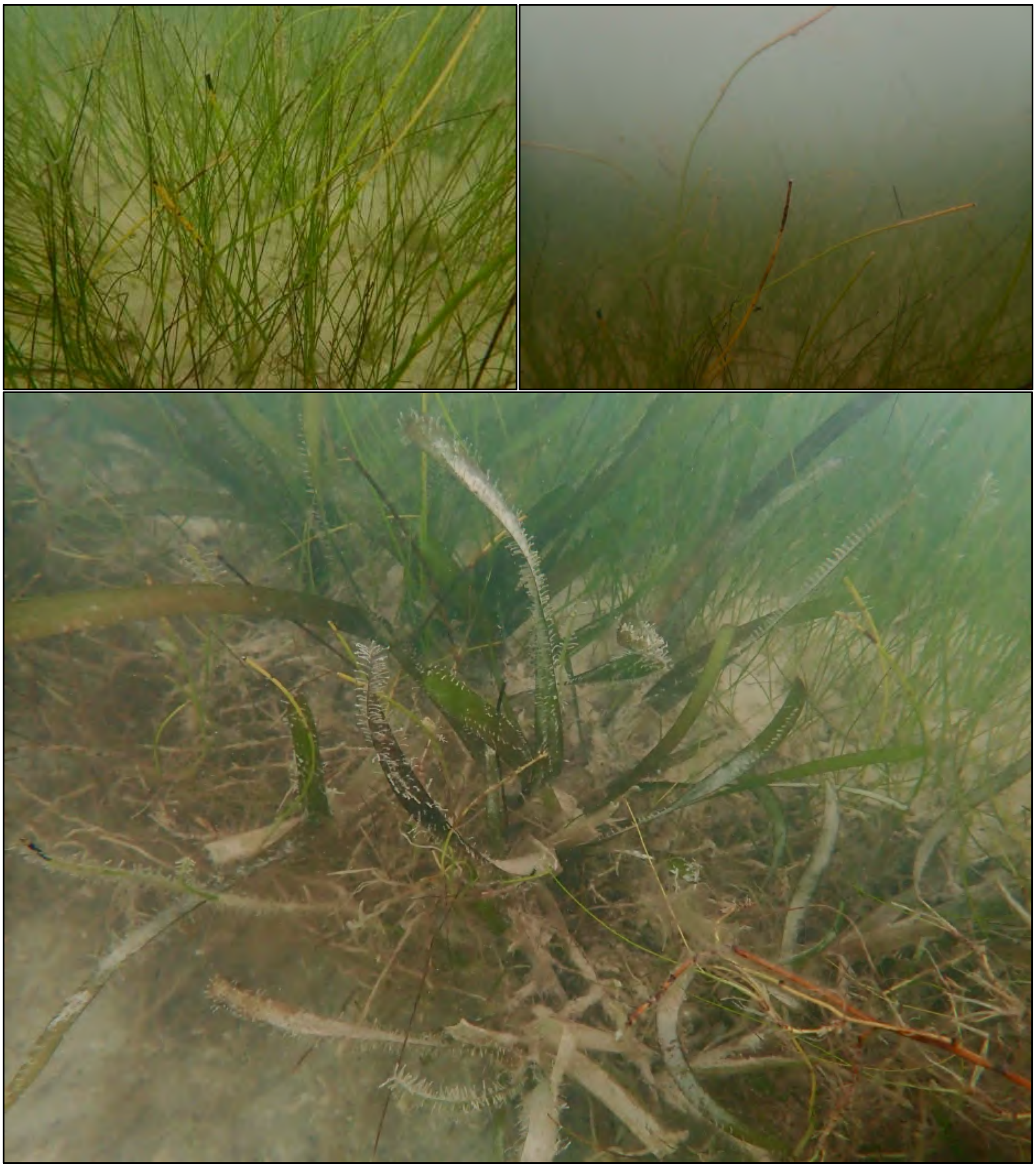

Figure 5.26: The seagrass community composition between 0-100 m from Jolly Beach into Lignum Vitae Bay, where (b) also shows the poor visibility due to high turbidity.

To examine the entire area, assessment of the marine environment using satellite imagery available on Google Earth was also performed. Clear images were available from February and August 2019, April 2020 and July 2022 (Figure 5.29). In February 2019, a sandy substrate with no solid coral reef habitat and sparse seagrass or algae is clearly visible. Benthic density of seagrass strongly increased by August 2019. It was visibly patchy again in April 2020, and showed solid benthic cover in August 2022. This suggests seasonality to the benthic cover in Lignum Vitae Bay, where seagrass cover is greater in the summer months. This result aligns with findings from seagrass seasonality studies (Metz et al 2020, van Tussenbroek et al 2014).

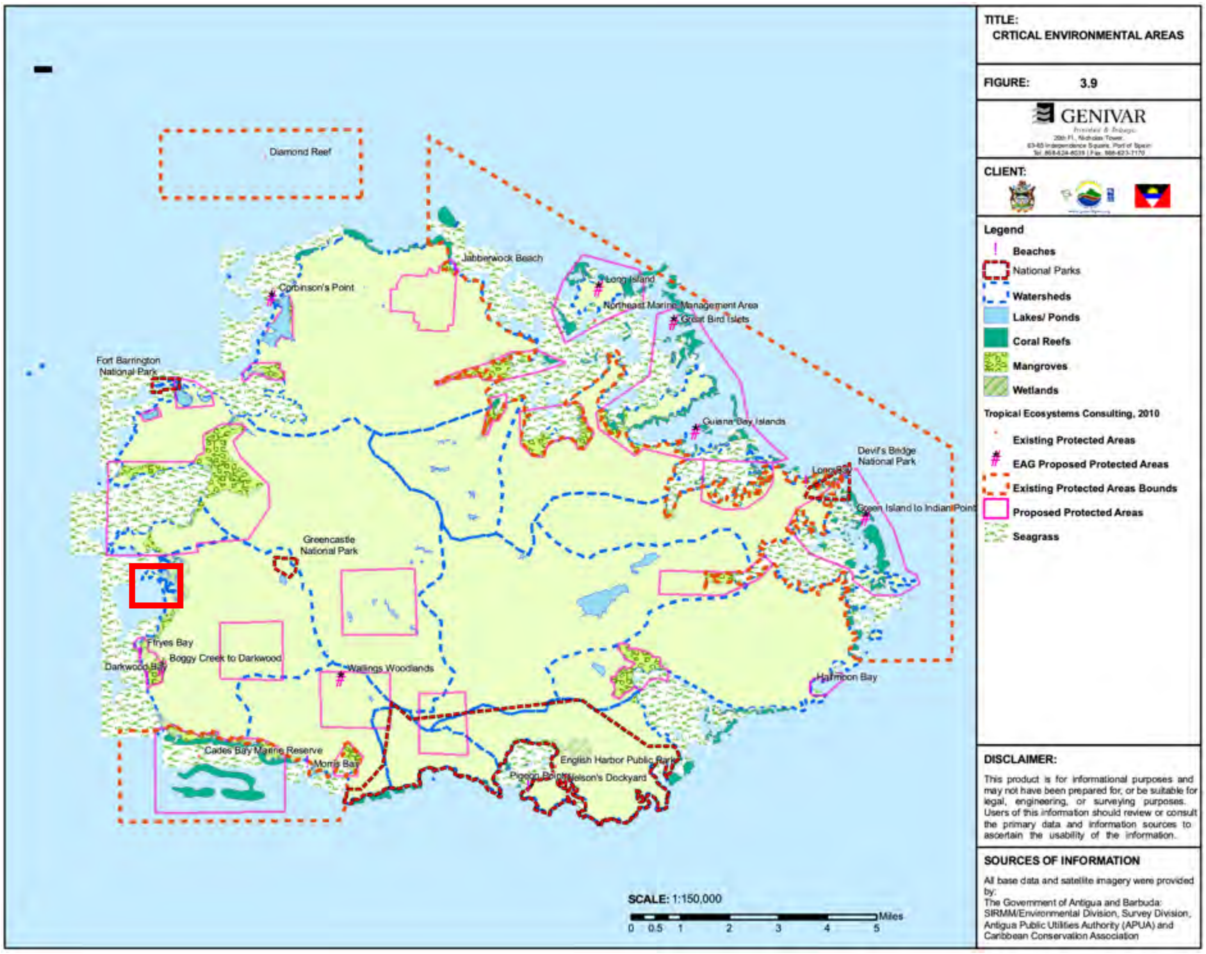

Figure 5.27: Critical environmental areas (SIRZMP, 2011)

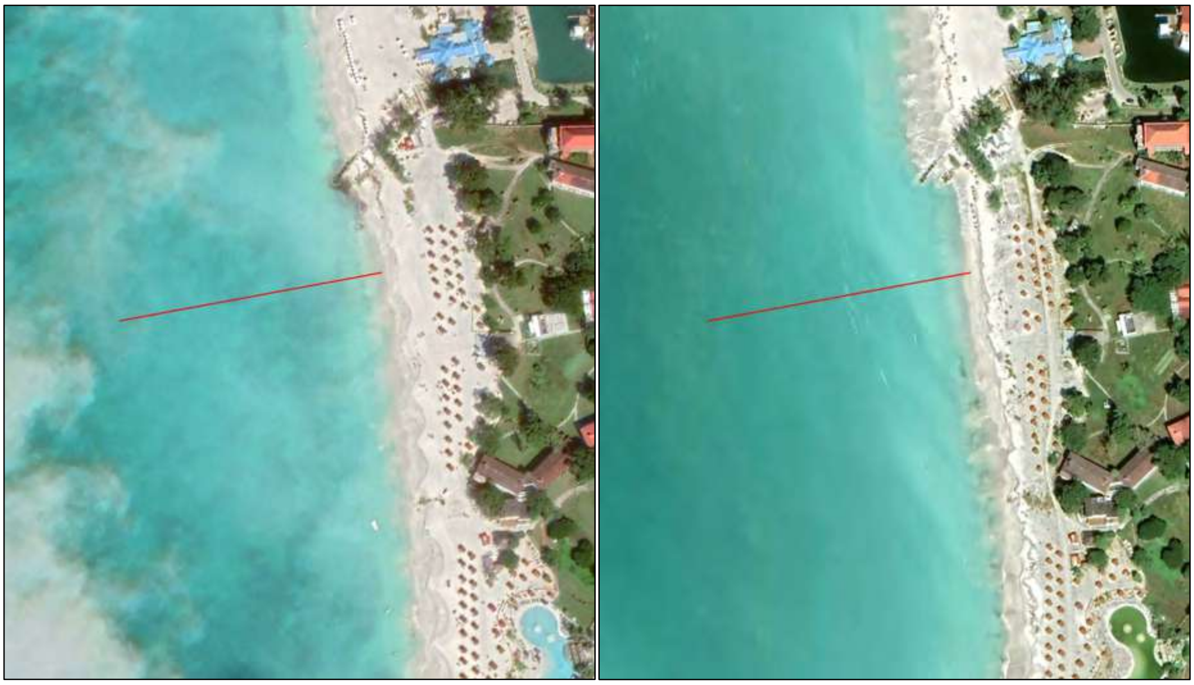

Figure 5.28: Examples of high-turbidity water and sediment plumes in Lignum Vitae Bay in (a) December 2019 and (b) November 2021. The red reference line extends 150 m from shore.

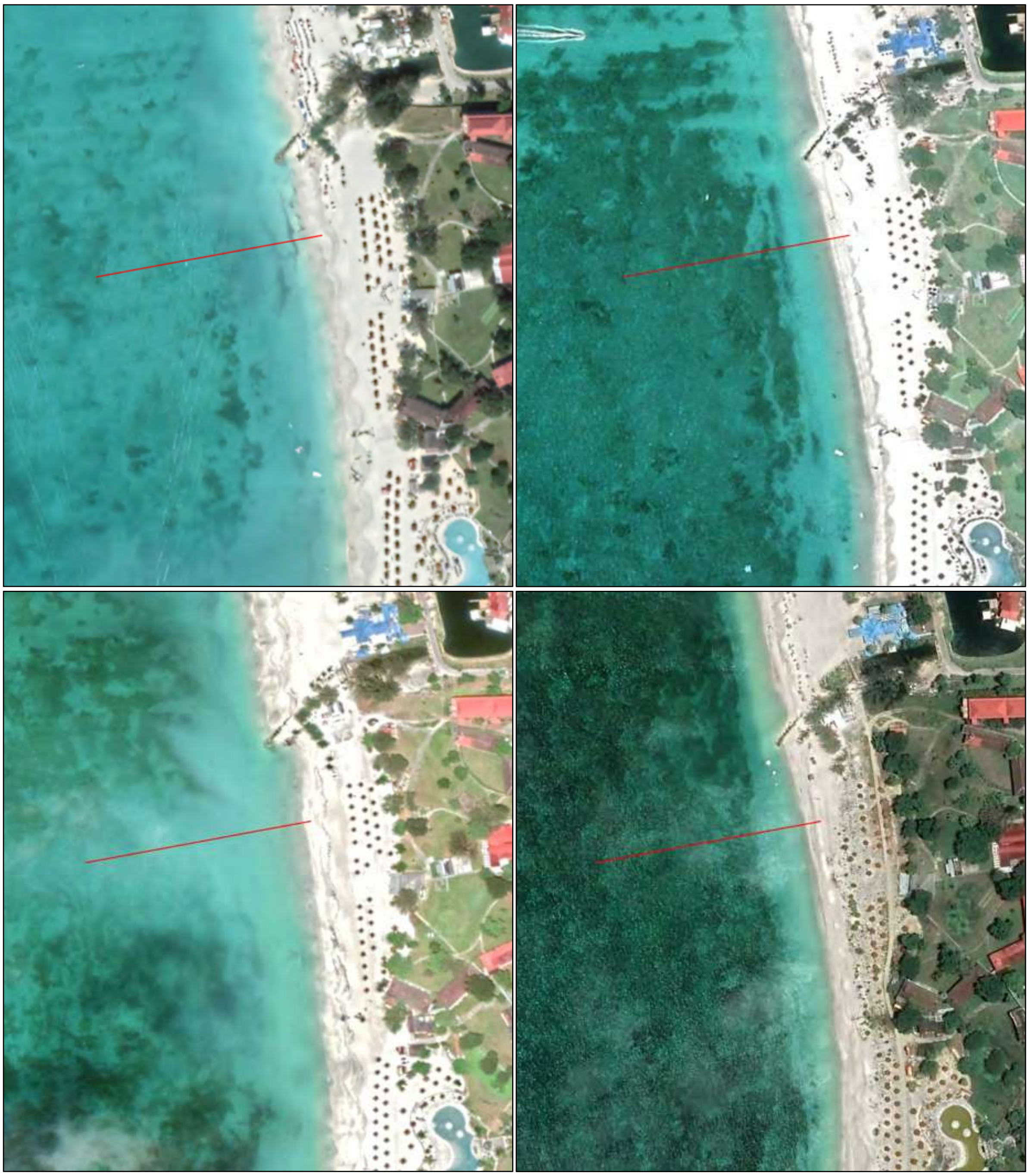

Figure 5.29: Satellite imagery of the nearshore waters in Lignum Vitae Bay in (a) February 2019, (b) August 2019, (c) April 2020, and (d) July 2022. The red reference line extends 150 m from shore.

5.2.4 Species of commercial importance

Near-shore fisheries, including snapper, grouper, conch, and lobster, are commercially important in Antiguan waters. None of these species have specifically been recorded in the nearshore waters of Lignum Vitae Bay. The seagrass beds within the Bay are potential habitat for Queen conch, however, their presence could not be confirmed during recent survey attempts due to high turbidity and low visibility.

5.2.5 Species with the potential to become nuisances or vectors

Mosquitoes are common in Antigua, where areas of stagnant water allow them to breed. In Jolly Harbour, Caribbean Development Antigua Ltd (CDAL) is proactive in addressing the mosquito population, and fogging of mosquito control substances takes place around the development. Proactive control measures and mitigation, including continual removal of standing water and fogging before mosquito outbreaks occur, minimize social and environmental impacts. Mosquitoes are vectors for several diseases including dengue, zika and chikungunya.

During vegetation surveys of the site, several nuisance plant species were recorded, including acacia, love vine and burr bush. These should be removed from the site during the course of the development phase.

Mongooses (*Herpestes javanicus*) are weasel-like animals and feed opportunistically on birds, small mammals, reptiles, insects, fruits and plants, as well as the eggs of endangered sea turtles. They are an invasive species in Antigua and Barbuda, but removal efforts by trapping have been limited to Antigua's smaller islands rather than the main island.

5.3. Natural hazards

5.3.1 Tropical storms and hurricanes

Antigua is located in the Atlantic hurricane belt, where the typical hurricane season is between June and November annually. The Lesser Antilles of the Northeast, including Antigua, are hit, on average, by three tropical depressions (DT) per decade, representing a moderate rate of cyclonic activity. Antigua is located on the west side of the major region for the development of the DT ("Tropical Depression Main Development Region"). This region represents a corridor, oriented from east to west in the North Atlantic, where waves from Africa develop in DT in the Cape Verde region and eventually travel to the Caribbean and the Americas. The maximum frequency of DT that affects this region per decade is 4-5, which is similar to the frequency observed in the Gulf of Mexico and the western region of the Caribbean Sea. Overall, this is a lower rate than the 6-7 TD per decade that effect the US coast (Rey et al 2019). NOAA's historical hurricane tracker indicates that 47 category 1-5 hurricanes passed within 50 km of Antigua, of which 5 hurricanes were category 4 and 5 between 1842-2022 (Figure 5.30).

Antigua's Physical Development Plan (SIRMZP, 2011) requires hurricane-resistant building guidelines to be applied for all construction throughout Antigua and Barbuda. Buildings in the development are being designed to meet the requirements of the 2021 International Building Code (IBC). The wind loads used for the structural design of the main lateral force resisting system are code prescribed from IBC 2021 with an ultimate design wind speed (700 year return period) of 160 mph. The 160 mph ultimate design wind speed is provided in the Organization of Eastern Caribbean States Building Code 7th Edition (OECS 2016).

The development site is classified to be at moderate risk of flooding due to its proximity to the sea and low elevation (Figure 5.11). Jolly Beach is classified as having low risk of erosion (Figure 5.11). In 1988, Lignum Vitae Bay was eroding at 0.75 m/year (CCA 1991), but between 1996 and 2001, accretion was the dominant process along this beach, where the mean profile area and width increased by 5.24 m^2 and at a rate of 0.23 m/yr., respectively (James, 2003).

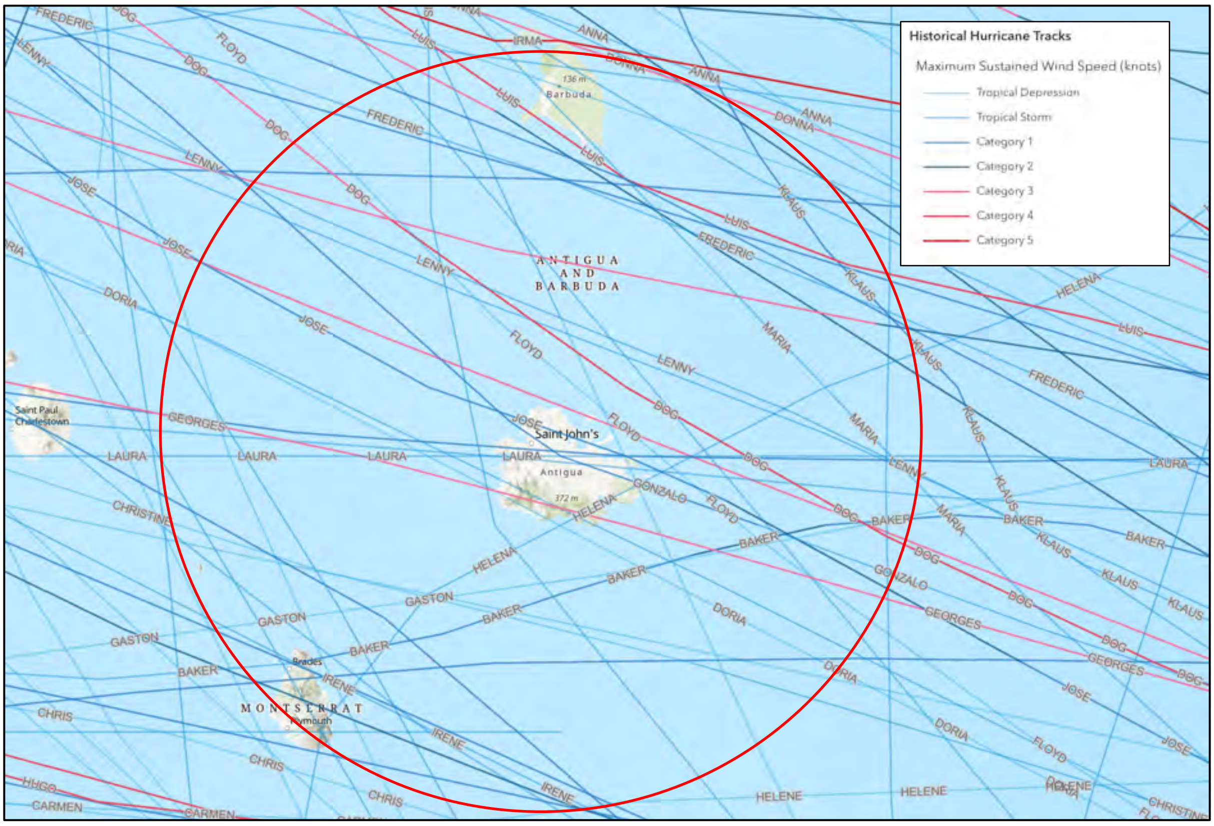

Figure 5.30: Hurricane tracks within 50 km of Antigua (delineated in red) between 1842-2022 (NOAA)

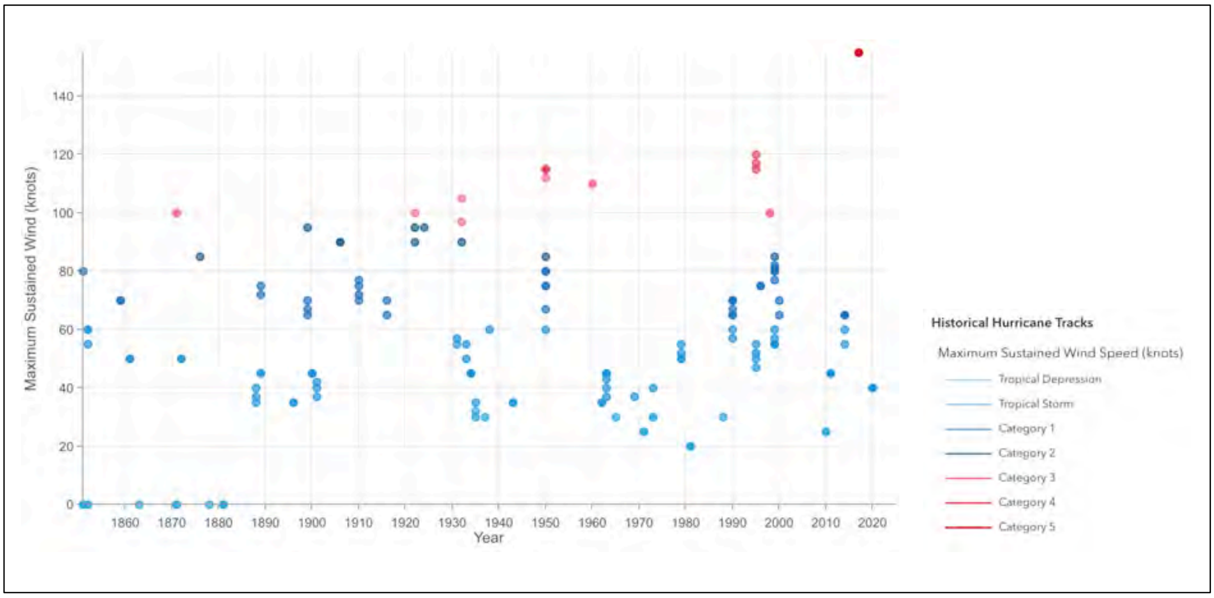

Figure 5.31: Hurricanes within 50 km of Antigua between 1842-2022 (NOAA)

5.3.2 Tsunamis

The Caribbean region is exposed to several hazards such as cyclone, seismic, eruptive and tsunami hazards. While tropical hurricanes affect the region frequently, tsunamis are rarer. Between the years 1482 and 2000, 91 possible tsunamis were documented (Figure 5.32). Of these, 53 were defined as "probable tsunamis" and of these, 19 were confirmed as tsunami waves and swells, some more than 10 m high. The last destructive tsunami in the Caribbean occurred in August 1946. Large destructive tsunamis usually occur at intervals of about 21 years and their effects are often limited to certain coasts or islands and not to the entire region.

Antigua lies on the tectonic plate boundary between the North American plate and Caribbean plate. The resulting volcanic activity and earthquakes may generate tsunamis. One of the earliest earthquake-generated tsunamis was recorded in Antigua on April 6, 1690, and was triggered by landslides at Nevis peak (UWI Seismic Research Centre, 2010). Antigua was also affected by another tsunami on November 18, 1867, caused by an earthquake and associated underwater landslide in the Virgin Islands. The most recent tsunami to effect Antigua was on December 25, 1969 (Zahibo & Pelinovsky, 2001).

The strength of the generating event and the distance from the source largely determine the type and intensity of tsunamis. If a tsunami was triggered by an earthquake in Nevis or volcanic activity in Montserrat, waves of 2-3 m could impact Antigua within 15 minutes (Pelinovsky et al., 2004). Nevis lies directly to the west of Antigua and if a tsunami event was triggered there, not only the Nikki Beach Hotel, but the entire west coast of the island, including Jolly Harbour and St. Johns, would be impacted. Coastal low-lying areas are naturally the most vulnerable during tsunamis as they are easily flooded, but areas up to 3 km inland have been previously impacted. The orientation of the coastline also plays an important role in local effects. For example, following a tsunami caused by an earthquake in November 1867, Basseterre in Guadeloupe reported a 1 m tsunami, while Pointe-à-Pitre warned of only a slight swell.

There are four sources of tsunamis in the Caribbean, which are described in the following sections.

5.3.2.1. Teletsunamis

These tsunamis result from tectonic events originating 1,000 km or more from the island. They are rare and devastating. According to historical reports, only two teletsunamis affected the Caribbean, both of which originated from the coast of Portugal. The first, from Lisbon, Portugal in 1755, took 9.5 hours to reach the Caribbean. A second teletsunami, generated by an aftershock in 1761, had no serious impacts in the Caribbean. Teletsunamis are damaging events, so the many hours between the tectonic event and the arrival of the wave in the region allows nations to prepare. If a similar event were to happen again, the large areas of the coastline of Antigua would be threatened and the evacuation of all citizens to high shelters would be necessary.

5.3.2.2. Tsunamis generated by a landslide

These tsunamis are created by landslides and underwater collapses at sea. These tsunamis are usually triggered by earthquakes and their destructive effects are frequently limited to areas in the vicinity of the original event. As the source of a landslide is normally near the shoreline, the warning time can be only a few minutes. This is the source of previous tsunamis effecting Antigua, triggered by landslides in Nevis. Since Nevis is directly to the west of Antigua, Jolly Harbour would be affected by any tsunami from this origin.

5.3.2.3. Volcanic tsunamis

Volcanoes can generate tsunamis in several ways, including explosion, caldera collapse, and pyroclastic flows. The size and impact of the wave created is related to the physical importance of the event (for example, the amount of material flowing into the ocean during a pyroclastic event), the distance from the volcanic event, and the orientation of the coastline. This is the most common type of tsunami in the Eastern Caribbean. The most recent volcanic tsunami to impact Antigua followed an eruption of the volcano in Montserrat in 1997. Montserrat reported a tsunami flooding of adjacent rivers and bays, Guadeloupe was only slightly affected and other islands including as far north as St Barths reported small tsunami like waves and conditions.

5.3.2.4. Tsunamis of tectonic origin

These tsunamis are generated by earthquakes created by the movement of tectonic plates. Typically, an earthquake must be 8.0 mV or higher to trigger a major tsunami. However, smaller earthquakes can produce waves that have the capacity to damage coastlines on a regional scale. For tsunamis triggered near land regions, the preventive time is on average 30-60 minutes, which is usually enough to evacuate low-density underground places. This type of tsunami nevertheless would affect the entire beach and possibly a large part of the coastline of the island.

Some parts of the Caribbean are more susceptible to certain types of tsunamis. For example, Jamaica is more at risk for tsunamis related to landslides, while Puerto Rico and the Virgin Islands are more likely to be affected by tsunamis of tectonic origin. At-risk populations are advised to watch for a recession of the sea after an earthquake and to take shelter on higher ground. In the Eastern Caribbean, including Antigua, most tsunamis come from volcanic activity and earthquakes. Since volcanic eruptions can last for several days or even months or years, local authorities should advise residents to make appropriate decisions.

5.3.2.5. Tsunami risks for the Nikki Beach Resort

In the event of a tsunami striking Jolly Harbour, the clientele and employees of Nikki Beach Resort and all other adjacent hotels and villas as well as individuals on the beach will be at similar risk. Any underground hotel facilities represent the greatest risk for the hotel.

A tsunami resulting from volcanic or seismic activity in Montserrat -the most likely source, or potentially Nevis would transmit rapidly to Antigua. In the event of a tsunami of tectonic origin, which is much rarer, the warning time of at least 30 to 60 minutes is anticipated.

At the national level, the government (NODS) is responsible for managing the risks associated with natural disasters as outlined in the Disaster Management Act (2002). The agency has previously conducted tsunami exercises. Additional information on tsunami warning services and programmes in the Caribbean and adjacent areas is provided in the Caribbean Tsunami Warning Program (CTWP).

In addition to government-led procedures, there are steps that the hotel can also take. To mitigate tsunami risks, Nikki Beach Resort should install warnings and establish an evacuation plan. Guests and staff should be educated to recognize the warning signs of tsunami such as ocean retreat and should be instructed to move quickly to a higher place. Directional signs and fact sheets should be placed in hotel rooms and rooms (Table 5.7) and annual disaster response training can be provided to hotel staff. These steps are part of a standard preparation.

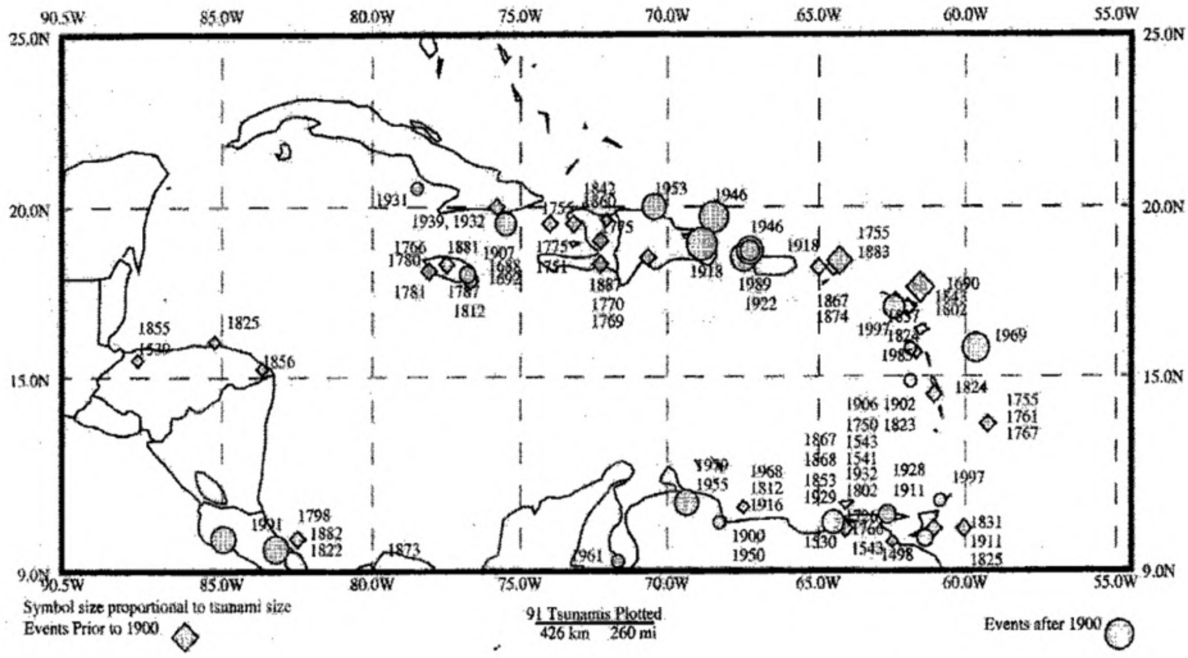

Figure 5.32: Location of 91 possible tsunamis in the Caribbean between 1482 and 2000 (Source: Lander et al 2002)

Table 5.7: Universal signs for tsunamis

		
Area susceptible to tsunamis	High ground shelter site: the sign is placed at a designated location as high ground that serves as a tsunami shelter	Shelter site in a building: the sign is placed at the entrance of a large building designated as a tsunami shelter area

5.3.2.6. Evacuation instructions for the Nikki Beach Resort

It is recommended that Nikki Beach Resort institute an evacuation plan and instructions according to the "Guide to Tsunamis for Hotels" created by the Intergovernmental Oceanographic Commission of UNESCO (Appendix 8). The Guide outlines the steps needed to develop a comprehensive plan, such as preliminary readiness assessment using a checklist, recognizing warning signs, choosing an evacuation strategy, considering the hotel as an evacuation zone, and standard tsunami operating procedures.

This guide is divided into five sections. The first section provides a brief description of tsunamis and explains the importance of managing this hazard in the hotel industry. Section 2 describes the risk of tsunami in the North-East Atlantic and Mediterranean Seas (all applicable to the Caribbean) and the measures that have been taken to reduce the impact of this hazard. The third section explains how to increase the effectiveness of precautions and elaborates on three different situations that influence evacuation strategies. Section 4 explains the prerequisite for establishing the hotel as an evacuation zone. Finally, the final section explains the standard planning and evacuation procedures that can serve as operational procedures for the Resort in the event of a tsunami. It is recommended that Nikki Beach Resort develop an evacuation plan as part of a participatory approach (with hotel staff and management), to increase ownership of the plan by all.

5.3.3 Earthquakes

The Leeward Islands area, which includes Antigua, is the most seismically active zone in the Eastern Caribbean due to the subduction zone between the Caribbean plate and the North American plate. These earthquakes are generated up to 200 km beneath the earth's surface. The largest earthquakes in the region since the 1600s have been recorded in this area (UWI Seismic Research Centre, 2024).The average number of background earthquakes is relatively consistent, with the island being affected approximately every 13 days. Between 16-40 earthquakes with magnitude 4+ were detected annually between 2014 and 2024. Activity in the area has been elevated since 2011, which may be the precursor for earthquakes of more significant magnitude (UWI Seismic Research Centre, 2024).

In modern times, the largest earthquake recorded with an epicentre within proximity to Antigua was in 1974 with a magnitude of 7.4 (UWI Seismic Research Centre, 2024). Larger un-reinforced buildings such as churches, public buildings and the West Indies Oil refinery took the brunt of the damage. Land slippage was evident in some areas like Deep Water Harbour. The region's largest earthquake was in 1843 with a magnitude of 8.0-8.5, which severely impacted Antigua.

Hazards from earthquake activity result from the effect of the ground shaking. Buildings can be damaged by the shaking itself or from the subsidence of the ground settling at a different level than before the earthquake. In Antigua, rock-falls and landslides are significant hazards (NODS, 2017). A primary hazard, particularly for low-lying sites close to the water table like Jolly Harbour, is soil liquefaction. This is the destabilization of sand or soil when groundwater is forced out from between the grains by the shaking. When this occurs, the strength of the substrate is reduced and may cause land slippage and the failure of building foundations.

The architects have taken account of the seismicity risks in the design of the hotel. The seismic loads used for the structural design of the main lateral force resisting system are code preserved from IBC 2021 with mapped accelerations from OECS 2016. The OECS 2016 indicates short period (0.2 sec) acceleration Ss as 1.513 g and the 1-second (S1) acceleration as 0.457 g. The main lateral force resisting system for the structures is reinforced concrete shear walls with reinforcement detailing for seismic design category D structures.

Earthquake preparedness for Antigua at a national level is described by the Country Document for Disaster Risk Reduction: Antigua and Barbuda, 2016 (NODS, 2017) and the CDEMA Standard for Tsunami/Earthquake Drill (CDEMA, 2015). Earthquake risk in Antigua was assigned a hazard priority score of 1 out of 6 based on frequency and severity of past effects (NODS, 2017).

5.3.4 Climate Change

The Caribbean islands are considered at high risk from climate change due to changes in the frequency and intensity of natural disasters, like hurricanes, floods and droughts forecast as well as rising sea levels and coastal erosion leading to greater beach loss. Sea temperatures in the Caribbean region were among the hottest recorded in 2023. By mid-July 2023, NOAA reported water temperatures throughout the Gulf of Mexico and in the Caribbean Sea as approximately 1-3˚C (1.8-5.4˚F) warmer than normal (NOAA, 2023). Coral bleaching (driven by higher temperatures) was prevalent throughout the Caribbean in 2023, and in September 2023, cumulative heat stress hit 22°C-weeks (40°F-weeks), nearly triple the previous record for the region. NOAA issued a bleaching level 2 alert (the highest level) in August 2023, which continued through to mid-October (Hansen, 2023). In Antigua, the Elkhorn Marine Conservancy reported large losses in coral cover due to bleaching, with survival of only 30% of their nursery corals (Elkhorn Marine Conservancy, 2023).

Global temperatures on land have also soared in recent years including in the Caribbean; Antigua recorded temperature of 33°C in both August and September 2023 (WorldBank, n.d.-b). Average temperatures have increased between 1920 and 2024 (Figure 5.33), where the average temperature across that 104-year period was 26.6°C. All temperatures have been above that mean line since 1980 (Figure 5.33). While in the Paris Climate Agreement, countries pledged to limit global warming to less than 2°C, aiming for 1.5°C, a recent World Meteorological Climate update indicated a 66% likelihood of exceeding 1.5°C increase between 2023 and 2027.

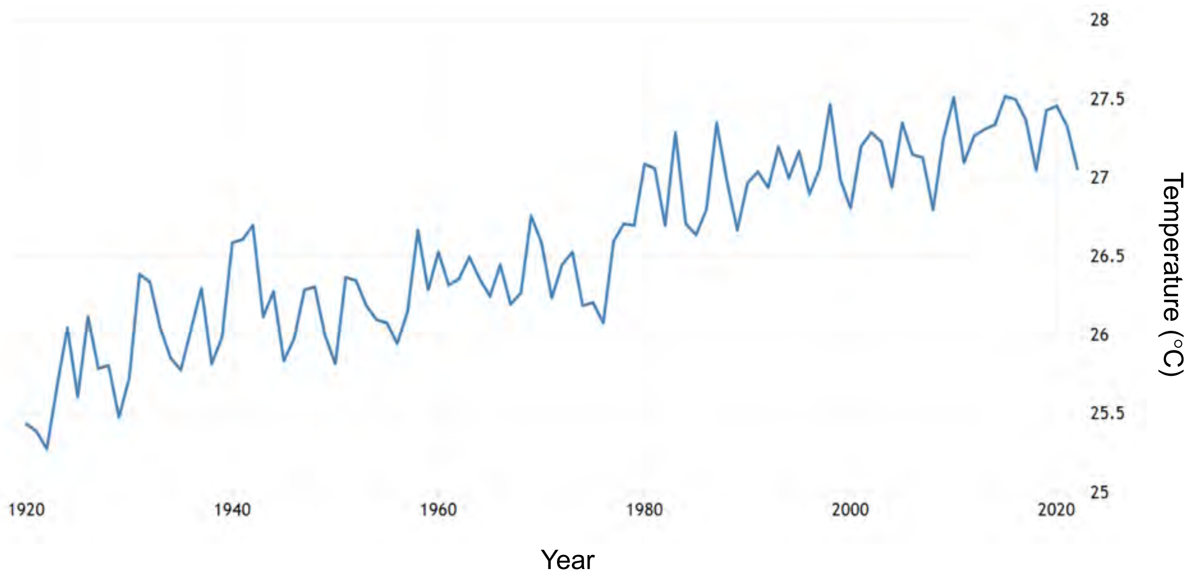

Figure 5.33: Monthly temperature data in Antigua and Barbuda between 1920-2024 (WorldBank, n.d.-b).

Sea level rise resulting from climate change is a very real threat to Caribbean Small Island States, like Antigua and Barbuda. In the Caribbean, it is estimated that this will result in a 0.3-1 m rise in sea level by 2050, affecting the 28 million people who live on the coast. Many of the island's most populated and economically important coastal areas have flat, low-lying topography and porous bedrock. This will have a direct effect on the potential for more damaging storm surge and flooding in coastal areas like Jolly Harbour and Lignum Vitae Bay. Beach loss from rising sea level and storms is a major concern for several beaches in Antigua and Barbuda. The cost of natural disasters to small island states is a huge burden, with droughts causing chronic losses in agriculture, and large hurricanes requiring many years and billions of dollars for recovery.

Sargassum

Since 2011, unprecedented influxes of pelagic sargassum have impacted Caribbean islands. While not caused by climate change, sargassum growth is exacerbated by it: climate change has warmed ocean waters and given the seaweed a more hospitable environment in which to grow (University of Florida 2023 cited in Rivero (2023)). Although Jolly Harbour is on the west coast of Antigua and is minimally affected by sargassum influxes, the overall presence of sargassum has negatively impacted tourism to Caribbean islands.

5.4. Socio-Economic & Health Environment

Jolly Harbour is a township on Antigua and is located on the southwest coast of the island in the Saint Mary Parish. The nearest settlement is Bolands. Jolly Harbour was development into a major hub for tourism in Antigua in the 1980s, which has been extensively described in Section 5.0 of this report. This development model has generally proven to be successful, but there is limited area for expansion of Jolly Harbour due to land constraints. The nature of the development also separates tourist and local residential areas, which has led to social and economic distortion. Presently, any development plans should consider the integration of aspects of local communities into both construction and operational phases.

The last population census in 2011(GoAB Statistics Division, 2011) indicated that 74.7% of the resident population in Jolly Harbour were of African descent and 17.8% were of Caucasian descent. These residents were predominantly citizens of Antigua and Barbuda (73.0%), followed by Jamaica (5.06%), the United Kingdom (4.9%), and Canada (3.09%). The primary religion in the area is Anglican (20.3%), followed by Adventist (13.0%), Roman Catholic (10.5%) and Pentecostal (10.1%).

Tourism drives employment and the economy in Jolly Harbour and Antigua as a whole (SIRMZP 2011). Jolly Harbour contains one all-inclusive resort, with several other hotels and resorts within 10 km. Currently, there are several shops and restaurants within the development, as well as a major supermarket. Jolly Harbour marina facilitates the operation of specialized trades related to yachting. Yachting tourism is also a considerable part of the economy in Jolly Harbour from both resident and transient yachts.

Jolly Beach is the primary beach in Jolly Harbour and is used by both tourists and locals. Currently, there is a public access on the proposed development site, which is utilized by vendors selling souvenirs and food, taxis, and locals and tourists to access the beach. Under the Antigua and Barbuda Physical Planning Act 2003 (Section 50) all beaches are public, and access must be provided. Public access to the beach must be maintained at intervals of 1 km (0.6 miles) or less (SIRMZP 2011). Although the development site is only 0.3 km long along the beachfront, a public access may need to be maintained as the other access to the southern end of Jolly Beach (0.7 km away) is via a long, unpaved, and overgrown track.

The development includes multiple three-story blocks of hotel rooms and apartments. This will aesthetically change the environment and will impact the view and shading of immediate neighbours.

In the ToR for this ESIA, the DoE specifically requested a focus on the vendor community at Jolly Harbor beach. A socio-economic baseline observation study was conducted as outlined by Dr. Liliana Duica Amaya, an Adjunct Professor in the Department of Anthropology at Georgetown University, Washington, D.C. Dr. Duica Amaya has extensive experience in stakeholder assessment for developments using qualitative methods. This baseline study specifically does not include interviewing or interacting with stakeholders to avoid biasing the data, but focuses on observation of normal activities and daily routines.

At this stage in the social analysis, the client informed us that there were significant and advanced discussions within the GoAB to create a vendor village to enhance tourism, provide greater economic opportunities for vendors and improve facilities. This village is proposed for a separate location, potentially in the Fryes area. It is proposed to relocate the vendors on

Jolly Beach to this location because of the greater economic opportunities and to provide them with more facilities. Because this is a separate and ongoing effort, we were informed by the client's representative that further activities and studies were not the responsibility of the client but involve the GoAB and the local community.

Therefore, we have included here the baseline observations regarding the vendor community, and the existing facilities and amenities, that at the very least would need to be replicated in any new location. Currently, vendors on and adjacent to the Nikki Beach site have:

- Established vendor sites (in the public access and along the beachfront)
- Easy access to the tourist market arriving by foot or taxi/cars etc.
- Public parking
- Prime location, next to or on the beach visited by both cruise tourists, hotel guests and other visitors
- Access to nearby restaurants.

At the very least these amenities must be provided, although we understand that the intent is to provide more facilities and amenities. For instance, the following amenities would be beneficial:

- Permanent structures that are protected and lockable, to save time and safeguard the vendors' wares.
- Dedicated running water and toilet facilities.
- More consistent and reliable access to the tourism market.

5.4.1 Baseline stakeholder observations

Two groups of stakeholders were identified. The first group includes those of primary importance to the DoE and that were specifically identified in the ToR for this ESIA and in subsequent meetings. They included vendors (selling t-shirts, jewellery and food) both at the existing public access and between the current Jolly Beach Resort and proposed development site (Figure 5.36), and Sandra's Beach Shop, Bar and Grill, a semi-permanent structure near the existing public access (Figure 5.37). The second group includes stakeholders not mentioned by the DoE that would still be impacted by the development and includes beach users and nearby homeowners.

Baseline stakeholder observations were completed on December 12, 2023 and January 10, 2024 between 9:00 am and 5:00 pm on both days. At 9:00 am on both days the public access was quiet, with no vendors or cars. There are 5 tent structures that appear to remain set up at all times (Figure 5.35). There was no activity at the Pop-Up Beach Bar, and Sandra's Beach Shop, Bar and Grill was starting to open. Most beach chairs remain out on the beach overnight and there were some tourists (less than 10) using them in the morning. In the area between the hotels, 2 vendors were open, and 3 were still closed. A jet ski rental tent is also present and remains up overnight.

Tourists begin use the public access to the beach typically around 9:15-9:45 a.m. Since none were driving, it seems likely they were staying in the Jolly Harbour area. Vendors in the beach access began to set up between 9:30 am (in December) and 10:15 am (in January). At this time, deliveries were also made to Sandra's, including petrol and propane. By 10:00 am, the carpark had mostly filled up with cars, but no taxis.

By 11:30 am, some minivan taxis of tourists started to arrive, and they occupied many more of the beach chairs, although less than half the chairs were in use on both days. It is likely that some of these tourists were from cruise ships; on both dates, there were two cruise ships in the port in St. Johns. December 12, 2023 these were the Costa Fortuna (3,470 passengers) and the Royal Clipper (227 passengers), and on January 10, 2024, the Silver Dawn (590 passengers) and Crystal Serenity (1040 passengers).

The Pop-Up Bar and Sandra's both had 10-30 seated guests at any point over the lunch period (approximately 11:30 am -1:00 pm)

By 3:00 pm, vendors in the public access had mostly packed up. Few (less than 10) sales to tourists were observed over both days. Vendors between the Jolly Beach Resort and the Nikki Beach Resort site remained open until about 4:00 pm. At this time, tourists started to leave the beach too, and by 5:00 pm on both days only a few tourists remained on the beach

Visual assessment of nearby residential properties suggested that less than 50% were occupied (based on the presence of peoples, cars, shutters on windows among other signs). In summary vendors were active for a maximum of 7 hours each day. There are many vendor 'huts' by Jolly Beach Resort that did not appear to be in use. Similarly, there are several vendors in an area close to the entrance to Jolly Harbour (Figure 5.36). Sandra's Beach Shop, Bar and Grill is a semi-permanent establishment that is active and frequented by guests

Impact Summary: The Nikki Beach development would increase the vendor access to the tourist market and potentially sales. However, if access is changed it will likely require a change in vendor locations. The Nikki Beach development may see the existing use of the beach for a semi-permanent restaurant and vendor as impacting the development itself. However, as there are discussions ongoing with Government and the community regarding relocation to a dedicated facility, this matter will need to be resolved outside of this discussion and effort.

Figure 5.34: Beach chairs on Jolly Beach looking north.

Figure 5.35: Current users of the public access, including (a) clothing and jewellery vendor, (b) locals, (c) taxis, (d) at lunchtime, food was sold in this tent.

Figure 5.36: Current vendors (a) selling beach chairs and water sports on the beach, (b) in purpose-built huts in front of Jolly Beach Resort, where many of the huts were not in use, (c, d) on the eastern side of Jolly Harbour.

Figure 5.37: Sandra's Beach Shop and Grill

6.0 ANTICIPATED IMPACTS AND MITIGATION MEASURES

During the project, all efforts will be made to avoid and mitigate for environmental impacts. Potential impacts, their severity and any mitigation measures are outlined in Table 6.1. Any impact will be avoided where possible, so there is no effect from the construction or operations of the hotel on the environment. If the impacts are unavoidable, mitigation measures will be implemented on site to reduce the effects. Finally, if an impact cannot be avoided or sufficiently mitigated for on site, compensation for the impact will be undertaken at an external site.

Cumulative impacts typically result from incremental impacts that compound when added to past, present and reasonably foreseeable future actions. Actions by third parties, e.g. governments, other developments, or sectors, are relevant.

Table 6.1: Summary assessment and mitigation of environmental impacts, where risk significance is designated as low, medium or high.

Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
Physical	Water quality	Medium	Prevent excessive runoff or discharge from both the construction site and operations of completed hotel by having adequate waste retention and processing facilities on site. Water used for dust suppression and other construction-related activities will be retained on site. Ensure safe disposal of all waste materials from both construction and operations. Water from the marina, channel and sea adjacent to the site will be tested throughout the construction and operational phases to ensure acceptable levels are maintained in accordance with the water quality standards for Class A waters as outlined in Schedule VII (Part C)(2) of the EPMA (2019). These are fully outlined in Section 8.5.	Low
	Noise pollution	High during construction phase, medium during operational phase	Construction hours can be restricted under the Physical Planning Act, and it is recommended that construction be limited to daylight hours to reduce disruption to neighbouring properties and the biological environment (e.g. nesting sea turtles). During the operational phase, noise levels from the resort will be consistent with that of existing development in Jolly Harbour. Music from the Beach Club is anticipated to contribute towards higher noise pollution in the surrounding area. This should be maintained at reasonable levels to avoid impacting neighbouring properties. The level of this noise will be assessed as part of the noise monitoring requirement of this EIA and the subsequent EMMP.	Low
	Light pollution	Low	Construction will primarily take place during daylight hours so light pollution will be minimal. During the operational phase, lights will be consistent with existing structures and light levels already present within Jolly Harbour.	Low
	Beach erosion	Low	Under current conditions, Jolly Beach is at low risk from erosion according to beach width monitoring by the GoAB and reports by USAID. This trend for beach accretion creates a lower risk environment for this development.	Low

			Measures should still be taken to prevent erosion as changing environmental conditions can impact this accretion rate. No construction will take place on the beach itself and the design does not include any vertical structures on the beach. Erosion controls will be implemented prior to construction and immediately after grading operations. All stockpiled topsoil and sand will be protected from wind/runoff erosion and weed infestation. All traffic into and out of the site will be controlled to minimize erosion and dust. Native dune vegetation will be planted to stabilize beach sand. The required setback for construction of 100 ft from the line of permanent vegetation will be adhered to.	
	Air quality	Medium	During the construction phase dust can be generated and this will be suppressed using water, preventing airborne particles leaving the immediate site area. Freshwater does not need to be used for this. Other methods of dust suppression include: • Clearing vegetation in staged manner. • Use of water trucks to spray down exposed areas or surfaces. • Sealing and/or re-vegetating disturbed areas as soon as possible after completion of each stage of construction works. • Planning haulage routes on sealed surfaces and using dust suppression on unsealed roads within construction sites. • Covering loads on public roads. • Using wind breaks. • Minimizing double-handling of materials. • Seeding, stabilizing, covering, or containing stockpiles where necessary The completed development will benefit from various trees and vegetation that contribute positively to the overall air quality in the area.	Low
	Chemical spills	Low	Various chemicals will be required on site during both construction and operational phases. To reduce risk of spillage and contamination, • Ensure all chemicals are stored and handled in accordance with their Materials Safety Data Sheet (MSDS). • Any chemical spill is treated immediately. • Excavate and remediate and potential contamination of groundwater. • Follow the Disaster Response protocols. More information about managing hazardous materials in a hotel environment and creating a disaster management plan are detailed in.	Low

	Soils	Medium	The soil in this area is neutral to slightly acidic. Clearing and grading of the site will involve disturbance and removal of a portion of the topsoil. This may be replaced by new topsoil once grading/construction are complete, and landscaping commences. Plans to withstand earthquakes and storm surge/flooding are code preserved from IBC 2021 and OECS 2016. During the operating phase, the soils of the plot could be impacted by soil leaching or runoff during rains. These impacts can be managed through pre-designed stormwater and discharge management plans.	Low
Biological	Effects on native vegetation	Low	The site is already developed and there are no primary native assemblages present, although it does contain many native tree and plant species protected under the EPMA (2019). These species should be preserved during this new construction. There is some beach vegetation in the centre of the plot, which forms the line of permanent vegetation. This includes several large Australian pine trees (*Casuarina equisetifolia*), which are an invasive species, as well as several palms and almond trees. Any other beach vegetation that once existed has been completely cleared by the current Jolly Beach Resort. The current plan for the site involves replanting vegetation between the beach and hotel predominantly with native flora.	Low
	Terrestrial wildlife	Low	The terrestrial wildlife populations present will be inconvenienced during the construction phase. Mobile animals such as birds, lizards, etc. will likely relocate and will be able to recolonize the area once the work is finalized. Since the site already represents a degraded environment in an urbanized area, the modification of the study area by the project does not represent the destruction of important bird or wildlife habitat and is not expected to endanger these species nor other very rare bird species.	Low
	Seagrass health	Low	If runoff into coastal waters is controlled, the development is not expected to impact the seagrass habitat off Jolly Beach. The existing environment in Lignum Vitae Bay is already highly turbid and seagrass cover appears to be dynamic.	Low

Infrastructure	Energy usage	Low	A new primary electrical service will be obtained from Antigua Power Utility Authority (APUA). During the operational phase, the estimated electrical load demand for the development will be approximately 10.2 MVA.	Low
	Fresh water usage	Low	During the construction phase, water will be supplied by Jolly Harbour. During operations, water will be supplied to the site from deep-water wells and deep-water rejections wells. Extracted well water will be treated on site by reverse osmosis. Storage of enough potable water for two days and a fire cistern reserve is planned. The potable water supply shall be designed to supply the peak domestic demand and consider the entire build-out in accordance with the approved Site Plan for development.	Low
	Construction waste	Medium	The first stage of the development will be the demolition of existing buildings and removal of waste materials from the site. Waste should be managed using the following protocols from the US EPA (2007): • Designate trash and bulk waste-collection areas on-site • Recycle materials whenever possible (e.g., paper, wood, concrete, oil) • Segregate and provide proper disposal options for hazardous material wastes • Clean up litter and debris from the construction site daily • Locate waste-collection areas away from streets, gutters, watercourses, and storm drains. Waste-collection areas (dumpsters, and such) are often best located near construction site entrances to minimize traffic on disturbed soils. Consider secondary containment around waste collection areas to further minimize the likelihood of contaminated discharges.	Low
	Sewage and wastewater	Low	The sanitary sewer collection and wastewater treatment systems will consider the entire build-out in accordance with the approved Site Plan for development. Wastewater will be treated on site by a decentralized membrane bioreactor treatment plant. Any solid waste from this process will be stored in underground sewage tanks and eventually taken off site. Clear water effluent will be stored on site and used for irrigation of green areas. Clear water from wastewater treatment plants can be high in concentrations of COD, TSS, nitrogen, phosphorus, bacteriology. Quality of this discharge will be in accordance with the	Low

			standards in force at international and national levels. In normal operation, given the discharge quality objectives, the impact of the discharge on the quality of aquatic environments (groundwater, surface, and coastal water) will be negligible.	
	Traffic increases and parking requirements	High during construction phase, medium during operational phase	During the construction phase, an increase in heavy machinery and trucks bringing materials to the site is unavoidable. This may lead to additional congestion on the road between St. John's and Jolly Harbour, and specifically at the single entrance to Jolly Harbour. Construction hours can be restricted under the Physical Planning Act, and it is recommended that construction be limited to daylight hours to reduce disruption to neighbouring properties and the biological environment (e.g. nesting sea turtles). Roads created on the site should be sealed during the construction period to reduce air pollution by dust and particulates. Approximately 150 parking spaces are planned for the site. Increased traffic from cars, taxis and delivery trucks will continue during the operational phase of the hotels due to its operational requirements.	Medium
Socio-economic	Human health	Medium	During the construction phase, health and safety standards will need to be enforced for the safety of the construction crews and staff. Dust and noise will result from the construction and should be minimized to reduce impacts on the workers and community. Specific regulations and actions are recommended in Section 8.6.1. Once operational the project is not expected to create any significant additional risks to human health. The hotel should take recommended precautions to reduce the density of disease-transmitting mosquitos.	Low
	Beach use	Medium	Jolly Beach is currently used by hotel guests, tourists and residents in nearby houses, and locals. The construction of a new hotel will increase beach use based on the planned number of rooms (184 residential units and 82 guestrooms) and occupancy; this northern area of the existing Jolly Beach Hotel is currently used less than the southern side of the hotel/beach and several of the buildings are derelict.	Low

			During socio-economic baseline observations (Section 5.4.1), it is estimated that there were less than 100 recreational beach users at any one time (excluding vendors and other workers) on the section of beach in front of the development site. Conservatively assuming all rooms can accommodate 2 guests, maximum hotel occupancy is 536 persons. Average hotel occupancy in January 2024 was 80.8% (Antigua and Barbuda Hotels and Tourism Association), resulting in approximately 425 guests on site. Approximately half of these may be on the beach during the day, which results in an estimated 213 additional beach users from the hotel alone, which is more than twice as many as present. It is anticipated that the Nikki Beach Beach Club will also attract customers (both tourists and locals), who will utilize the beach. A potential impact is the increase of garbage from daily activities, so appropriate garbage receptacles should be installed. Overall, no long-term impact on this natural resource is expected as Jolly Beach is a large, stable, accreting beach that already used for tourist activities.	
	Relocation of vendors	High	Vendors currently operating on the development site may be required to relocate. This relocation is of central concern to the DCA and DoE. Several options have been proposed for their relocation, including beach vendor huts in front of Jolly Beach Resort and Spa, a proposed artisan and vendor village at Coco Beach, and existing areas for vending near the eastern side of Jolly Harbour which can be expanded. Currently, vendors on and adjacent to the Nikki Beach site have established vendor sites (in public access and along the beachfront), easy access to foot traffic and tourists, public parking, a prime location, next to or on the beach, near both cruise tourists and hotel guests, and easy access to places for them to buy food. It would benefit both the project and the vendors for relocation efforts to provide additional amenities, including permanent space that is protected and lockable, to save them time and protect their wares, running water and toilet facilities, as well as consistent access to tourists, from both cruise ships and nearby hotels.	Low

	Maintenance of public beach access	Medium	Public beach access to Jolly Beach will be maintained.	Low
	Housing for workers	Low	Local workers will be employed where possible, and in 2021, approximately 84% of workers in Antigua and Barbuda were employed in the tourism sector. Any overseas workers will require accommodation within Jolly Harbour or the surrounding areas. Depending on the number, this may have cumulative effects on the housing market in the area, as it may cause less housing availability for locals, and will be ongoing throughout the operational phase of the resort.	Low
	Public services	Low	Local staff will already be part of the community, but overseas workers may become long-term residents, using hospitals and schools etc. for themselves and their families. It is not clear if this increase in residents will stress the health or school system.	Low
	Local economy	Medium	The hotel will have a positive impact on the economy in Antigua, and specifically Jolly Harbour, by increasing tourism revenues and creasing short-term (during construction) and long-term (during operation) jobs. The developers estimate the creation of up to 500 jobs for a range of workers in both construction and operational phases. Aesthetically, the construction of this resort will improve the site as many of the current buildings are derelict and overgrown. However, this hotel is larger than the current one and occupies much more of the site so nearby residents may oppose the development.	Medium

7.0 DISASTER MANAGEMENT PLAN (DMP)

Emergency situations in a hotel environmental can take many forms and can arise from both internal and external forces. External sources generally take the form of natural disasters, including hurricanes, earthquakes, tsunamis, flooding, drought, or extreme heat, while internal sources include fire, chemical spills, and health emergencies. A Disaster Management Plan (DMP) is aimed to ensure the safety of life and property during any type of emergency.

Caribbean Disaster Emergency Management Agency (CDEMA) has developed a Comprehensive Disaster Management (CDM) Strategy and Results Framework for 2014-2024 that outlines the need for the development of multi-hazard contingency and coordinated response plans as a means to mitigate and lessen their potential impacts. In Antigua, the National Office of Disaster Service (NODS) has a disaster risk reduction plan (NODS, 2017) and ensures national hazard plans and policies are current and provides warnings during potential hazard situations.

The five major steps of a disaster management plan are:

- **Prevention** – Actions taken to avoid an incident, including deterrence operation and surveillance.
- **Mitigation** – Refers to measures that prevent an emergency, reduce the chance of an emergency happening, or reduce the damaging effects of unavoidable emergencies. Typical mitigation measures include establishing building codes and zoning requirements, installing shutters, and constructing barriers such as levees.
- **Preparedness** – Activities that increase the ability to respond when a disaster occurs. Typical preparedness measures include training for a disaster response team, conducting disaster exercises to reinforce training and test capabilities, and presenting all-hazards education campaigns.
- **Response** – Actions carried out immediately before, during, and immediately after a hazard impact, which are aimed at saving lives, reducing economic losses, and alleviating suffering. Response actions may include activating the emergency operations centre, providing mass care, emergency rescue and medical care, firefighting, and urban search and rescue.
- **Recovery** – Actions taken to return to normal or near-normal conditions, including the restoration of basic services and the repair of physical, social, and economic damages. Typical recovery actions include debris clean-up, financial assistance to individuals and governments, rebuilding of roads, buildings and key facilities, and sustained mass care for displaced populations.

General prevention, mitigation, and preparedness protocols to allow for self-sufficiency for a minimum of several days should be implemented on site. These include:

- Designation of a Disaster Response Team that is always represented by staff members on site.
- A thorough list of emergency contacts that is up to date.
- Ensuring there are enough emergency supplies (including dry food, water, batteries and first aid supplies) on site to last all staff and guests.
- Storage of all emergency supplies in a location that is easy to access and well-known to all staff.
- Practise emergency response drills with the Disaster Response Team and all staff so the actions are familiar during an emergency.

7.1. Disaster risks and mitigation

The disaster risks associated with the Nikki Beach Resort are identified in Table 7.1, as well as the significance of the risk and any mitigation measures to be implemented.

Table 7.1 Summary of risks associated with natural hazards and mitigation measures.

	Impact	Brief Description	Risk Significance High/Medium/Low	Mitigation Measures
External origin	Extreme rainfall event/ flooding	Flooding typically results from prolonged rainfall. Soil becomes saturated and, if drainage systems are not appropriate, water collects on the surface. Antigua's rainy season is between June and November annually. The western slopes of the island are generally subject to higher precipitation due to convection (Ivor Jackson & Associates, 2001). Highest volume of rainfall is likely to coincide with tropical storms or hurricanes effecting the island. Currently the elevation of the development site is +1-2 m. Flooding from storm surge is addressed below.	High	• Plan efficient drainage system and implement stormwater management plan. • During the redevelopment of the site, it will be graded to remove any areas that allow water to collect and new drainage infrastructure will be constructed. The baseline drainage report summarised in Section 5.1.4 and fully presented in Appendix 3 describes the current drainage patterns on the site.
	Extreme drought	Drought is a recurrent feature in Antigua and Barbuda which results in insufficient rainfall to meet the island's needs. Antigua's official Average Yearly Rainfall is 1048 mm and drought is categorized as a percentage of this volume, from slight (95% or 996 mm) to extreme drought (70% or 734 mm). If monthly rainfall is less than 53 mm over 6 months, drought is considered to be imminent by the country's Meteorological Office convection (Ivor Jackson & Associates, 2001). Per capita water use by hotel guests is significantly higher than residents; estimated as 300 gal/day vs. <100 gal/day convection (Ivor Jackson & Associates, 2001)	Low	• Ensure there is enough water on site for the hotel's needs for potable water as well as for daily activities. • Ensure that reverse osmosis plant on site can supply demand. Should be considered before installation. • Use of water reclaimed from wastewater processing for irrigation.

	Extreme heat	Global temperatures are generally increasing, with more frequent and severe heat waves. Extreme heat can be categorized using the heat index (Figure 7.1). Antigua's daily humidity is generally between 70-80%, so heat caution is advised from 28°C.	High	• Ensure outdoor workers are provided with appropriate personal protective equipment (PPE), hydration and breaks. • Electricity load to run AC throughout hotel. • Appropriate insulation of buildings and glazing of windows and doors to maintain stable temperature inside buildings. • Extensive planting of natural areas to provide heat-absorbent surfaces and shade from vegetation. • Provide information to guests about heat-related illnesses (heat stroke, heat exhaustion), and appropriate hydration for tropical climates. • Train hotel staff to recognize and treat heat-related illnesses. • Make contingency plan in the event that extreme heat event is combined with loss of electricity to the hotel, including back-up generators.
	Hurricanes	Hurricanes are relatively common in the Caribbean and Antigua has been impacted by 47 category 1-5 hurricanes between 1842 and 2022. Hurricanes are often simultaneously associated with storm surge and flooding.	High	• Ensure that all buildings are up to code regarding hurricane regulations to prevent loss of roofs and structural damage. • Hurricane preparedness plan that includes assembly and checking of emergency supplies (e.g. food, water, medical supplies), employee training, protocols for protecting vital documents, guest security and for information dissemination to guests. The Hurricane Procedures Manual and preparedness checklist created by USAID and the OAS is included in Appendix 6. • Ability to maintain connection with weather information sources (radio, internet). • Annual tree assessment and trimming to reduce potential for damage to buildings and utilities. • Proper storage of loose items to reduce flying debris.

	Sea level rise	Sea level rise is inevitable under current climate change projections, and the IPCC predicted up to 0.25-0.30 m rise in the Caribbean before 2050. This is likely to increase the effects of storm surge and coastal erosion.	High	• Build the development with mandated setback from the sea. • Plant a boundary of vegetation between the beach and the hotel to stabilize the sand. This acts to reduce erosion and disperse wave energy from any storm surge.
	Earthquake	Antigua is subject to earthquakes of magnitude higher than 5.0 every few decades, and many low-magnitude earthquakes each year.	Low	• Ensure that all buildings are up to code regarding earthquake regulations. • Make an earthquake preparedness plan for employees, which includes actions to take when indoors and outdoors, the location of emergency muster points. • Ensure that the Disaster Response Team knows how to access shut off valves for all water, gas and electrical lines as they will need to be turned off if damaged.
	Tsunami	The most likely source of a tsunami is from volcanic or seismic activity on Nevis or Montserrat and would not allow for sufficient time for a complete evacuation of the property. In the event of a tsunami of tectonic origin, which is much rarer, the warning time of 30 to 60 minutes, which would allow for the possibility of some evacuation.	Low	• Resort should install warnings and the UNESCO tsunami evacuation procedure for hotels should be implemented (Appendix 7, Appendix 8). • Guests and staff should be educated to recognize the warning signs of tsunami such as ocean retreat and will be instructed to move quickly to a higher place. • Directional signs and fact sheets can be placed in hotel rooms and rooms. • Annual disaster response training can be provided to hotel staff. • Monitoring the Caribbean Tsunami Warning Program (CTWP).
	Storm surge	Storm surge is a common impact resulting from tropical storms or hurricanes and waves can be 3-10 m in height. The power of the waves can destroy buildings that aren't protected in addition to water damage from the flooding.	High	• Implement efficient drainage system with appropriate subsurface pipes, drains and soakaways to reduce potential flooding as part of the stormwater management plan. • Setback of 30 m (100 ft).

				• Dune enhancement through renourishment and stabilization, including a vegetation boundary between the hotel and the beach. • Facilitate rain absorption by planning as much natural garden area as possible within the grounds of the hotel. • Ensure a secure shelter-in-place location within the hotel for guests displaced from front-row residences due to flooding and storm surge in a 100-year or other storm event. • All seaward buildings and pool decks should be elevated and founded on piles with minimal retaining walls.
Internal origin	Fire	Hotels are at high risk of fire due to their large volume occupancies and use of flammable materials.	High	• Use non-flammable materials for construction where possible. • Designated no smoking zones around chemical storage areas, propane, and flammable gas storage. • Install smoke alarms, A-B-C type fire extinguishers, hydrants, and fire suppression systems, and ensure regular servicing. • Fire cistern reserve of fresh water on site. • Emergency exit signs in all buildings • Education of guests and staff in fire response actions and emergency muster points. • Ensure proper maintenance of electrical outlets, appliances, and wiring. • Ensure proper storage of combustible materials, including cardboards, paper, and cloth.
	Chemical spills	Various chemicals will be stored on site during both construction and operational phases. These include cleaning products, pesticides, fertilizers, fuels (petrol, oil, diesel, liquified petroleum gas), swimming pool chemicals, and oil-based paints	Medium	• Ensure all chemicals are stored and handled in accordance with their Safety Data Sheet (SDS). • Any chemical spill is treated immediately. • Excavate and remediate and potential contamination of groundwater.

		and varnishes. Guidelines for hotels for storage and use of chemicals are included in Appendix 9.		
	Health/ disease	If disease is introduced into a hotel, there is high risk of spreading due to the high density of workers and guests.	Low	• Ensure proper sanitation of laundry and guest rooms by housekeeping. • Implement strict food and beverage standards to prevent food-borne diseases. • Removal of standing, untreated water on site to prevent waterborne diseases and propagation of disease vectors (e.g. mosquitoes). • Efficient air circulation and HVAC equipment. • Plan in the event of health emergencies on site, including staff first aid training, nearby clinics or hospitals, and evacuation procedures.

Temperature (˚F)

Relative Humity (%o)

00	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	96	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution   Extreme Caution   Danger   Extreme Danger

Figure 7.1: Likelihood of heat disorders with prolonged exposure or strenuous activity. Source: National Weather Service Heat Index.

7.2. Evacuation

The decision to evacuate the premises is influenced by the level of threat involved and should be made on a case-by-case basis. All evacuations will be managed by the Evacuation Officer on the Disaster Response Team. Some emergencies, including weather-related situations, chemical spills, or man-made disasters, will involve keeping staff and guests inside the hotel. This is known as "shelter-in-place" and requires organization of persons on site and supplies for self-sufficiency. A central location in the hotel should be identified as a shelter. Additionally in the event of damage to accommodation buildings, the client should designate a specific "bunker" site for the guests/residents for protection and temporary living.

Other emergencies, such as fire, flood, or extreme weather, may require evacuation or "shelter-out". In the case of extreme weather, evacuation may occur before or after the event. Evacuation before a natural disaster may involve movement of guests to a muster point in walking distance (e.g. the car park), where transportation to the airport or higher ground can occur. Regional shelters are designated by Antigua's Director of Disaster Preparedness and Response under the Disaster Management Act (2002).

8.0 ENVIRONMENTAL MONITORING AND MANAGEMENT PLAN

The project is required to prepare and submit an Environmental Monitoring and Management Plan. The purpose of this Environmental Monitoring and Management Plan (EMMP) is to provide a framework for the management of the environmental risks identified through the Environmental and Social Impact Assessment (ESIA) process for the Nikki Beach Resort development. This EMMP is a condition of the Antigua and Barbuda Environmental Protection and Management Act (EPMA, 2019). Implementation of EMMP alongside the construction and operation of the development will ensure that environmental risks are reduced to as low as reasonably possible. It will ensure that all environmental obligations from legislation, regulations, conditions of approvals, permits and licenses issued to the project are met.

The EMMP contains a series of management sub-plans that address the key environmental themes that relate to the development, including biodiversity, water, erosion and sediment, socioeconomic, noise, human health and safety, and air quality sub-plans. Each sub-plan clearly articulates management objectives and performance criteria and outlines the management measures to be applied to avoid and minimize environmental impacts during the relevant phases of the project. Monitoring and reporting requirements, corrective actions, and key responsibilities are also explained.

The plan for construction of the project is as follows:

- Demolition of existing structures and preparation of grounds (including clearing and grading) – approximately 6 months duration. Aim to be completed at the end of 2024.
- Construction of major infrastructure and buildings – aim to start in early 2025 with 3.5 years duration.
- The hotel aims to be operational by 2028.

The DoE and DCA can further determine the priorities, requirements and frequency of submission of the elements included in this EMMP.

8.1. Roles and responsibilities for environmental management

The roles and responsibilities of the project's stakeholders in implementing the EMMP are outlined in Table 8.1.

Table 8.1: Roles and responsibilities within the EMMP

Entity	Roles and responsibility
Muqali Ltd / Nikki Beach Resorts	Overall developer and investor with ultimate responsibility for the project.
Project Manager (Muqali Ltd/Nikki Beach Resorts)	Overall oversight of implementation of the EMMP. Site auditing of sub-contractors on a discretionary and strategic basis. Environmental training and complaints management. Liaises with Project/Facility Environment Personnel. Notifies Science/Environment Team and DCA of any non-compliance with EMMP.
Construction subcontractors	Report to Project Manager, implement all actions in relevant sub-plan of EMMP, including management actions and reporting. Supervise environmental performance of each task against the EMMP. Notifies Project Manager of any non-compliance with EMMP.
Development Control Authority	Overall authority governing development. Reviews monitoring and environmental audit reports.
Department of Environment	Environmental agency with responsibility for environmental compliance. Undertakes audits of project site as required and assesses compliance with EMMP in accordance with Government approvals. Reviews monitoring and environmental audit reports.
Environment personnel EP	Trained and technically qualified personnel to conduct EMMP (may comprise consultants and/or staff)

	Conducts on-site monitoring and evaluation of EMMP. Works with the Project Manager to communicate any concerns and assist in developing any necessary responses or changes. Prepares and submits regular EMMP reports to Nikki Beach Resort and to Government.

8.2. Incidents and complaints

An Incident and Complaints register will be established and maintained by Developers. Any incidents of non-compliance with the EMMP will be recorded including measures taken to address the incident, and the DCA/DoE will be notified as soon as possible. Any complaints received will be recorded in the same register. The Developers will make a record of any complaints received as soon as possible. The register will include a record of when the complaint was received, the nature of the complaint, when it was responded to, by whom and how, and if DCA/DoE was informed.

8.3. Monitoring, auditing, and reporting

8.3.1 Monitoring

Monitoring will be undertaken to assess compliance with the EIA approvals and the EMMP and ensure that the magnitude of any impacts is within the approved limits. Ongoing monitoring of the site will be undertaken by a qualified environment personnel who is aware of the EMMP requirements.

The environment personnel (EP) will keep the Developers informed of all monitoring activities, results, and promptly report any concerns or non-compliance. In the event of a non-compliance incident requiring a response, the EP will work with the Developers to promptly develop and implement an environmentally appropriate response and will record all measures taken. Developers and the scientist-monitor will meet periodically to review the program and activities.

The EP will be responsible for independently conducting monitoring to the appropriate scientific standards, analyzing and synthesizing data, and creating reports for the Developers that will be used by Nikki Beach Resort and sent to DCA/DoE. The EP will keep copies of all raw data as well as analysis conducted.

8.3.2 Reporting

EMMP reports will be submitted in accordance with the timelines determined by DCA/DoE. This may include monthly, quarterly and/or annual reports in the construction and operational phases of the project.

The reports will include:

- List of actions from the EMMP that have been implemented including photographic evidence.

- Details of any non-compliance activity and measures taken to address it.
- Results of monitoring including e.g. marine, water quality and vegetation.
- List of any complaints received from adjoining residents.
- Any unexpected impacts to the environment that was not adequately accounted for.
- Any corrective or positive actions implemented.

8.3.3 Adaptive Management

Mitigation and avoidance measures have been developed as part of this EMMP that are intended to reduce the risk of the project significantly impacting the environment. In the unlikely event that the monitoring shows that the impact has exceeded the performance indicator, the proposed management actions would need to be revised. Any changes to environmental management will be proposed as part of the final quarter EMMP report and will be developed by the Developers in conjunction with the EP, and appropriate Government agencies. Changes to environmental management will only be proposed if the performance indicators outlined in the EMMP are exceeded within the reporting period. Any approved changes to environmental management will be incorporated into a revised EMMP.

8.4. Biodiversity management sub-plan

8.4.1 Vegetation

The biodiversity of the Nikki Beach Resort development site and the adjacent coastal waters were assessed as part of this ESIA. The biodiversity value of current vegetation on the site relates to the presence of sensitive species, which are those that are re listed as threatened or endangered (IUCN Red List), regionally endemic (as determined by Pratt et al., 1997), listed in the Environmental Protection and Management Act (2019), or a key stone species, which are those that are critical to ecosystem diversity and functionality and that can enhance the landscaping environment. On the Nikki Beach site, the sensitive species include Agave (*Agave karatto*), Broom (*Chamaecrista glandulosa*), Buttonwood (*Conocarpus erectus*), Palmetto/thatch palm (*Coccothrinax barbadensis*), Geranium tree (Cordia sebestena), Torchwood (*Jacquinia arborea*), Cabbage/Imperial Palm (*Roystonea aleracea*), West Indian Mahogany (*Swietenia mahagoni*), and White Cedar (*Tabebuia, heterophylla*), as well as trees with a girth 180 cm or greater (EPMA 2019). The loss of these native species during construction should be minimized by adopting the sensitive vegetation management plan which is described in detail below. The environmental management and protection process follows an adaptive framework. It facilitates the identification of sensitive species prior to any land activity and then developing and implementing techniques to best ensure the protection and long-term presence of these species at Jolly Harbour.

Since the Nikki Beach Resort site has already been developed, most protected and sensitive species are trees, with some shrubs. The following process should be implemented to preserve these species on the development site.

8.4.2 Environmental Process for Sensitive Vegetation Management at Nikki Beach

The science team and biologists at Deborah Brosnan & Associates have worked diligently to develop a science-based practical process to assess, manage, and mitigate sensitive vegetation and assemblages for development sites. The team has worked closely with the Government of Antigua and Barbuda, specifically the Development Control Authority (DCA) and the Department of Environment (DoE) to create a process that is replicable, can be deployed, and that will be approved and supported by the GoAB. A key element in the process is to manage and mitigate the ecological elements of the site while also allowing permitted developments to proceed.

The DCA has informed the Nikki Beach Project that it requires a protection protocol for certain trees on the project site. The science team also consulted with the DoE to discuss the site and its requirements for sensitive vegetation management. Based on site-specific feedback from the GoAB, the review of the vegetation surveys conducted, and knowledge of the site, we detail sensitive species management actions, the recommended sensitive species process tailored to the Nikki Beach site, and the specific geo-located trees and plants on site that require management actions.

This process described below should be followed during the development associated with the current submission for the Nikki Beach Project.

8.4.2.1. Sensitive Vegetation Management Actions

Sensitive vegetation comprises plant species that are listed as threatened or endangered (IUCN Red List), regionally endemic (as determined by Pratt et al., 1997), listed in the Environmental Protection and Management Act (2019), or a key stone species, which are those that are critical to ecosystem diversity and functionality and that can enhance the landscaping environment.

The environmental management and protection process for sensitive vegetation follows an adaptive framework. It is based on surveys to identify the presence of sensitive species prior to any land activity and then developing and implementing techniques to best ensure the protection and long-term presence of these species at the Nikki Beach site.

Depending on species and number of plants present, management actions may include:

1) **Non-disturbance**: No activity takes places in the area where the plants are present (for instance, well established, mature, large trees that are considered sensitive).

2) **Salvage**: Where the plants are removed and transplanted to a new site at Nikki Beach or to a plant nursery and planted later.

3) **Seed collection:** Where only the seeds are collected, and the plants grown in pots in a nursery and planted later.

4) **Propagation:** Where plants are taken to a plant nursery, divided to increase the number of plants, and replanted.

5) **Replacement:** Where it is most feasible to replace the species with commercial stock e.g., buttonwood.

8.4.2.2. The Environmental Process

The environmental process consists of the following steps:

1. Prior to land clearing, the Deborah Brosnan & Associates biologist conducts an ecological survey to characterize the ecosystem and identify any sensitive or endangered species. Surveys are intensive and conducted by foot.

2. If sensitive plants are present, the species are recorded, and their location identified by GPS. Small, concentrated areas of plants may be flagged with survey tape. Extensive areas of scattered sensitive plants are delineated on a map using a GIS-based platform.

3. In addition to providing a geo-referenced map, the Deborah Brosnan & Associates biologist reviews the best practices for plant management and protection based on the site findings. These include the five options identified above. It is recommended that a plant nursery is established by the project for propagating native species to be used in the development, and some plants may be temporarily located in the nursery prior to out-planting.

4. Results of the plant surveys are reported by Deborah Brosnan & Associates to the client (next section). The assessment report identifies and geo-references the sensitive species found in the survey area and provides protocols for best management and protection practices (BMP). The map serves as a field-guide to the team in conducting their work. The geo-referenced map allows for monitoring and tracking of sensitive plant species areas. Subsequent monitoring during BMP documents the management efforts taken.

5. The project should identify a plant management team to implement the best management techniques (salvage, seed collection, propagation, or replacement) based on the recommendations of the report.

6. The process follows an adaptive management framework, and each event is treated as an opportunity to learn lessons. In some cases, the plant management team must adapt management techniques to meet site specific situations or based on identifying plant preferences. For instance, the team may find that a plant species grows well in a certain part of the site, and not in others. This "lessons learned" approach is vital to developing the BMP suitable for the ecosystem and site.

7. The plant management team should monitor the activity that has been conducted. For instance, it should record how many of each sensitive species are salvaged, propagated, replaced, or mitigation actions taken, and should also note seed collection activities, as well as which trees are undisturbed. This information will become important during the Environmental Management and Monitoring Plan (EMMP) which will be required by the DoE as part of the ESIA. The team should also document the success of the work to communicate to GoAB as part of the transparent process. Field visits may occur by DoE and DCA to confirm the efforts and outcomes.

8.4.2.3. Sensitive Vegetation Species Management, Mitigation, and Protection Protocols for the Nikki Beach Site

As part of the environmental process outlined above, the science team conducted its *in situ* assessment and survey to identify and geo-locate sensitive species at the project site. The team also evaluated the tree survey information provided by the client and cross referenced with the *in situ* data. These data have been collated and used to create a site-specific sensitive vegetation species protocol for the project.

Tree Preservation

The client provided the science team with tree survey information and measurements. The team reviewed the data to identify which trees are protected and require conservation and/or mitigation. The EPMA (2019), in addition to listing specific species for protection, states that trees that have a girth equal to or greater than 1.8 meters, are protected and should be preserved. The protection of large, mature trees is critical to provide soil stabilization through their root systems, shade, habitat and foraging spaces for birds, and aesthetic value to the site.

Of the 115 trees recorded and measured, 27 are West Indian Mahogany trees which are protected under the EPMA (2019) and listed as endangered on the IUCN red list. Each of the Mahogany trees have measured girths greater than or equal to 1.8 meters. Therefore, all Mahogany trees should be preserved on site (Table 8.2).

The remainder of the trees identified are native species, but not considered sensitive. However, in addition to the Mahogany trees, 51 of the 115 trees surveyed in the topography map provided have a girth of 1.8 m or greater. These trees should be preserved as per the EPMA (2019) and are listed along with the Mahogany trees in Table 1, and which corresponds with Figure 8.1 below the table.

Table 8.2: Trees onsite that should be preserved due to sensitive status and size.

Number (Unique ID in the Topographical map)	Tree Type	Girth (meters)
230	willow	2.3
236	mahogany	2.8
237	mahogany	2.6
238	mahogany	2.1
240	mahogany	2
241	mahogany	2.6
242	mahogany	2.5
243	mahogany	2.8
244	mahogany	2
245	neem	2.6
246	flamboyant	3.1
247	willow	4.3
248	mahogany	2.9
249	mahogany	3.7
250	mahogany	3.7
251	mahogany	2.6
253	mahogany	4
255	flamboyant	2.8
256	flamboyant	2
258	flamboyant	2.3
259	mango	3.9
261	flamboyant	2.6
262	mahogany	2.3
265	almond	2.5
266	coconut	1.9
267	seagrape	2
269	flamboyant	3
270	neem	2.8
271	whitewood	3.2
272	whitewood	2.3
273	mahogany	3.3
274	neem	3.2
275	whitewood	2
276	neem	4.8
277	eucalyptus	3
278	eucalyptus	2.6

279	neem	3
280	mahogany	2.9
283	whitewood	2
284	whitewood	3.2
286	neem	2.7
287	mahogany	2.5
289	mahogany	3.8
290	mango	2.4
291	mango	3.4
292	mahogany	2.4
293	neem	2
294	mahogany	2.25
295	mahogany	2.1
296	mahogany	2.9
297	mahogany	1.8
299	seagrape	3.7
300	mahogany	2.7
301	willow	4.5
302	seagrape	3.6
303	seagrape	3.1
304	mahogany	3
305	mahogany	2
306	willow	1.9
308	willow	3.3
309	willow	2.3
310	willow	2.1
311	willow	1.8
315	willow	1.9
318	willow	2
323	whitewood	2
324	whitewood	2
331	whitewood	2
332	whitewood	3.1
337	whitewood	2.4
342	neem	2.6
344	whitewood	2.26
345	neem	1.8
346	neem	2
348	seagrape	3.7
361	mahogany	3.2

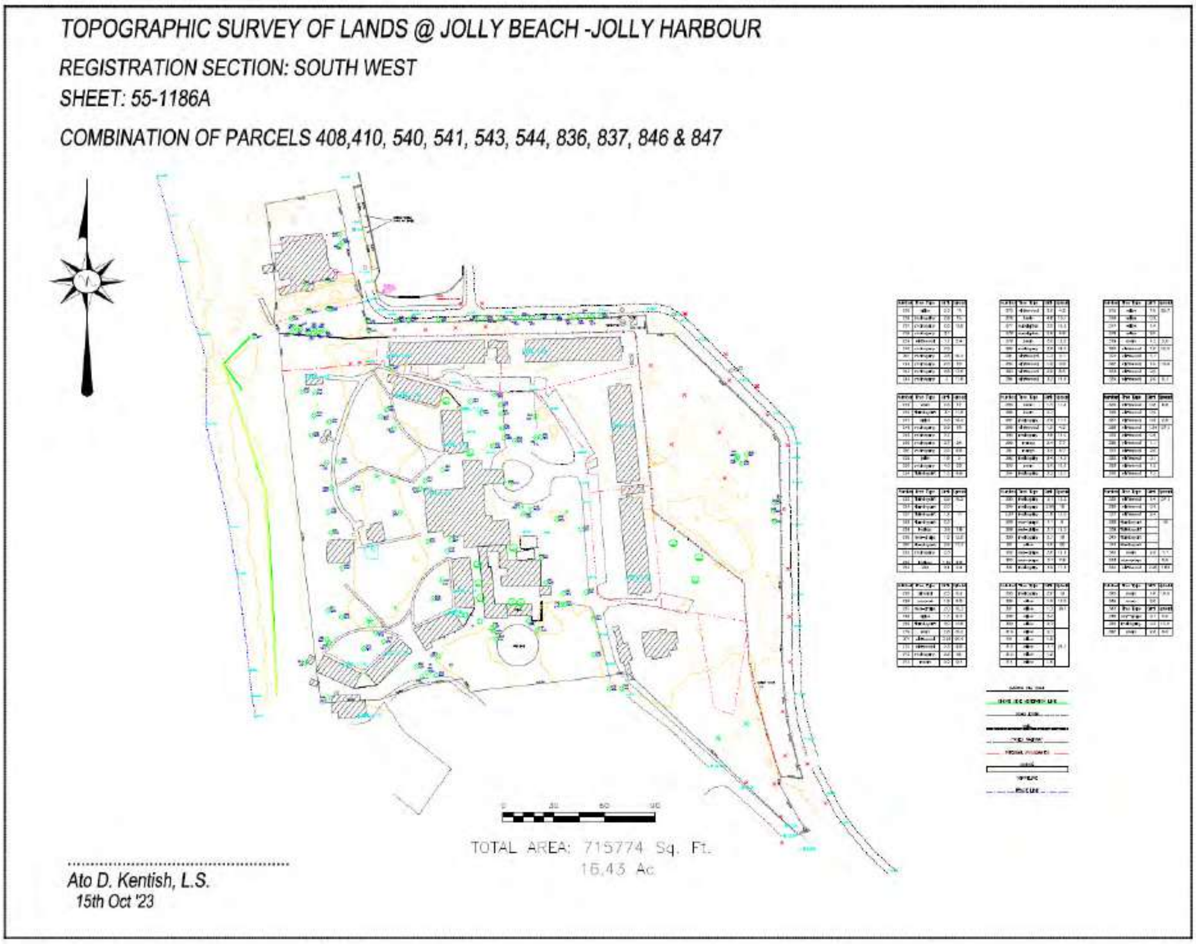

Figure 8.1: Topographic survey with trees identified, marked, and measured.

It is important to maintain and protect as many of the trees listed as possible, and especially critical to preserve all the Mahogany trees due to their status under the EPMA and IUCN. If it is not possible to preserve all the other large native species of trees on site due to development planning, certain management and mitigation actions are recommended.

The underlying principle that drives mitigation for tree removal is to achieve no net loss of vegetation coverage. For instance, for the removal of every large tree, another tree should be planted to replace the canopy (spread) area that was removed at a 1:1 ratio. Therefore, if one large tree is removed, the same species should be propagated and planted on site to grow, with the expectation that the new tree will cover the same canopy area as the removed tree when it grows to maturity. Given that the site was already impacted and developed previously, a 1:1 mitigation ratio is acceptable.

Specifically, the plant management team should collect clippings for propagation and seeds from the trees if they will be removed, to grow them in a nursery and eventually outplant on site as part of the landscaping effort. This will ensure that the native vegetation assemblages on site are preserved. As mentioned in the environmental process above, it is recommended that the project build an onsite plant nursery to plant and propagate native vegetation for mitigation actions and to assist with the landscaping effort.

8.4.2.4. *Additional Sensitive Species and Management Actions*

During the *in situ* survey, the science team recorded over 35 plant species. Of these, there were 9 sensitive species recorded, including 5 regionally endemic and/or 5 protected under the EPMA (2019) as well as one listed on the IUCN red list as endangered. If it is not possible to preserve the sensitive plants in their current locations on site, there are specific mitigation actions recommended for each sensitive species.

In general, any sensitive species that is less than 5 ft in height can and should be salvaged and transplanted in a nursery or elsewhere on site for landscaping and to maintain the native assemblage. For sensitive plants and trees larger than 5 ft, where the extent and establishment of root systems would prevent transplantation success, it is recommended to collect seeds for growth and propagation in a nursery. However, if tree spade machinery is available, these can be used to remove and transplant larger trees. The species-specific mitigation actions are identified in Table 8.3.

Table 8.3: Sensitive vegetation recorded by the science team on site and associated mitigation actions.

Scientific name	Common Name	Mitigation Action	Protection status
Agave karatto	Agave	Collect full plant and transplant	EPMA (2019) protected
Chamaecrista glandulosa	Broom	Transplant smaller saplings, seed collection for propagation	Regional Endemic per Pratt et al. (1997)
Conocarpus erectus	Buttonwood	Transplant smaller saplings, seed collection, and/or commercial replacement	EPMA (2019) protected
Coccothrinax barbadensis	Palmetto/Thatch palm	Transplant smaller saplings, seed collection for propagation	EPMA (2019) protected, Regional Endemic per Pratt et al. (1997)
Cordia sebestena	Geranium Tree	Transplant smaller saplings, seed collection for propagation	Regional endemic per Pratt et al. (1997)
Jacquinia arborea	Torchwood	Preserve large trees, Transplant smaller saplings, seed collection for propagation	Regional Endemic per Pratt et al. (1997)
Roystonea aleracea	Cabbage/Imperial Palm	Transplant smaller saplings, seed collection for propagation	EPMA (2019) protected
Swietenia mahagoni	West Indian Mahogany	Preserve large trees, transplant smaller saplings, seed collection for propagation	EPMA (2019) protected, IUCN red list endangered
Tabebuia heterophylla	White Cedar	Preserve large trees, Transplant smaller saplings, seed collection for propagation	Regional Endemic per Pratt et al. (1997)

The sensitive species onsite were geolocated to assist with the identification during clearing and development activities. Figure 8.2 corresponds to Table 8.4 which lists the species and associated field location and notes. For those species that were found in several locations, images are provided to assist with *in situ* identification.

Figure 8.2: Map showing GPS locations of sensitive species on the development site.

Table 8.4: Sensitive vegetation and the waypoints showing their locations on site.

Scientific name	Common name	GPS field location	Notes
Agave karatto	Agave	1313, 1314	
Chamaecrista glandulosa	Broom	Various locations on site	See image below
Conocarpus erectus	Buttonwood	1313	
Cordia sebestena	Geranium Tree		See images below
Coccothrinax barbadensis	Palmetto/Thatch Palm	1331	
Jacquinia arborea	Torchwood	Various locations throughout the site	See images below
Roystonea aleracea	Cabbage/Imperial Palm	Various locations throughout the site	See images below
Swietenia mahagoni	West Indian Mahogany	1310, 1329, 1331, 1332, 1334, 1335, 1337, 1339, 1343, 1344	Row of large trees along the border of the meadow to the east of the site
Tabebuia heterophylla	White Cedar	1311, 1312, 1313, 1314, 1315, 1321, 1323, 1323, 1324, 1326, 1327, 1328, 1331, 1334, 1340, 1341, 1342, 1345	#1315-1317 Row along the northern fence line. #1324 and 1340 is a grove of juvenile plants ideal for salvage.

Images to assist the plant management team within *situ* identification:

Figure 8.3: Agave (*Agave karatto).*

Figure 8.4: Broom (*Chamaecrista glandulosa).*

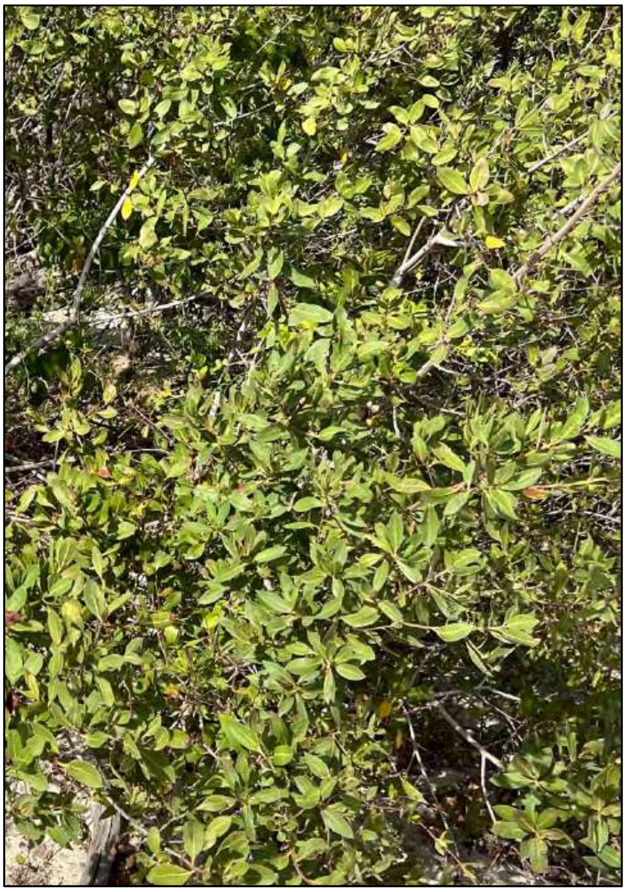

Figure 8.5: Buttonwood (*Conocarpus erectus)*

Figure 8.6: Geranium tree (*Cordia sebestena*). Left: seed, Right: flower.

Figure 8.7: Palmetto/Thatch Palm (*Coccothrinax barbadensis*)

Figure 8.8: Torchwood (*Jacquinia arborea*).

Figure 8.9: Imperial/Cabbage Palm (*Roystonea aleracea*).

Figure 8.10: White Cedar (*Tabebuia heterophylla*). Seed pod circled in red.

Figure 8.11: West Indian Mahogany (*Swietenia mahagoni*).

8.4.3 The marine environment

The near-shore marine environment adjacent to the Nikki Beach Resort site is characterized by seagrass beds. Total seagrass cover offshore can be assessed using mapping of satellite imagery. Normally, this would be combined with regular underwater monitoring to evaluate any changes in abundance, but it was not possible to conduct these surveys during this EIA due to extremely high turbidity. Turbidity is reported to be lower and visibility higher in August and September so it may be possible to establish permanent GPS-located transects for permanent monitoring at this time. These surveys will include species diversity, percent cover, short shoot density, stem length, and epiphyte cover, as well as observations of fish, turtles, conch and other marine species. Any observed human impacts (e.g. boat scars) will also be identified and documented. This data will be used to identify changes in seagrass community species composition over time. If this *in situ* monitoring is not possible, broad scale dynamics of seagrass cover will be the primary monitoring tool.

Jolly Beach is a minor nesting beach for hawksbill sea turtles (*Eretmochelys imbricate*), and they have been observed in the waters of Lignum Vitae Bay. As such, any nesting or hatching activity should be reported by Nikki Beach Resort staff and be recorded by the scientist-monitor.

8.4.4 Management actions

A list of management actions to be undertaken to avid and mitigate impacts to biodiversity is outlined in Table 8.5 below.

Table 8.5: Biodiversity management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Vegetation and landscape management			
Minimize removal of native and protected species. Maintain soil and beach stability provided by vegetation	• Prior to construction, identify and fence off any native trees or areas of vegetation to be retained. • Incorporate existing trees and native species into landscaping where possible.	Ongoing monitoring by Developers	Continued growth of trees and vegetation identified for preservation
Marine environment			
Protect seagrass habitats	• Regular monitoring of seagrass beds off Jolly Beach using available satellite imagery, and *in situ* surveys if possible. • Minimize runoff	Regular monitoring of salinity and turbidity in nearshore waters during construction	No net loss of seagrass health or habitat associated with the development
Protection of sea turtles at sea, nesting sites, and hatchlings	• Use of Best Management Practices (BMPs) in all pre-construction and construction activities. This includes use of appropriate light fixtures, light bulbs, and light orientation as to not disturb nesting female turtles and hatchlings. • Use of construction barriers to prevent sea turtles and hatchlings from entering the construction zone. • Cease operations if any sea turtle or hatchlings are observed within 300 ft of the construction site. • Careful use of vehicles along shorelines and beaches to not crush nests and/or hatchlings emerging from nests.	Fence off any established nests Use sea-turtle friendly lights during construction Training of construction subcontractors and personnel in BMPs and recognition of nests/nesting activity	No loss of sea turtle nests or hatchlings within construction site

	• Disturbance/collision with sea turtles immediately reported to DB&A, Fisheries, and DoE.		

8.5. Water management sub-plan

Disturbance to the land from development can exacerbate the rate of erosion, resulting in reduced water quality and increased turbidity. The Nikki Beach Resort site abuts the coastal waters of Jolly Beach to the west and Jolly Harbour marina to the north and northeast. Storm water management during both construction and operations is also critical to avoid degradation of nearshore habitats. Risks to nearby waterways include changes in water quality from land-based construction and storm water run-off, and subsequent increases in pollutant and nutrient levels that exceed acceptable levels (EPMA 2019). These impacts can adversely affect nearby marine habitats as well as the aesthetic quality of the environment.

The marine waters around Jolly Harbour are identified as Class A under Schedule VII of the EPMA (2019), with the following water use classifications and criteria:

i. the uses to be protected in this class of waters are recreational (including swimming, bathing, and other water contact sports), aesthetic enjoyment, and the support and propagation of aquatic life;

ii. it is the objective that this class of waters be used for recreational purposes and aesthetic enjoyment shall not be limited in any way;

iii. Class A waters shall be kept clean of any trash, solid materials, or oil, and shall not act as receiving waters for any effluent which has not received the highest degree of treatment or control practicable under existing technological and economic conditions and shall be compatible with the standards established for this class.

The following are specific water quality and standards guidelines for Class A waters as outlined in Schedule VII (Part C)(2) of the EPMA (2019):

- Microbiological requirements
  - Faecal coliform count shall not exceed a geometric mean of 200/100ml for any 10 consecutive samples nor shall any single sample exceed 400/100 ml.
  - Enterococci count shall not exceed a geometric mean of 33/100 ml for any 5 samples in a given 30-day period; no single sample shall exceed 60/100 ml.
- pH Units
  - pH variation shall be within 7.7 and 8.5 units.
- Nutrient Availability
  - The ratio of total nitrogen to total phosphorus concentration shall be within: 11.1-27.1% variation of the naturally occurring ratio.
  - The concentration of total nitrogen and total phosphorus shall not vary by more than 10% from the natural conditions.
  - Except for concentrations attributable to natural causes, nutrient concentration shall not exceed:
    - Total Phosphorus: 0.025 mg/l as P
    - Total Nitrogen: 0.400 mg/
  - To support coral reef growth the yearly average primary productivity of plankton should not exceed 100 mg of carbon per square meter per day.
- Dissolved Oxygen

- Dissolved oxygen concentrations shall not vary by more than 25% from natural conditions.
- Except for concentrations attributable to natural causes, dissolved oxygen concentration shall not be less than 5.0 mg/L

- Salinity
  - Salinity changes shall be less than 5% from natural background levels.
- Temperature
  - Temperature shall not vary by more than 2 degrees Celsius from the natural conditions
- Turbidity
  - Turbidity as measured by Nephelometric Turbidity Units (NTU) shall not be greater than 10% above natural conditions.
- Light penetration
  - The euphotic depth shall not vary by more than 10% from the natural euphotic depth.

8.5.1 Stormwater management

Stormwater management is the effort to reduce runoff of rainwater that does not immediately soak into the ground. This runoff can cause flooding and erosion as it flows from one are to another or pools in low-lying areas. Average rainfall in Antigua is about 1100 mm per year and typically occurs in downpours that can lead to high runoff and flooding.

The drainage report summarised in Section 5.1.4 and fully reported in Appendix 3, indicated several low-lying areas on the development site that currently accumulate runoff until it percolates into the ground. The developers plan to fully grade the site, and the removal of these areas will require installation of specific infrastructure for drainage of this runoff.

8.5.2 Management actions

During construction, water quality will be managed by implementing best management practices to prevent and minimize sediment and contaminants from reaching nearshore waters. An appropriate drainage and stormwater management system should be built during the construction phase. This includes but is not limited to, appropriate sub-surface pipes for drainage, drains and soakaways, curbs to direct water flow, and water pumps to address water collection in any low-lying areas. These will help ensure that stormwater is (1) not retained on the property to cause flooding or erosion, and (2) is directed to areas where it can be incorporated into the landscaping, percolate into the ground, or flow out to sea.

The DoE has specified that water quality monitoring should be completed every 3 months during the construction phase and annually during the operational phase of the project. Management actions are detailed in Table 8.6 below. Monitoring protocols are outlined in Section 8.5.3 below.

Table 8.6: Water quality management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Marine water quality			
Protect the health of the marine ecosystem and comply with EPMA (2019)	Maintain the health of biological communities and waters for marine life and recreational activities.	Water quality monitoring protocol in Section 8.5.3.	Remedial action if water quality exceeds regulated values.
Protect marine ecosystems from	The marine environment appears to be seasonally turbid from natural processes across Lignum Vitae Bay.	Water quality monitoring	Does not exceed thresholds as per the EPMA 2015

increased turbidity	Consistent monitoring of water quality and understanding of coastal dynamics will help determine patterns of seasonality.	protocol in Section 8.5.3.	for Class A waters.
Storm water management			
Minimize flow of water to the ocean to reduce impacts to coastal resources. Protect against chemical spills	Chemical Handling • Ensure all chemicals are stored and handled in accordance with their Materials Safety Data Sheet (MSDS). • Any chemical spill is treated immediately. • Excavate and remediate and potential contamination of groundwater. • Follow the Disaster Response protocols	Ongoing site monitoring by developers. Water quality monitoring protocol in Section 8.5.3. Chemical and toxins storage and handling managed by Developers according to best practices.	Water quality does not exceed thresholds as per the EPMA 2015 for Class A waters. Chemicals are stored properly, and spills are reported and treated immediately.

8.5.3 *Water sampling protocol*

DoE has instructed that water quality should be monitored every 3 months during the construction phase of the hotel. Once Nikki Beach Resort is operational, water quality will be measured every 6 months. This will ensure early detection and rapid response if there are development related impacts to the water quality of Lignum Vitae Bay, and mitigation measures can be implemented to address the water quality concerns.

Analyses will be conducted by the Analytical Services Laboratory (ASL), in Antigua and as per the request of DoE. Water samples will be tested for nitrate, phosphate, salinity, pH, turbidity, Enterococci, and fecal coliform to align with the capabilities of the laboratory and the parameters required by the DoE. Temperature and dissolved oxygen were measured *in situ* with a YSI probe, and salinity using a refractometer, by the science team. All water measurement reporting measurements and standards have been provided by the DoE. These standards require that phosphates and nitrate results be reported in mg/mL, and since the ASL reports these metrics in ppm, all results should be converted from ppm to mg/mL.

8.6. Erosion and sediment management sub-plan

Land disturbance from construction accelerates erosion rates and is one of the major causes of pollution and coastal resource problems during development. Erosion increases when vegetation is removed, altered or when land is graded, or soils stockpiled. During storm events that cause stormwater runoff, any chemicals or pollutants in the soil can be transported to marine water or other sensitive locations. Controlling erosion means preventing or minimizing the amount of sediment and water runoff from the development site.

The risks for erosion and sediment during construction of Nikki Beach Resort are:

- Erosion of beach sands to vegetation clearing, construction activities, and sand stockpiles.
- Transport of sediments to nearshore waters increasing the Total Suspended Solids (TSS), degrading water quality, and impacting nearshore seagrass habitats.

- Transport of nutrients (especially nitrates and phosphorus), fertilizers, pesticides and hydrocarbon compounds, and heavy metals common to construction sites to nearshore waters degrading water quality and impacting marine resources.

8.6.1 Management actions

To prevent erosion and sediment runoff during the construction phase of the project, Best Management Practices (BMP's) through deliberate erosion control measures will be used in areas near the shoreline. BMPs are designed to reduce the velocity of runoff, allow for infiltration of rainwater, trap sediments, and support the establishment of vegetative cover.
BMP are structured to:

- Prevent erosion when possible
- Minimize erosion to the best possible standard
- Mitigate for the effects of erosion
- Monitor and take corrective actions when necessary
- Report for overall compliance

To prevent erosion and sediment runoff during the operational phase of the project, an appropriate drainage and stormwater management system should be built during the construction phase. Additional sediment retention structures such as berms or swales may also be required.

Table 4 outlines BMP actions that will be under the authority and oversight of the Vice President of Development to implement. The scientist-monitor will conduct monitoring and reporting of specific measures as outlined in the monitoring protocol and will work with the Vice President of Development to help to facilitate successful on site-level BMP implementation.

Table 8.7 Erosion and sediment management sub-plan actions

Objective	**Management actions**	**Monitoring**	**Performance indicators**
General			
Minimize erosion and pollution and their impacts on humans and coastal resources	General management practices to be overseen by the Developers. They include: • Secure erosion controls in place prior to construction, particularly in areas close to the shoreline • Permanent soil erosion control for all channels or disturbed land areas to be completed immediately after grading operations. If permanent controls are not possible, temporary erosion controls such as planting native plants and grasses, piping or slope drains, settlement basins, artificial coverings, berms etc., should be used. • Revegetation/stabilization works are to occur as early as practicable on cleared and disturbed areas.	Implementation of BMP by the Developers Dust or particle impacts on human health to be reported to the Developers	Beach width Water quality

	• Stockpiled topsoil or sandpiles for re-use appropriately and protected from wind/runoff erosion and weed infestation. • Control all traffic into and out of the site, including movement of traffic within the site to minimize erosion and dust. • Maintenance and monitoring of the erosion and sediment control measures are to be applied for the full construction period. • All staff working on the site need to be trained and informed of the importance of maintaining good erosion and sediment control procedures with oversight from the Developers.		
Dry and drought conditions			
Limit impacts of dust and sediment pollution on human health and vegetation, and prevent transport into the marine environment	Activities that may be additionally necessary Ensure exposed soil surfaces to be kept in a moist condition. Alternatively, dust suppressants such as soil binders can be used. • Promptly stabilize areas where work is completed or where stabilized through measures such as landscaping, mulching, soil binders or grassing.	Increased monitoring may be necessary TBD by scientist-monitor	No increase in sedimentation. No impacts on human health
Wet and flood conditions			
Prevent increased erosion runoff and sedimentation	Activities that may be additionally necessary • Construct sediment catchment devices, typically a temporary basin. • Install sediment control devices such as silt fencing, berms, and swales. • Divert storm water runoff away from disturbed areas of the site and into existing intact native vegetation, sediment control devices or existing drainage systems. such as landscaping, mulching, soil binders or grassing.	Increased monitoring may be necessary. TBD by scientist-monitor	No increase in sedimentation. No impacts on human health.

8.7. Socio-economic and cultural management sub-plan

The Nikki Beach Resort site is located within a highly developed area and its beach, Jolly Beah, is utilized by both tourists and locals. The background of its use and the details of stakeholders who will be displaced by the proposed development are further described in Section 5.4. These stakeholders are primarily vendors, and several options exist for their relocation, including beach vendor huts in front of Jolly Beach Resort and Spa, a proposed artisan and vendor village at Coco Beach, and existing areas for vending near the eastern side of Jolly Harbour which can be expanded.

Overall, the Nikki Beach Resort will add considerable social and economic value to the Jolly Harbour area. As a luxury hotel, it will provide high-quality accommodation for tourists, and the beach club will add a high-end restaurant to the area. It will directly employ local labour for both construction and operations of the resort and will provide training for locals to achieve the high standard of service required by the resort.

8.7.1 Management actions

To enhance and sustain the community of Jolly Harbour, Nikki Beach Resort will employ local labour, and provide training in the service industry. This effort will be implemented by the Developers and, where appropriate, with assistance from specific personnel/consultants. The Developers will keep track of metrics, such as jobs created, and the EP will compile the data into quarterly or yearly reports as requested by DoE and DCA.

Table 8.8 Socio-economic management sub-plan actions

Objective	**Management actions**	**Monitoring**	**Performance indicators**
Activities related to current beach access			
Address any required vendor action	TBD by GoAB		TBD by GOAB
Maintain beach access on site	Move the public beach access to the northern-most end of the site	Beach access provided	Access confirmed
General			
Enhance socio-economic wellbeing of Jolly Harbour community	General Best Management Practices to be applied and overseen by the developer		
Job creation and training	Job creation and training for locals. Other local outreach, such as educational talks	Quarterly/annual reporting on job creation, training, events	Number of jobs created, training provided, and events conducted

8.8. Noise management sub-plan

Noise quality impacts from construction are expected to be largely temporary and mostly during the construction phase of the project. The specific noise risks during construction include construction workers working with loud machinery. These noise impacts may be considerable on the neighbouring residential and commercial properties as the development site is fully embedded within the Jolly Harbour community. Ongoing noise risks during the operational phase are from music from the Beach Club and may impact properties immediately adjacent to the northern end of the development site.

8.8.1 Management actions

Management actions are outlined in Table 8.9 below.

Table 8.9: Noise management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Construction workers			
Ensure the safety of all construction workers in terms of noise exposure and through the lifetime of the project.	Adopt necessary precautions in accordance with construction and operations standards as set for in “Environmental, Health, and Safety (EHS) Guidelines: Noise Management, 2007” and conform to noise standards of U.S. Occupational Safety and Health Act of 1970 (OSHA).	Ongoing site monitoring and auditing by the Health and Safety Officer, designated by the Developers	Noise exposure not to exceed standards (Table 8.10) Number of noise complaints by workers No noise- related deterioration in worker’s health
Construction			
Minimize disturbances to residents of Jolly Harbour	• Follow standard operation guidelines including confining construction to normal working hours and avoiding weekend construction. • Use temporary noise barriers or provide respite periods. • Equipment and noisy machinery should be located away from noise sensitive residents, and all equipment should be well maintained. • Provision of noise attenuating controls at the source, such as mufflers, acoustic screens. • Provide notice to residents of any planned activities that may exceed noise and vibration targets. • Modification of work activities where noise or vibration is found to cause unacceptable impact. • Ensure that managers effectively communicate acceptable and unacceptable work practices for the site.	Ongoing site monitoring and auditing by the Health and Safety Officer designated by the Developers. Complaints from residents	No construction during non- work hours Number of noise complaints
Operational noise and music			
Noise and music from operational Beach Club	• Reasonable noise and music levels should not be exceeded. • Loud music should be confined to normal operating hours for restaurants in the area.	Ongoing site monitoring and auditing by the Health and Safety Officer designated by the Developers.	Number of noise complaints

		Complaints from residents	

Table 8.10: U.S. Occupational Safety and Health Act of 1970 (OSHA) standards & OSHA Hearing Conservation Program Amendment (Occupational noise exposure - 1910.95)

Duration per day (hours)	< ¼	1	1 ½	2	3	4	6	8	16	32
Sound level (db(A)) Slow Response	115	110	105	102	97	95	92	90	85	80

8.9. Human health and safety management sub-plan

Human health and safety risks include:

- Construction workers working with loud machinery – covered in the Noise Management Plan (Section 8.8)
- Dust particles from construction – covered in Air Quality Management Plan (Section 8.10)
- Noise pollution from construction activities and operation – covered in Noise Monitoring Plan (Section 8.8)
- Workers using cleaning chemicals – covered in Disaster Management Plan (Section 7.0)

8.9.1 Management actions

Management actions are outlined in Table 8.11 below.

Table 8.11: Human health and safety management sub-plan actions

Objective	**Management actions**	**Monitoring**	**Performance indicators**
General			
Ensure the Health and Safety of all workers and residents are maintained	Choose least hazardous, safer, cleaning chemicals. Use safe work practices when using cleaning chemicals (e.g. not mixing bleach and ammonia, using only as much as is needed) Proper worker training on use, storage, and emergency spill procedures	Ongoing site monitoring and auditing by the Health and Safety Officer designated by the Developers	Worker/Resident complaints Training records

8.10. Air quality management sub-plan

Any air quality impacts are anticipated to occur during the construction phase, which will span a period of about 3.5 years between early 2025 and mid 2028. Air quality risks include:

- Use of construction materials, particularly fine sediment materials
- Use of transport vehicles (emissions and dust generation)
- Windborne dust from construction activities, as well as storage of topsoil and sand

8.10.1 Management actions

Management actions are outlined in Table 8.12 below.

Table 8.12: Air quality management sub-plan actions

Objective	**Management actions**	**Monitoring**	**Performance indicators**

General			
Maintain threshold air quality by minimizing dust movement and emissions from vehicles and generators	Minimize dust creation: • Vegetation cleared in staged manner. • Use water trucks to spray down exposed areas or surfaces. • Sealing and/or re-vegetating disturbed areas as soon as possible after completion of each stage of construction works. • Planning haulage routes on sealed surfaces and using dust suppression on unsealed roads within construction sites. • Covering loads on public roads. • Using wind breaks. • Minimizing double-handling of materials. • Seeding, stabilizing, covering, or containing stockpiles where necessary. Ensure purchase and use of modern, recent, and good working order equipment that is industry compliant	Ongoing site monitoring and auditing by the Developers	Dust minimizing actions are taken. Equipment purchased is up to date and industry compliant. Nitrogen oxide, sulfur dioxide and particulate matter emissions are within recommended National Ambient Air Quality Standards (Table 8.13)

Table 8.13: National Ambient Air Quality Standards (40 CFR part 50 of the Clean Air Act)

Pollutant		**Standard**	**Averaging time**	**Level**	**Form**
Nitrogen dioxide (NO_2)		Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and secondary	1 year	53 ppb	Annual mean
Particle pollution (PM)	PM2.5	Primary	1 year	12.0 μg/m^3	Annual mean, averaged over 3 years
		Secondary	1 year	15.0 μg/m^3	Annual mean, averaged over 3 years
		Primary and secondary	24 hours	35 μg/m^3	98th percentile, averaged over 3 years
	PM10	Primary and secondary	24 hours	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulphur dioxide (SO_2)		Primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Notes:
Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.
Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

8.11. Monitoring inspections

Suggested inspection checklist. The final version of this checklist will be determined between the GoAB, EP and the Developers.

Table 8.14: Suggested EMMP Checklist

Date	Inspected by/company:	Stage(s) of development:

✓	Monitoring action	Response/result
BIODIVERSITY		
	Are trees identified for protection still on site/ fenced off?	
	Have any nesting turtles or hatchlings been observed?	
	Native plant species incorporated into landscape and dunes	
	Has seagrass monitoring at control and impact sites been evaluated	
	Has beach width been recorded?	
	Have all data been entered in digitally? If so, which ones and if not, why are they missing?	
WATER		
	Has water quality monitoring in the marina, flushing channel and beach been conducted this quarter?	
	Has the stormwater management plan been developed and implemented	
	Are all chemicals stored and handled in accordance with their MSDS?	
	Have all chemical spills been treated immediately according to disaster response protocols?	
EROSION AND SEDIMENT CONTROL		
	Have water or soil binds been applied to newly exposed soil?	
	Have exposed areas been revegetated or stabilised as soon as practicable?	
	Are any sediment catching devices in place?	
	Is storm water being diverted away from disturbed areas?	
	Are stockpiled topsoil and sand piles appropriately protected from wind/runoff erosion and weed infestation?	
	Is traffic movement into and out of the site controlled and confined to dedicated roads?	
	Any complaints from surrounding residents or workers about dust?	
	Have staff/subcontractor trainings occurred this period?	
SOCIAL AND ECONOMIC		
	Have the vendors been successfully relocated?	
	Number of jobs created or continued	
	What trainings were provided this monitoring period	
	How many events (such as educational talks) were held this period?	
	Has beach access been preserved for the local community?	
NOISE		
	Are noise levels within acceptable levels?	
	Have there been any complaints from workers about noise impacts?	
	Have any noise barriers been necessary and used?	
	Have there been any noise complaints received from residents?	
	Have residents been informed of potential noise disturbances?	
HUMAN HEALTH AND SAFETY		
	Have there been any work-related health complaints from workers?	

	Have all relevant workers been trained on use, storage, and emergency spill procedures for chemicals?	
AIR QUALITY		
	Have there been any worker or resident complaints about air quality?	
	Are traffic areas clearly delineated?	
	Has air quality been tested this period?	
COMMENTS		
Any further comments or any communication with referral/regulatory authorities about potential breached of the EMMP.		

9.0 PUBLIC CONSULTATIONS

During the initial stages of the socio-economic study (as reported in this ESIA), we were informed that there were significant and advanced discussions within the GoAB to create a vendor village to enhance tourism, provide greater economic opportunities for vendors and improve facilities. This village is proposed for a separate location, potentially in the nearby Fryes area. Because this is a separate and ongoing effort, we were informed by the client's representative that further activities and studies were not the responsibility of the client but involve the GoAB and the local community and no further vendor-related activities were undertaken.

Any further public consultations, in addition to publication of the ESIA on the DoE website are at the discretion and request of DoE

10.0 CONCLUSION

Muqali Ltd proposes to construct the Nikki Beach Hotel as a luxury resort in Jolly Harbour, Antigua. It aims to create an exquisite and unrivalled guest experience while increasing high-end tourism in the area and redeveloping the site of an existing dilapidated hotel. The development site is zoned for tourism. It will provide local jobs and financially benefit Antiguan businesses, including suppliers, restaurants, vendors and taxi operators. It will be a significant financial investment into the Jolly Beach area and will provide both social and economic benefits.

Electricity for the site will come from the Antigua Power Utility Authority. During the construction phase, potable water will be supplied by Jolly Harbour while the operational hotel will create potable water on site via reverse osmosis. Any brine produced will be disposed of by deep-water rejection wells. All wastewater will be treated on site using a decentralised package membrane bioreactor treatment plant. Clear water effluent will be used on site for irrigation. Native plants will be included in the landscaping as much as possible. No other sustainability measures, e.g. photovoltaic panels, solar water heaters, or green roofs have been considered.

The impacts of primary concern, as identified in the ToR, include hydrology and drainage, storm surge and coastal flooding, and socio-economic concerns as the main factors to address in the assessment.

Current drainage infrastructure was assessed by a site inspection. The entire site has low elevation (+1-2 LSD), which makes it vulnerable to flooding and highlights the importance of appropriate drainage infrastructure (e.g. subsurface pipes, gutters, drains, vaults etc.) in the new development. During the development, the entire site will be graded to fill in current low-lying areas and low impact development practices, such as swales, boreholes and soakaway inlets, will be implemented for stormwater management. The drainage canal is not functioning as intended and will be filled in.

The developers will follow the recommendations from the site-specific hydrodynamic modelling by applying a 30 m setback from the LPV and a FFE of +2.44 m. The latter is appropriate for a 100-year storm event with present-day sea level but does not include any factor of safety for sea level rise (sea level rise was not included, apparently per client request to ATM engineers). Further protection against coastal hazards should be implemented by planting native dune plants between the development and the sea, and ensuring the first row of buildings are secured using piles or other foundation that can withstand wave action.

The numerous stakeholders who currently use the development site include vendors selling souvenirs and food, taxis, locals and tourists to access the beach, and Sandra's Beach Shop, Bar and Grill. Muqali Ltd is in communication with the GoAB regarding the relocation of (1) vendors to a new vendor village with improved amenities, and (2) Sandra's Beach Shop, Bar and Grill. These are complex issues beyond the scope of this assessment, however, the baseline observations of stakeholder activities on Jolly Beach are reported here.

No potentially significant ecological impacts of the development were identified with regards to vegetation, water quality, marine habitats, or marine and terrestrial species. Best management practices should be applied during the construction and operation of the development, and these are detailed in this ESIA.

The EMMP proposed here will provide a comprehensive ongoing assessment of the impacts of the development on the physical, biological and socio-economic environment on the site itself as well as the neighbouring areas.

Based on our assessment and findings, including consideration of the current land use and zoning regulations, the team did not find any major concerns that in its view would prevent the project moving ahead.

This ESIA was carried out in accordance with the ToR provided by DoE and DCA and following additional communication with the agencies to determine the detail required and areas of concern.

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12.0 ANNEXES

12.1. Disclosure of Consultants Engaged

DEBORAH BROSNAN, Ph.D.

Dr. Deborah Brosnan has 30 years of experience in crafting science-based solutions to environmental risk and with a specialty in Small Island Developing States. She brings extensive experience in leadership and management combined with scientific knowledge to help resolve a diversity of challenging situations

PRESIDENT AND FOUNDER, DEBORAH BROSNAN & ASSOCIATES
A company focused on solutions to environmental risks globally, provides expertise in land land/sea planning and decisions, disaster risk reduction and climate change, endangered species. Science based, strategically and solution focused and serving clients in all sectors 2011-present. St Barthelemy FWI and Washington D.C.

FOUNDER AND CEO, SUSTAINABLE ECOSYSTEMS INSTITUTE
A non-profit organization that integrated science and carried out scientific research to address environmental problems throughout the USA 1994-2011. Established and grew organization, focused on endangered species, forestry, oceans, laws and policies & held several multi-million IDIQ government contracts. Built and deployed effective multi-sector and multi-disciplinary outcome orientated teams Recruited 1,000 credentialed scientists to affiliate as on-call experts

ACADEMIC APPOINTMENTS
Full Adjunct Professor of Biology Virginia Tech. Faculty of the Global Change Institute and Fellow of Global Forum for Urban and Regional Resilience. 2012- Present.
Environment and Policy Faculty. One Health Institute, University of California Davis, 2011-2015
Senior Visiting Researcher, Smithsonian Institution 2013-2016.
Visiting Scholar, Stanford University, Dept. of Biology 2009-2010 and 2002-2003.
Visiting Professor Northwestern School of Law. Developed and co-taught marine science and law, and curriculum on ecological science and law. 1999- 2002 and on occasional basis.

EXPERIENCE
Science-based Environmental Risk Reduction and Problem-Solving
Dr. Brosnan has led several teams that successfully resolved the national environmental challenges involving multiple interests and complex issues where financial and environmental stakes were high and costs escalating (e.g. several high-rishk/high profile situation: Everglades Restoration, endangered species) and mulit-sector clients The process she developed was independently evaluated as the subject of a Ph.D. dissertation (by M. McEathron) and won praise from all sides in the environmental debate for its effectiveness. Dr. Brosnan holds an MOU with the U.S. Dept. of Interior US Geological Survey to provide scientific advice and resources during hazards and crises and has held IDIQ with US Government. Specific Project Examples: S, Florida Everglades Restoration: Management of the Missouri River; Columbia River Dredging and Endangered Species: Atlantic Salmon (State of Maine); Land Use/Development California, Caribbean, Colorado, High-altitude wetlands, public-private partnership for marsh restoration. Dr. Brosnan has provided expert testimony to US Senate and US House Committees

Sustainable Development

Private land use and development is often fraught with investment and regulatory risks. Private landowners, investors, and resort developers have sought Dr. Brosnan's assistance on investment and development strategies in a diversity of environmental areas. Work has included sustainable forestry practices under land management and compliance; Resort and private development covering topics such land suitability; cost-effective building with nature; environmental regulatory compliance; climate change risks and mitigation; biodiversity and sensitive habitats; risks and return on investment; environmental certification. Relationships between private and government sectors must often be brokered for solutions that benefit environment and enterprise, permission must be secured, and community concerns and benefits addressed- these are areas in which she has a proven track record. The scale of her projects has ranged from ownerships of 23.5sq miles (66 km2), properties and entire small islands up to 11sq miles (28 km2), to individual properties with complex developments.

ISLANDS AND EMERGING NATIONS

Dr. Brosnan, a resident in the Caribbean maintains a specialized practice in islands.
Examples of work include:

Assessments, EIAs, Land and Marine use planning and development for private and public sectors spanning ecological, environmental, energy issues. (several islands)

Design and implementation of ecosystem-based solutions Assisted multi-sector clients on building with nature in a cost-effective way as part of their ethic, brand, solution to climate-change and hazard risks, and compliance. Project have spanned design to implementation and included e.g. entire beach length dune-restoration, coral reef restoration, site assessments e.g., hydrodynamic and biological analysis, building community relations, permitting etc. Numerous Islands include St Barthelemy, St Kitts and Nevis and adjacent state; and the integration of environment, natural resources and infrastructure for solutions in the Montserrat Volcanic crisis

Design and implementation of the Marine Reserve, St Barthelemy the first network-designed reserve in the Caribbean.

SOLUTIONS TO HAZARDS, DISASTERS AND CLIMATE CHANGE

Science and Technology for Resilience. As part of the leadership team with NASA and The Nature Conservancy, we have designed a state of the science GIS based resilience tool that is web accessible and can be used by the community in their evaluation and decision-making. (2014-present)

Tsunami Planning California. Evaluated risks and consequences to California and the national economy from distant-sourced earthquakes and tsunamis. As part of the leadership Dr. Brosnan led the scenario effort on impacts on ports, fisheries, endangered species, protected lands and coasts, evaluating ecological, economic and social impacts. Working with 6 teams of scientists from disciplines including economics to engineering, we provided forecasting on direct and cascading impacts.

Extreme Geohazards. As a member of the Geo-hazard team we evaluated the likelihood of extreme volcanic eruptions and their potential impacts on communities, trade and policy (project at the request of European Science Foundation).

Design and Implementation of New Town and Port Facility to mitigate Montserrat Volcano: Led the environmental assessment and planning the engagement of government and community and worked with the engineers and government to design an ecologically-sustainable new town and port facility that would provide necessary infrastructure, transportation, government and community services and natural resource and habitat basis for fisheries, tourism and farming. This proved vital when subsequently the eruption destroyed main town, transportation and services.

CAPACITY BUILDING AND MULTI-DISCIPLINARY ENGAGEMENT

Dr. Brosnan has developed and implemented innovative and cross cutting workshops and capacity building experiences including:
Integrating ecosystems, Disaster Risk Reduction and Climate Change in policy and actions for Organization of Eastern Caribbean States (11 nations) 2016.
Science in the Courtroom: Workshops and lectures for State Supreme Justices and US Justices.
Science Arbitration: Using science to resolve complex environmental disputes (Lecture and Workshop series for professionals and graduate students)
Marine science and Law: Course for environmental lawyers and students and practitioners.
Recent Presentations (2016-2017)
Upcoming Sustainable Infrastructure, Miami Green Infrastructure Conference March 2018.
TEDx Aligning with Nature: Sun Valley 2017
Green, Gray and Hybrid Solutions: Why they matter to you? American Society of Civil Engineers Sustainable Infrastructure Conference (Speaker and Session Convenor) Nov 2017.
Ports and Coasts: Evaluating Risks and Designing Solutions. World Ocean Council (Industry Group for Oceans and Maritime issues) Nov 2016 Rotterdam
Oceans – 3 Lectures in French Polynesia 2016
Workshop on New Sustainability: Incentives and Opportunities in Design and Legal Framework Florida Green Building Coalition Convention Miami Sept 2016
Innovations in ecosystem-engineering for disasters and climate Change (Workshop U.N. Bonn 2016)
In the heat of the moment effective use of science and scientists during crises and hazard events (Workshop San Francisco Dec 2016)

PUBLICATIONS
Over 50 publications in peer reviewed, reports and popular literature, including edited book
Frequent Expert Contributor to Huffington Post on science environment and disasters. http://www.huffingtonpost.com/author/brosnan-132 Articles and Op-eds published to Washington Post, New York Times

BOARDS OF DIRECTORS AND ADVISORY BOARDS
Dr. Brosnan serves and has served on a number of Boards and Advisory Boards including:
President of the Board of Directors, Wild Geese Network of Irish Scientists- international diaspora of Irish scientists, engineers and technologists. 2014- present
Board of Trustees and Past Chair- University of California Davis, Wildlife Health Center, SeaDoc Society. 2000-present. A wildlife science and medicine program to restore and sustain ecosystem and human health.
American Society of Civil Engineers. Member of Committee on Sustainability. 2016-present
National Courts and Sciences Institute. Science Board Member 2014- Present. Education of justices in scientific practices and knowledge.
Board of Directors, PADI Project AWARE a global SCUBA diving conservation organization office in 8 Regions around the world 2011- Present
Science Advisor to The Environmental Agency St Barthelemy FWI. 2013-Present.
Commissioner IUCN Commission on Ecosystems 2014- Present.
Global Risk Forum, Davos, Board of Advisors 2014- Present. Comprehensive Disaster Risk Reduction globally
Conservation Committee, American Ornithological Society 2014-2016.
Joint USA- Italy Commission on hazards and disasters 2015-2016
BBC The World, Science Advisor 2006-2012 3BBC Radio Series.
Oregon Health and Sciences University, Board of Advisors, Coastal Oceans Monitoring Program 2005 to 2015. High-tech ocean observation and monitoring system for biological and physical aspects of the ocean including fisheries conditions and tsunami risks.

Public Trustee, Board of Directors, Oregon State University, College of Forestry, appointed by State as the Public Representative 1997-2005. State oversight and assistance for forestry research and practices.
Board Member of National Science Foundation Group to form the National Ecological Observatory Network (NEON) 2001-2004. Developed vision, organizational structure and legal entity, and set up the US NEON Observatory platform.
Chair, US Department of the Interior, Blue Ribbon Scientific Ethics Panel 2002.Led the effort to develop and review a code of scientific ethics adopted for the conduct of science by all the agencies under the US Dept. of Interior.

Other Fellowships and Awards
Inducted into Ireland 100 for services to US higher education and learning. 2015
Science-artist in residence Cill Rialig Ireland August 2015.
Senior Whiteley Fellow, University of Washington 2010, 2005
Red Cross Hero's Award for saving lives in 747-plane crash.

ADDITIONAL COMMUNITY WORK
Founded Tsunami Reef Fund (2005) linking international scientists, professional divers with local communities affected by the tsunami. Provided practical economic and scientific assistance locally in marine debris clean up and reef recovery, and re-engage communities with the ocean. Travelled throughout region to establish program and long-term linkages.

LANGUAGES
English, French (medium), and Gaelic

ACADEMIC CREDENTIALS
Ph.D. Oregon State University. Effect of extreme events on marine community dynamics. 1994
M.S. National University of Ireland Fisheries Science: Thesis Experimental Fishery for Spider Crab Maia squinado 1982
B.S. honors in Zoology and Botany, University College Galway 1978

ALANNA WALDMAN CARROW, M.Sc.

Mrs. Waldman Carrow has a strong background in environmental research and reporting. She has worked on marine ecosystems to compile and analyze data to inform coastal and marine resource management projects in Florida and throughout the Caribbean. Specifically, this research has focused on coral reef restoration, assessment, and monitoring to inform conservation efforts, beach renourishment projects, marine protected area management, and mitigation of invasive species impacts. She has also designed and managed programs for dune restoration, mangrove rehabilitation, sea turtle monitoring and protection, and sensitive vegetation mitigation.

Through her experience in research and outreach, she has worked with U.S. federal, state, and non-governmental agencies on best practices for coral restoration and management. Mrs. Waldman Carrow has conducted field work collecting data on fishes, stony corals, macroalgae, sponges, water quality, and beach renourishment and port development impacts on coastal ecosystems. She has extensive experience in project and program management with research and nonprofit organizations. Mrs. Waldman Carrow holds a Master of Science Degree in Marine Biology from Nova Southeastern University.

HOLLY TREW, Ph.D.

Dr. Trew has 15 years of environmental research experience and reporting. She has worked on marine ecosystems throughout the Caribbean, collecting, compiling and analyzing data. This research has specifically focused on coral reef monitoring surveys, experimental assessments and reef health to inform conservation efforts, academic research, and mitigation of invasive species. Dr. Trew has conducted multiple environmental assessments for private entities and the government in Barbados relating to baseline assessments for coastal construction projects and monitoring of ecological growth on existing structures. Dr. Trew holds a B.Sc. (hons) from Dalhousie University in Nova Scotia, Canada, and a Doctor of Philosophy in Ecology from The University of the West Indies, Cave Hill, Barbados.

12.2. Declaration of Completeness and Authenticity

Mr. Frederick Southwell
Chief Town and Country Planner
Development Control Authority
St. Johns, Antigua
12th August 2024

Dear Mr. Southwell,

Deborah Brosnan & Associates is pleased to submit this ESIA for the proposed Muqali Ltd development of the Nikki Beach Hotel. Plan Application #G12-2023.

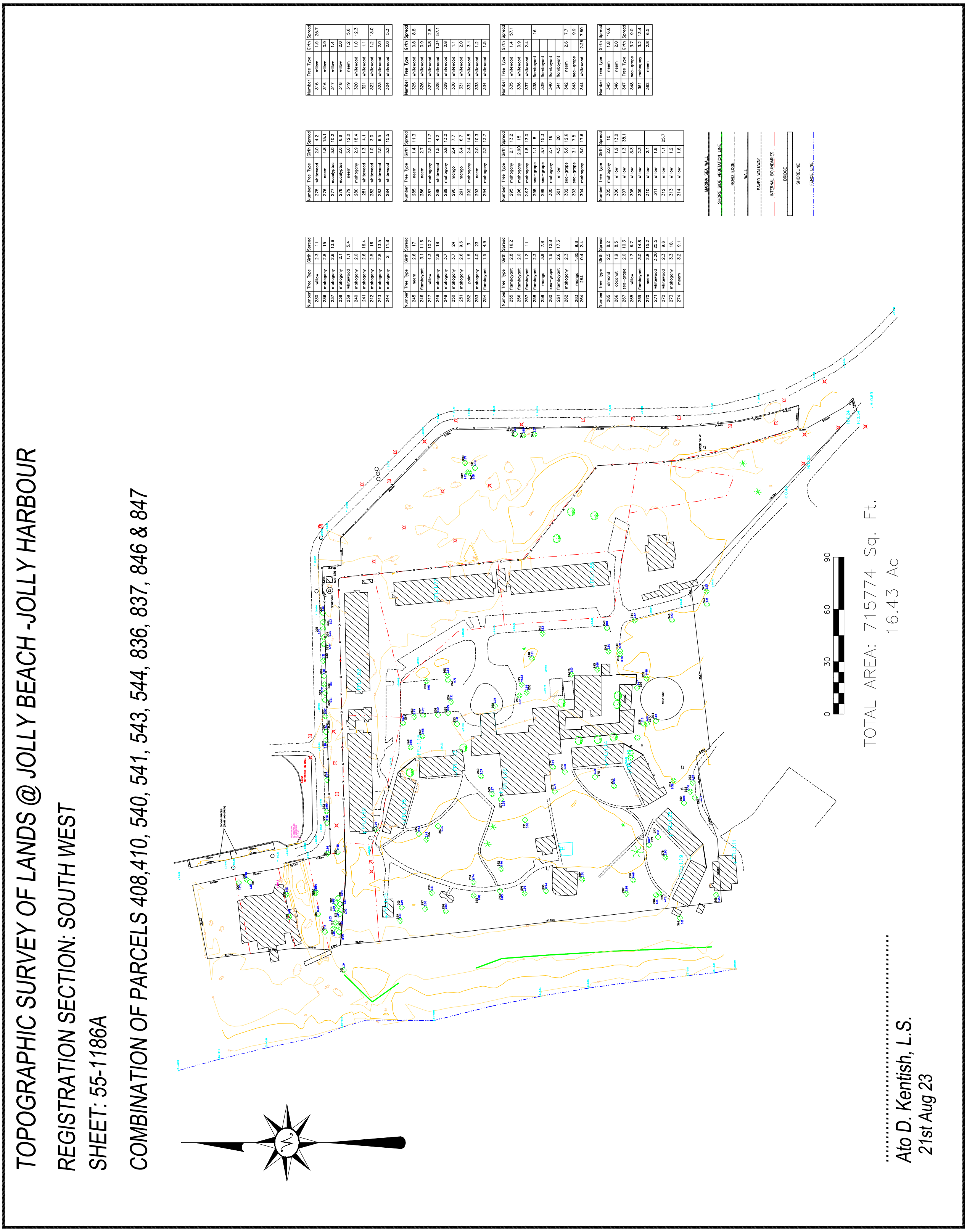
This ESIA is submitted according to the review and Terms of Reference provided to Deborah Brosnan & Associates in November 2023. We confirm that this work was completed by Deborah Brosnan & Associates. This document has been prepared based on technical and other information and assessments supplied to us by the client and the clients technical/engineering, architectural and other professional teams. We have not verified all of this information but taken it at face value against known factors and international standards where possible. Where such information does not provide details yet to be finalised such as details on the sewage treatment plant and drainage, and or other factors, we have used peer-reviewed standards and acknowledged that best practice will be implemented throughout the construction, commissioning and operation of the new development. These have been indicated in the ESIA and the information provided evaluated to the best of our professional ability.

Yours sincerely,

Deborah M. Brosnan

Deborah Brosnan Ph.D.
President,
Deborah Brosnan & Associates

Appendix 1 – Topographic Survey of Lands



Appendix 2 – Water Quality Results

Department of Analytical Services
Friars Hill
St. John's
Antigua
T: 462-9437/462-6281
E: linroy.christian@ab.gov.ag

Certificate of Analysis

This Report should not be used for purposes of advertising, publicity or litigation, nor shall it be reproduced, whether in part or in full, without the written consent of the Department of Analytical Services

Date of Issue	:2023-11-30
Client	:Deborah Brosnan & Associates
Report #	:DBA005
Sample Submission Date	:2023-11-20
Temperature on Arrival (°C)	:<10
Sample Type	:Environmental Water

Lab ID	Sample ID	Sample Description	Enterococci (<35) cfu/100ml	Faecal coliform (<200) MPN/100ml	pH (6.5-8.5)	Turbidity NTU	Salinity ppm	Nitrate ppm	Phosphate ppm
DBA-202311-01	M1	Marina 1	3	<20	8.0	2.45	$3.49x10^4$	<0.001	0.04
DBA-202311-02	M2	Marina 2	1	<20	8.0	2.50	$3.40x10^4$	<0.001	0.04
DBA-202311-03	M3	Marina 3	1	<20	8.2	1.60	$3.44x10^4$	<0.001	<0.02
DBA-202311-04	C1	Channel 1	ND	<20	8.0	5.71	$3.42x10^4$	<0.001	0.04
DBA-202311-05	C2	Channel 2	9	<20	8.0	4.94	$3.31x10^4$	<0.001	0.04
DBA-202311-06	C3	Channel 3	ND	<20	7.8	29.3	$3.17x10^4$	0.676	0.06
DBA-202311-07	B1	Beach 1	ND	<20	8.0	43.5	$3.54x10^4$	<0.001	<0.02
DBA-202311-08	B2	Beach 2	13	<20	8.1	40.4	$3.53x10^4$	<0.001	<0.02
DBA-202311-09	B3	Beach 3	ND	<20	8.1	54.6	$3.50x10^4$	<0.001	<0.02

ND-Not Detected

Approved by:

Dr Linroy Christian
Director

Page 1 of 1

Table 12.1: November 20, 2023 water quality results from *in situ* measurements until a YSI probe for DO and temperature, and a refractometer for salinity.

Site	Time	Temperature	Dissolved oxygen (DO)	Salinity	Notes
M1	09:17	28.6	6.01	28	Fish present
M2	09:22	28.6	5.75	32	Fish present
M3	09:26	28.8	5.89	31	NA
C1	09:31	28.5	4.44	30	Fish present
C2	09:34	28.3	4.43	29	Fish present
C3	09:36	27.6	4.78	28	NA
B1	09:43	28.3	7.19	32	Milky, turbid water
B2	09:47	28.4	7.51	33	Milky, turbid water
B3	09:50	28.5	7.47	33	Milky, turbid water

Appendix 3 – Jolly Beach Resort Civil Site Assessment Report

JOLLY BEACH RESORT
JOLLY HARBOUR, ANTIGUA

CIVIL SITE ASSESSMENT REPORT

PREPARED FOR:
MUQALI LTD.
44 Church Street
St John's, Antigua and Barbuda

PREPARED BY:

HARRIS CIVIL ENGINEERS, LLC
1200 Hillcrest Street
Orlando, Florida 32803
(407) 629-4777
Mr. David Taylor

April 5, 2024

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Appendix B – Pre Development Basin Delineation Exhibit
Appendix C – Additional Site Photos

1.0 INTRODUCTION

Harris Civil Engineers, LLC (HCE) has been engaged by Muqali Ltd (the Client) to perform a site drainage evaluation for a portion of the existing Jolly Beach Resort in the Jolly Harbour area on the island of Antigua.

The property is located west of Palm Beach Drive, along the Lignum Vitae Bay oceanfront. The property is currently still in use and had active guest reservations at the time of visit. However, only a portion of the existing buildings were being occupied. The property extents additionally encompasses a beach front restaurant, Pop Up Beach Bar, to the northwest of the resort. The restaurant was also still currently in use.

On March 26, 2024, two representatives of HCE walked the property with Daryl Benjamin (Site Representative), of D Benjamin Architects, to observe and study the existing stormwater runoff patterns. It is HCE's understanding that the Client desires to demolish all the current buildings and infrastructure to construct a new resort concept. As the subject property is only a portion of the existing Jolly Beach Resort to be redeveloped, the remaining portion must be severed and self-sustaining.

The purpose of this report is to provide our site observations and delineate the existing, or pre-development, drainage areas for the Client. This report is broken into the following sections:

- Existing Site Infrastructure
- Drainage Evaluation (on and off-site)

To HCE's knowledge, there are no previous construction plans or design reports for the resort available to review. Our site assessment is based on limited information available, observations made and conversations with the Site Representative and resort staff. Field observations were visual in nature and did not include any testing, underground excavations, or other invasive means and methods of evaluation.

2.0 EXISTING SITE INFRASTRUCTURE OBSERVATIONS

At the time of visit, the resort had active guests and buildings in use. There are four (4) large, 3-story buildings along the eastern and northern boundaries that appeared to be dilapidated and no longer in use. Vegetation has outgrown many of these entrances and pathways making access to the structures difficult. There were a few smaller structures near these buildings (i.e. the previous check-in office) that also did not appear in use and were abandoned.



Photos 1-3 - Dilapidated 3-story building (left & right) and check-in office (center)

Per conversations with the Site Representative, all the buildings and associated infrastructure on site are to be demolished. All current utilities that may serve the resort will be capped at the property line and demolished internally. The new resort concept will install and route applicable utilities to service the proposed development. HCE observed piping and a meter near the current guard house at the property entrance.


Photos 4-5 - Utility piping (left) and water meter (right)

The resort has concrete roadways, as well as concrete and paver walkways throughout the property. The roadways have curbs to help direct drainage runoff. The existing curbing had cut marks and/or holes/penetrations in the curbing to convey drainage to landscape areas. The walkways appeared to be slightly elevated above the surrounding grade. Portions of the concrete walkways had moderate cracking and appear to have been patched previously. Many of the concrete walkways adjacent the building foundations had signs of washout and undermining, likely caused by erosion. In some of these observed locations, rocks and/or gravel was placed to aid in dissipating the runoff.



Photos 6-8 – Concrete roadways (left), curbing with holes for drainage (center), and elevated walkway with undermining (right)

The property has an above ground water tank. The water tank appeared to be functional, as running water could be heard from outside the tank walls. Portions of the upper tank edges had vegetation growth. The Site Representative informed HCE that the water tank was full but not in use. Upon observation of the water tank, there was a pipe noted at the top that appeared to be connected to an above ground cistern. The cistern was not accessed or evaluated at the time of visit, and it is unknown if it is in use. HCE did not confirm the operation of any pumping systems.



Photos 9-11 – Above-ground tank (left), pipe between tank and cistern (center), and above-ground cistern (right)

A sanitary lift station was noted on site. The wet well valve vault was located near the gazebo structure. It is unclear at this time if there are other stations on property, or if a portion of the site is serviced via a gravity sewer system. There is another lift station denoted on the received survey and is located within the property boundary at the northeastern corner. The lift station was next to an electrical substation. The Site Representative relayed that said lift station does not service the property but instead services the surrounding marina development.



Photos 12-14 – Lift station near Gazebo (left), lift station near northeast property corner (center), and elevated electrical substation near northeast corner (right)

There were several above ground concrete structures/vaults around the site. Many were inaccessible. It is unknown to HCE the nature of said vaults or if the vaults have operating utilities below.



Photos 15-17 – Above ground concrete vaults

There is a short, rock wall to delineate the property from the public beach along the western boundary line. The wall appeared aesthetic and does not appear to function as a retaining wall. Additionally, there is an existing 6-foot block wall on the north side, adjacent the public beach access point.

Photos 18-19 – 6-foot block wall (left) and Aesthetic wall along western boundary (right)

Refer to **Appendix A** of this report for a site observation exhibit of the above-mentioned infrastructure, in addition to the site photos at the end of this report.

3.0 DRAINAGE EVALUATION

3.1 EXISTING CONDITIONS & ON-SITE DRAINAGE

Stormwater inlets were noted on site at the time of visit. The inlets were located within the roads and/or drive aisles. Many of the inlets were full of sediment and debris. It was unclear if the structures were connected via a piping system or if the inlets acted as exfiltration boxes. HCE was unable to determine if the inlets were connected to a larger stormwater system. The inlets did not appear to be operable and blinded.

Photos 20-22 – Stormwater inlets blinded by sediment and debris

The buildings have roof gutters for drainage. The gutters are in varying conditions. Some buildings have gutters that appear to be in good condition and operable, whereas others have major portions of the gutter damaged, removed, or overgrown vegetation within. The downspouts for the gutter systems appear to terminate slightly above grade and do not tie into a larger drainage system. Where there is damage to the gutters, stormwater appears to be sheeting directly off the roof and onto the ground causing erosion adjacent the walkways. It appears gravel and stones have been placed in these areas by maintenance staff to help dissipate the runoff and mitigate future erosion.



Photos 23-25 – Roof gutters (left), downspout terminating above grade (center), and gravel to mitigate erosion (right)

Many of the buildings that are assumed to be abandoned had above-ground header pipes collecting the roof gutter systems. HCE was able to observe said piping from the Palm Beach Drive roadway. It is unclear where these pipes are routed, if the system is operational, and where they ultimately discharge to.

Photo 26 – Roof gutters of the 3-story buildings connecting to above-ground header pipe

There is a flushing channel at the northwestern corner of the property that is connected to the marina North of the property via concrete culverts. It appears this area historically conveyed water between the marina and the ocean. However, the area has been dammed and does not appear to be functioning as intended.

Photos 27-28 – Flushing channel (left) and dammed area preventing flow between the marina and ocean (right)

The site currently does not have a defined stormwater pond to attenuate runoff within the property extents. Runoff for the site appears to be conveyed across land via gravity or directed to low-lying grassed or landscape areas. These low-lying areas appear to be intentional to allow stormwater to collect and percolate into the ground. The internal buildings, walkways and beach frontage are elevated higher than these areas effectively containing the runoff.

Photos 29-31 – Low-lying grassed areas

A vault was noted that appeared to be in use for pumping stormwater. The vault was located at the southern property boundary, between the spa building and the above ground water tank. The vault was positioned at the bottom elevation of a determined low-lying area. At the time of visit, HCE was unable to determine if the pumps were operable. There was visible piping from the vault, routing under the walking bridge and leading in the direction of the adjacent property. It is unclear where the system pumps to and where the water is ultimately discharged.



Photos 32-34 – Location of stormwater vault (left), internal view of stormwater vault (center), and piping from the vault routed toward the adjacent property (right)

HCE evaluated the site before and after a minor rain event. After the rains subsided, it was apparent that rainwater collected in the suspected low-lying areas noted. The following day, HCE returned to the site and found that much of the previous water ponding on site had percolated into the ground. The soil appears to percolate well, however, further geotechnical analysis is recommended.



Photos 35-37 – Low-lying area before rainfall (left), shortly after rainfall (center), and the following morning (right)

In conversations with maintenance staff, it was relayed that during large rainfall events the ponding on site can reach notable elevations. Additionally, it was communicated that the property was built on a wetland/mangrove habitat. It is unclear at this time if during significant rains the water on-site reaches an elevation that allows it to escape the property to off-site areas.

3.2 OFF-SITE DRAINAGE

There are existing drainage systems for Palm Beach Drive road and/or right-of-way. These systems are approximately to the North and East of the property boundary. The systems vary in design and seemingly convey water to the marina. The noted off-site drainage systems consist of an above ground concrete lined swale as well as grated inlets. HCE did not evaluate any off-site drainage systems.

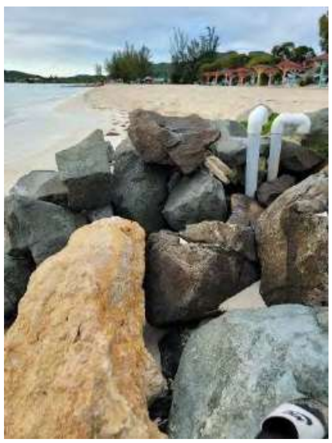
Photos 38-40 – Off-site above-ground concrete swale (left) and grated inlet (right & center)

Refer to **Appendix B** of this report for the site's pre-development basin delineation exhibit, in addition to the site photos at the end of this report.

4.0 UNKNOWNS AND ASSUMPTIONS

Without previous construction plans or reports, HCE made assumptions where needed. Below is a list of unknowns that will require further investigation. These unknowns include but are not limited to:

1. The found vault between the spa and water tank that is assumed to pump stormwater. Is the station functional? Where does the station discharge?
    - Pipes were found on the beach that appear to be routed in the direction of the spa building. It is unknown if these are the outfall pipes from the stormwater pumping station.




Photos 41-42 – Pipe terminals noted on beach

2. The 3-story buildings were inaccessible. It is unknown where the roof collection piping system discharges to. At this time, they are assumed to discharge on-site and do not connect to an off-site drainage system.

3. The area to the east of the 3-story buildings, assumed currently to be a parking area, is very flat. At this time, HCE assumes the runoff from this area is conveyed overland to the Palm Beach Drive roadway drainage system off-site.

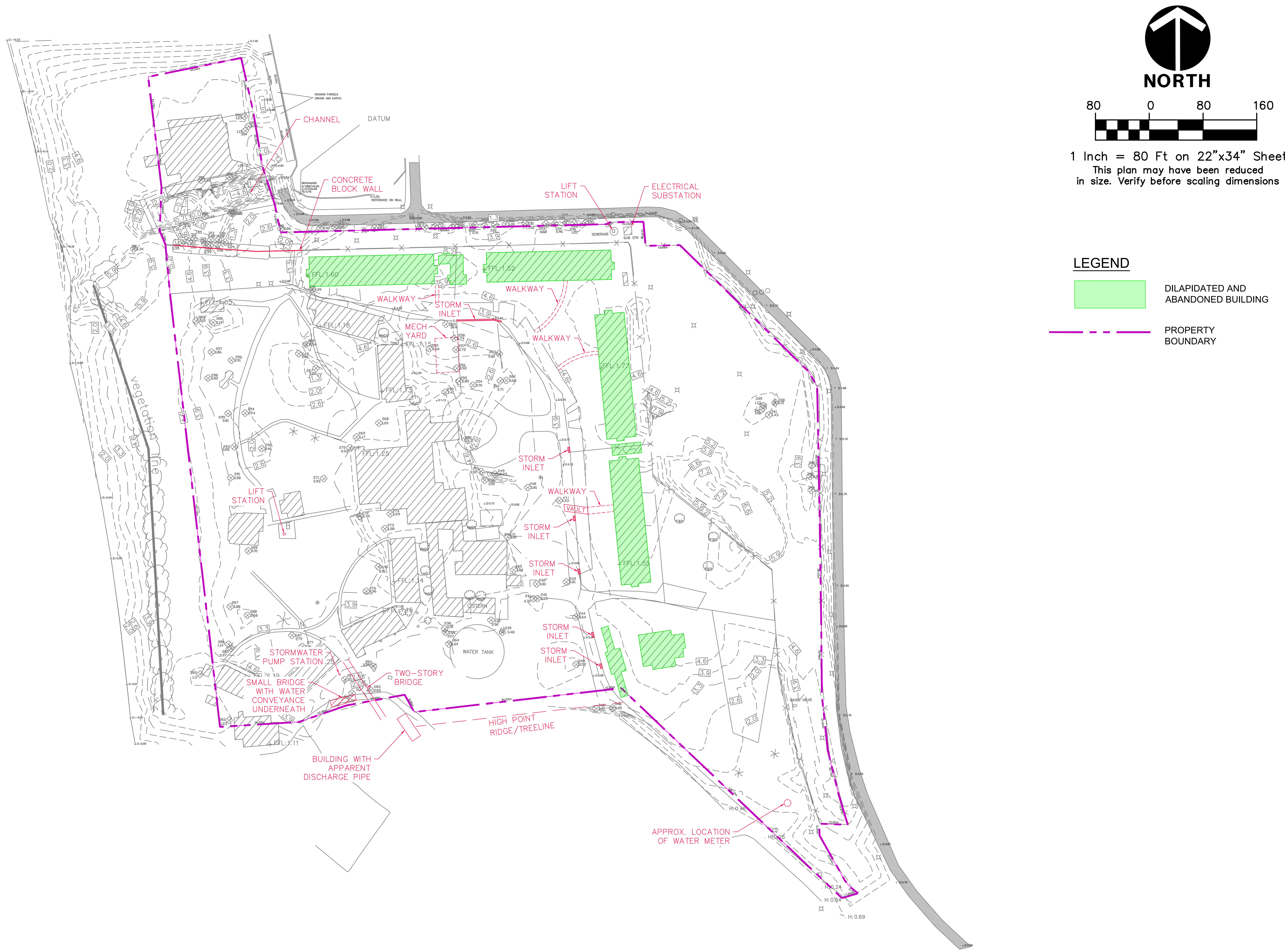
4. There is a building on the southern adjacent property with what appears to be a discharge pipe terminating in the direction of the low-lying area near the water tank. Is this building a cistern? Is the noted pipe an overflow pipe that will discharge on property?



Photos 43-44 – Building with apparent discharge pipe (left), pipe routing (center), and roof of building (right)

APPENDIX A

SITE OBSERVATION EXHIBIT



Harris Civil Engineers, LLC
1200 Hillcrest Street
Suite 200
Orlando, Florida 32803

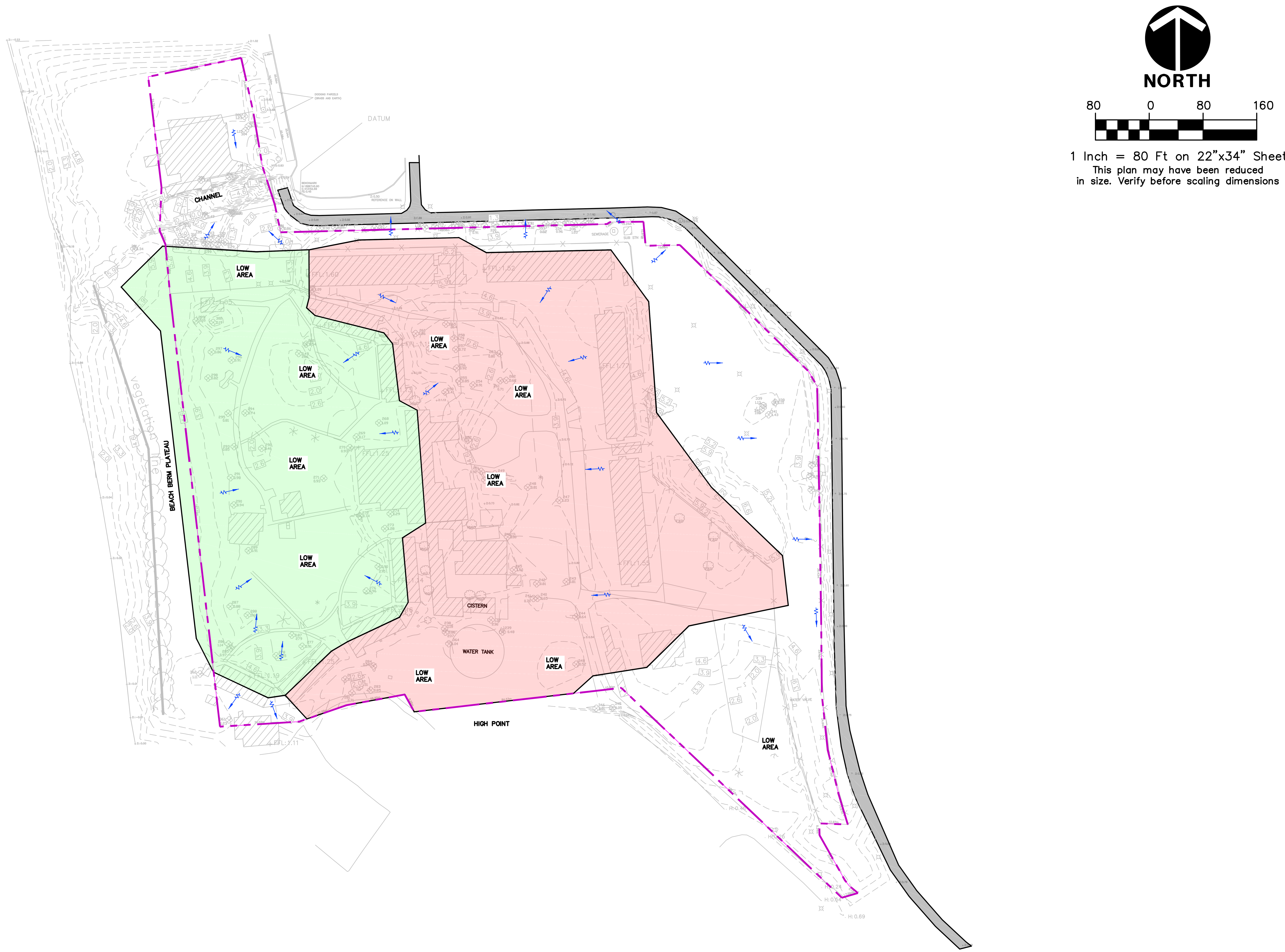
HARRIS CIVIL ENGINEERS

JOLLY BEACH RESORT
SITE OBSERVATIONS EXHIBIT

APPENDIX
A

APPENDIX B

PRE DEVELOPMENT BASIN DELINEATION EXHIBIT



Harris Civil Engineers, LLC
1200 Hillcrest Street
Suite 200
Orlando, Florida 32803

JOLLY BEACH RESORT
PRE DEVELOPMENT BASIN DELINEATION EXHIBIT

APPENDIX
B

APPENDIX C

ADDITIONAL SITE PHOTOS

A. Buildings









B. Walls



D. Off-Site Roadways






C. On-Site Roadways/Walkways









E. Existing Utilities









F. Low-Lying Areas

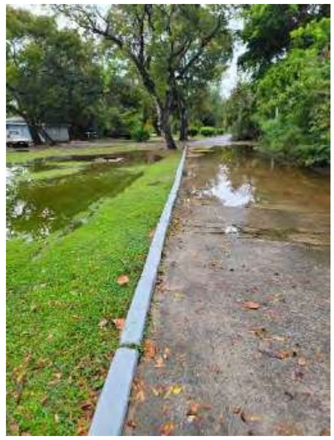








G. Post Rainfall






Appendix 4 – Stormwater Management Report

Stormwater Management Report
Nikki Beach Resort and Branded Residences
Jolly Harbor/Mosquito Cove, Antigua
(Revision 0)

Prepared By:

Thompson Ehle Company
2 Sun Ct., Suite 450
Peachtree Corners, Georgia 30092
(404) 266-1400

August 23, 2024

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Methods and References

Appendix

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B. Storm and Sanitary Analysis Model 2023 Nikki Beach Resort
C. Rain intensity NOOA ATLAS 14 PR & USVI
D. Figures
E. Conceptual Drainage Plans and Details

1. INTRODUCTION

Thompson Ehle Company has been engaged by HKS Hospitality Group to complete the site drainage evaluation and calculations for the Nikki Beach Resort and Branded Residences. These calculations are based upon the master plan design produced by HKS Hospitality Group which was released in 2023. The property is located at Jolly Harbor/ Mosquito Cove. The property is currently used as a hotel, front beach club and a beach bar. Only portions of the guest buildings are being occupied.

1.1 General

- **Project Description:** The future development is composed of the following elements:
  - 82 Key Hotel - 4 Buildings on site
  - 180 Residential Units – 3 High Rise Buildings and 5 Villas
  - Parking Garage
  - 14,461 sq. ft Wellness Center
  - 21,500 sq. ft Beach Club

The area which will be impacted by the proposed development is approximately 16.43 acres and is indicated in Figure 1.1, shown below.

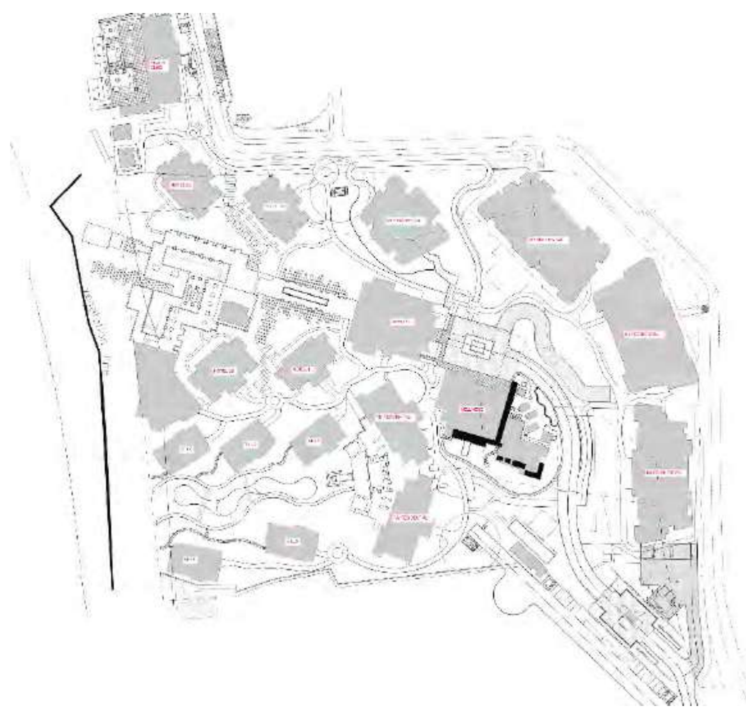


Figure 1.1 Development Area

1.2 Document Structure and Methodology

The calculations in this drainage report were produced following the Antigua and Barbuda Drainage Code and Guidelines dated November 2022 methodology for a Type A -Stormwater Management Approval.

Design philosophy. The contributing drainage area for the development was delineated with consideration given to the area's topography, drainage systems, roadways, existing and proposed development. This contributing area was then divided into sub-basins based on the same considerations as the original delineation.

Second, design criteria were identified for each sub-basin to satisfy the components of the USDA Urban Hydrology for Small Watersheds TR 55. The model described in TR-55 begins with a rainfall amount uniformly imposed on the watershed over a specified time distribution. Mass rainfall is converted to mass runoff by using a runoff curve number (CN). CN is based on soils, plant cover, number of impervious areas, interception, and surface storage. Runoff is then transformed into a hydrograph by using unit hydrograph theory and routing procedures that depend on runoff travel time through segments of the watershed. The required criteria were the run-off curve numbers, surface run-off area, soil, cover conditions and time of concentration. For rainfall distribution data the NOOA ATLAS 14 Rainfall Data with a Type II distribution for PR & USVI was used.

Peak discharge rates for the site were then calculated based on the design criteria using Hydraflow Extensions. Hydraflow Extensions is an application for urban hydro systems engineering capable of analyzing the hydrologic properties of simple and complex watersheds and model entire drainage basins and detention ponds

Once peak discharges for each basin were established pre-development and post-development peak flows were compared to determine if on site detention or storage facilities were required. The Antigua and Barbuda Drainage Code and Guidelinesdated November 2022 performance standard in section 2.1.7.1 if the predevelopment flows are exceeded by the post development flows by 5% margin SWM Detention facilities are required.

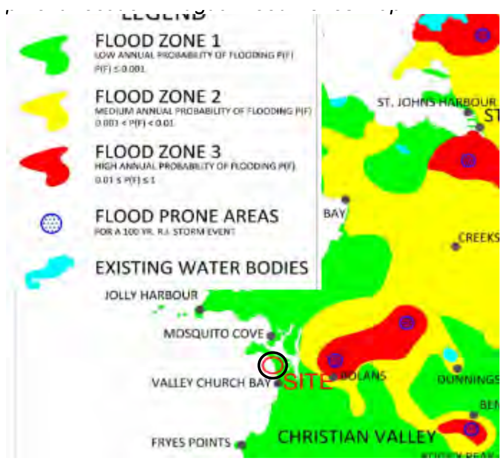
Finally, drainage structures were designed and sized to accommodate the peak discharge rates calculated for the design storm per Antigua and Barbuda Drainage Code and Guidelines dated November 2022 performance standard in section 3.1.1 Figure 3.1. Using the rational method to determine peak flows for each drainage system.

The rational method represents a steady inflow-outflow condition of the watershed during the peak intensity and considers the drainage basin, runoff coefficient (C), is the ratio of runoff to rainfall and runoff coefficient (C), also called the “coefficient of imperviousness,” is the ratio of runoff to rainfall. Autodesk Storm and Sanitary Analysis Model used for design and analysis of urban drainage systems, storm sewars, and sanitary sewers was used to produce pipe sizing and profiles.

1.3 Location of Site Development

The property is located at Jolly Harbor/ Mosquito Cove west of Palm Beach Drive. By graphical plotting only the site is on Flood Zone 1 with an annual probability of Flooding (F) less or equal to 0.001, low classification. Refer to Figure 1.1. for the Antigua Flood Zone Map and Figure 1.2 for site aerial photo below.

Figure 2.2 Development Location Antigua Flood Zones Map



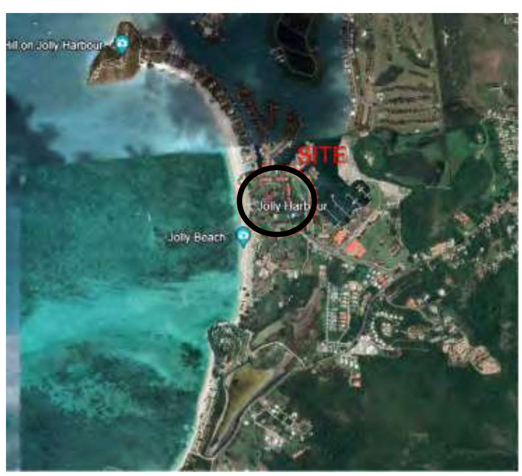


Figure 3.3 Development Location Antigua Aerial Photo

PROJECT	Nikki Beach Resort	**PROJECT NO.**	222042	**PAGE**	6 of 29
CLIENT	HKS Hospitality Group	**PREPARED BY**	R. Baez	**DATE**	08/23/2024
SYSTEM	Drainage Report	**CHECKED BY**	N. Comm	**REV**	0

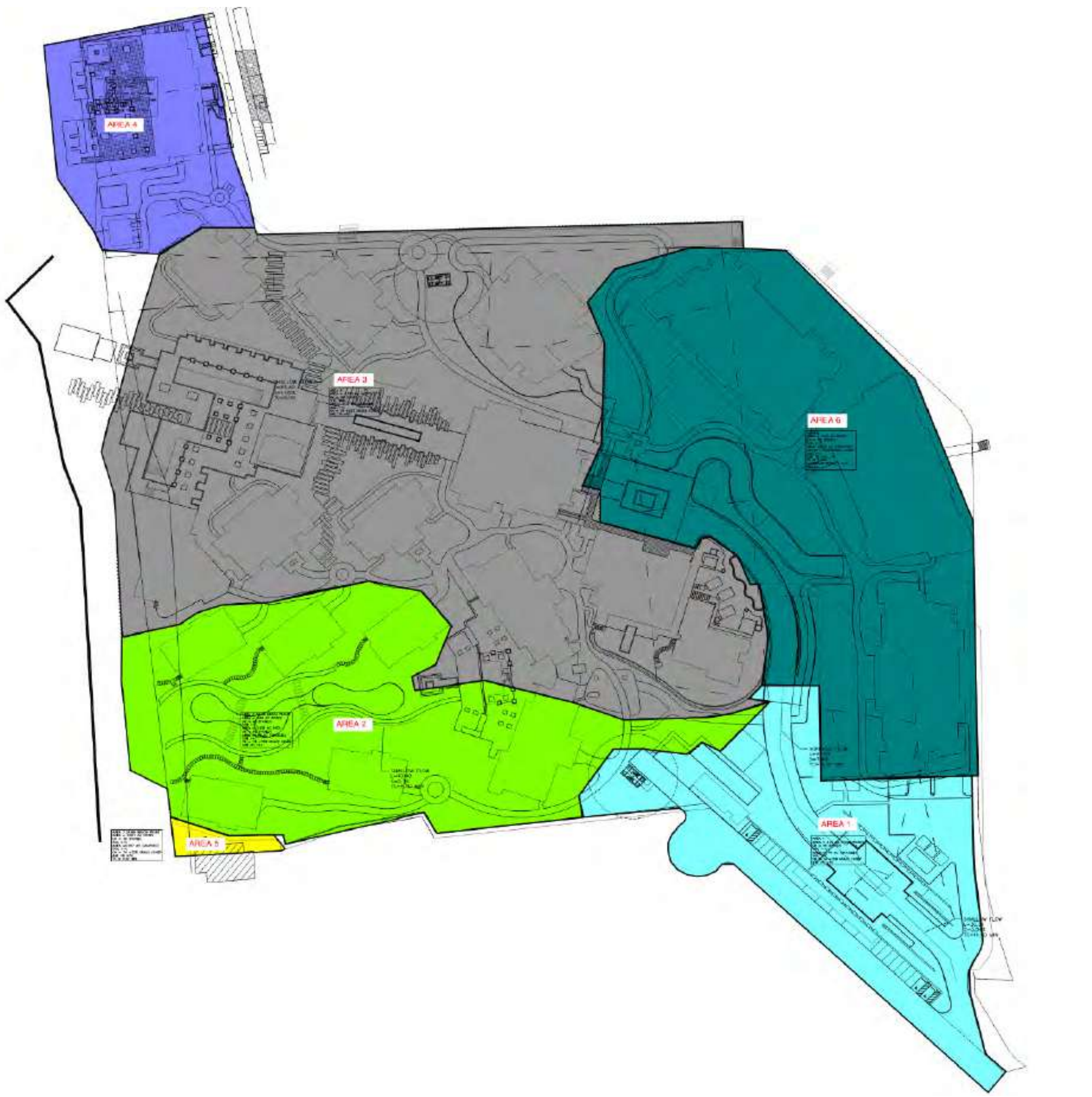
2. BASIN DELINEATION

The total drainage area for the existing and proposed development (shown in Figure 2.1 and 2.2) is approximately 16.43 acres. The drainage area maps below includes the areas which will be developed.

The total drainage area has been subdivided to calculate more accurate peak discharges and isolate components of the basin contributing to each proposed drainage structure.

Figure 2.1 Pre-Development Basin Delineation

Figure 2.2 Post-Development Basin Delineation



3. DESIGN CRITERIA

The Urban Hydrology for Small Watersheds TR -55 Method for determining peak discharges requires four parameters to be identified:

1) Time Parameters based on velocities of flow (Tc, minutes)
2) Surface Run-off Area (A, in acres)
3) Curve Numbers (CN, -)
4) Hydrological Soil Groups

3.1 Surface Runoff Area (A)

The area of each sub-basin was determined digitally using Autodesk Civil 3D and is given acres for the pre-development and post-development conditions see in table 3.1 and 3.2 (below).

Sub-Basin	Area (AC)	Discharge to
Area 1	3.86	Harbor
Area 2	7.33	Low Area on site
Area 3	4.77	Low Area on site
Area 4	0.14	Flushing Channel
Area 5	1.18	Offsite

Table 3.1 Sub-basin Areas Pre-Development

Sub-Basin	Area (AC)	Discharge to
Area 1	2.06	Harbor
Area 2	2.88	Low Area on site
Area 3	6.86	Low Area on site
Area 4	1.11	Beach Front
Area 5	0.074	Beach Front
Area 6	4.09	Low Area on site

Table 3.2 Sub-basin Areas Post-Development

3.2 Curve Numbers (CN)

Curve Numbers depend on several factors, including soil type, land slope, vegetation, and impervious surface. Table 3.3 lists the runoff coefficients used for Antigua.

The tables below provide established CN values for cover types and hydrologic conditions based on Hydrological Soil Group classification. These values were adopted from the Texas Department of Transportation (TxDOT) Hydraulic Design Manual (2019). The developer shall select the CN corresponding to the predominant surface cover type that best suits the sub-catchment being assessed for the pre-development and post-development conditions of the watershed/development site.

Table 1: Runoff Curve Numbers for Urban Areas

Cover type and hydrologic condition	Average Percent Impervious	Hydrological Soil Group A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, etc.):					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Paved parking lots, roofs, driveways, etc. (excluding		98	98	98	98
Streets and roads:					
Paved; curbs and storm drains (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (townhouses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas: Newly graded areas (pervious area only, no vegetation)		77	86	91	94

Table 3.3 Curve Numbers

Figure 3.1 shows the Hydrological Soil Group “C” for the Site.

Pre-development conditions the site areas range from combination of existing buildings, parking lots, concrete sidewalks and grassed areas ranging from poor to fair conditions. CN numbers were weighted per sub basins to reflect these conditions. Refer to Table 3.1 for the Average Curve Numbers calculated for the Pre-development Conditions.

Post-development the site areas range from combination of buildings, permeable walks and good condition landscape areas. Refer to Table 3.2 for the Average Curve Numbers calculated for the Post-development Conditions

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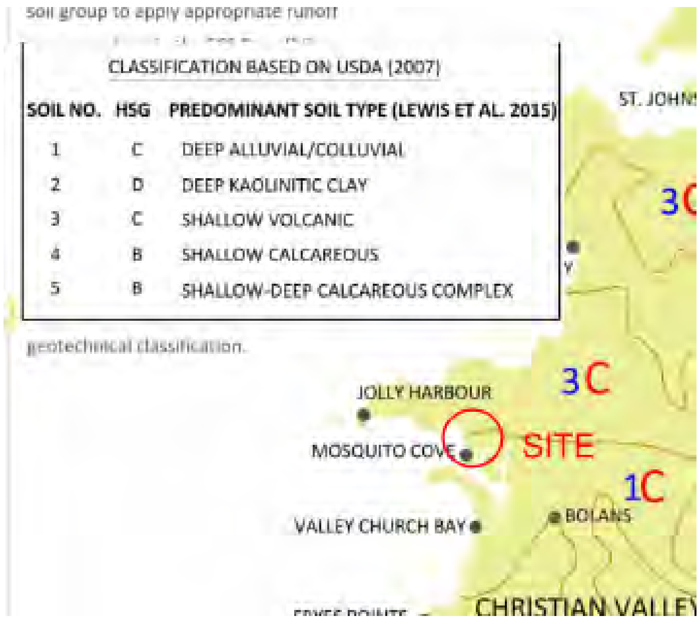


Figure 3.1 Hydrological Soil Groups

Sub-Basin	Average CN/Tc
Area 1	74/20.2
Area 2	80/23.7
Area 3	83/37.80
Area 4	87/6.00
Area 5	89/11.20

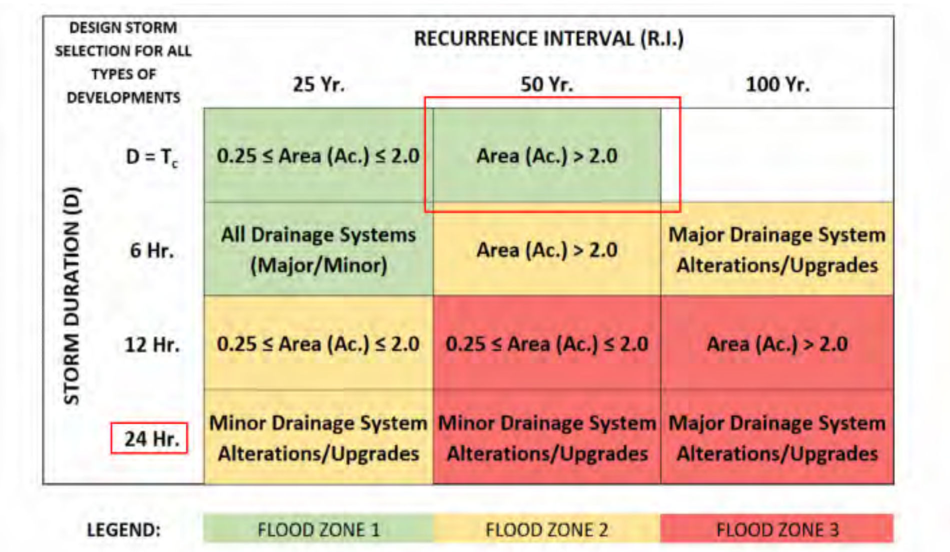
Table 3.4 Curve Numbers Pre-Development

Sub-Basin	Average CN/Tc
Area 1	92/11.90
Area 2	81/5.00
Area 3	85/5.00
Area 4	85/5.00
Area 5	79/5.00
Area 6	86/5.00

Table 3.5 Curve Numbers Post-Development

4. HYDROLOGY CALCULATIONS

In this section, the design criteria identified in section 3 will be used to calculate peak discharges per basin for the design storm using Hydraflow Extensions. The jurisdictional design storm for Stormwater management mitigation for the site was determined to be 50 yr – 24 hour storm. Refer to Appendix A for the complete Civil 3DHydraflow Extensions report.



DESIGN STORM SELECTION FOR ALL TYPES OF DEVELOPMENTS	RECURRENCE INTERVAL (R.I.) 25 Yr.	50 Yr.	100 Yr.
STORM DURATION (D): D = T_c	0.25 ≤ Area (Ac.) ≤ 2.0	Area (Ac.) > 2.0	
6 Hr.	All Drainage Systems (Major/Minor)	Area (Ac.) > 2.0	Major Drainage System Alterations/Upgrades
12 Hr.	0.25 ≤ Area (Ac.) ≤ 2.0	0.25 ≤ Area (Ac.) ≤ 2.0	Area (Ac.) > 2.0
24 Hr.	Minor Drainage System Alterations/Upgrades	Minor Drainage System Alterations/Upgrades	Major Drainage System Alterations/Upgrades

LEGEND: FLOOD ZONE 1 FLOOD ZONE 2 FLOOD ZONE 3

Figure 3-1: Chart for Design Storm Selection

Table 4.1 Chart for Design Storm Selection

4.1 Calculated Peak Discharges

Below a table resume with the Hydraflow Extensions Hydrographs for the different storm events analyzed for the site pre-development and post development conditions. The hydrological analysis shows an increase in peak flow for the post development of less than 5% no SWM Detention facilities are required.

Table 4.2 Drainage Summary Pre-Development

Pre-Development Peak Flow	
Storm Frequency	**Peak Inflow**
(Years)	**(cfs)**
50	8.35

Post-Development Peak Flow	
Storm Frequency	**Peak Inflow**
(Years)	**(cms)**
50	9.19

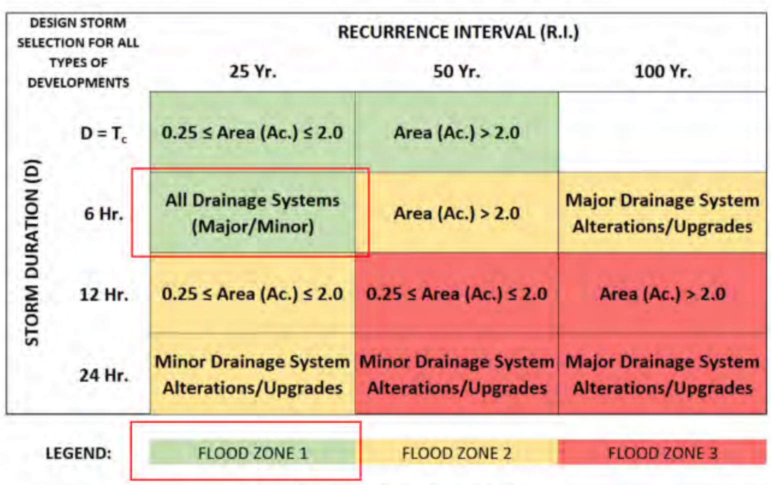
Table 4.3 Drainage Summary Post-Development

Post-Development % Increase	
Storm Frequency	**Increase**
(Years)	**%**
50	4.75%

Table 4.5 Post-Development % Of Increase

5. HYDRAULIC CALCULATION AND DRAINAGE FACILITIES

For the design of all proposed components of the drainage systems on site the rational method model using Autodesk Storm and Sanitary Analysis Model to produce pipe sizes and pipe profiles. The piping and swale locations are delineated in figure 5.1.
The jurisdictional design storm for Stormwater management mitigation for the site was determined to be 25 yr – 6 hour storm.



DESIGN STORM SELECTION FOR ALL TYPES OF DEVELOPMENTS	RECURRENCE INTERVAL (R.I.) 25 Yr.	50 Yr.	100 Yr.
STORM DURATION (D): $D = T_c$	0.25 ≤ Area (Ac.) ≤ 2.0	Area (Ac.) > 2.0	
6 Hr.	All Drainage Systems (Major/Minor)	Area (Ac.) > 2.0	Major Drainage System Alterations/Upgrades
12 Hr.	0.25 ≤ Area (Ac.) ≤ 2.0	0.25 ≤ Area (Ac.) ≤ 2.0	Area (Ac.) > 2.0
24 Hr.	Minor Drainage System Alterations/Upgrades	Minor Drainage System Alterations/Upgrades	Major Drainage System Alterations/Upgrades
LEGEND:	FLOOD ZONE 1	FLOOD ZONE 2	FLOOD ZONE 3

Figure 3-1: Chart for Design Storm Selection

Table 5.1 Chart for Design Storm Selection

5.1 Calculated Peak Discharges

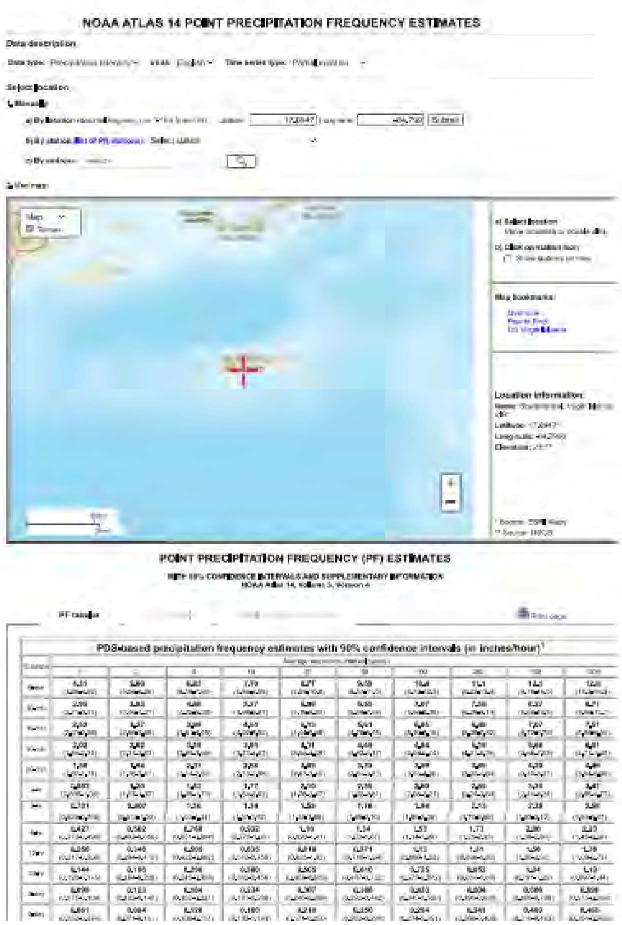
For the design of the drainage components, the rational method was used to calculate discharges for each sub-basin. The formula is below:

$$Q = k_c * C * I * A * (1.10)$$

Where,

Q = the peak discharge (m/s)
k_c = constant of 0.00278
C = runoff coefficient (-)
I = Rainfall Intensity (mm/hr)
A = the area of each sub-basin (ha)
1.10 = 10% Climate Change Adjustment (-)

Table 5.2 NOAA Atlas 14



Using this formula, the peak discharges were calculated for each sub-basin. The calculations are shown in table 5.3 (below). Refer to Figure 4.1 and 4.2 for Map of Sub Basin layouts.

Sub-Basin	C	Area (Ha)	Qp (cms)
A-1	0.50	1.64	0.08
A-2	0.90	0.66	0.06
A-3	0.90	0.17	0.015
A-4	0.50	0.40	0.02
A-5	0.50	1.52	0.08
A-6	0.60	3.70	0.23
A-7	0.50	2.10	0.10
A-8	0.70	0.83	0.060
A-9	0.60	0.25	0.015
A-10	0.60	9.14	0.28
A-11	0.60	9.14	0.28
A-12	0.60	2.98	0.18
A-13	0.60	2.00	0.13
A-14	0.60	4.45	0.27
A-15	0.90	1.19	0.11
A-16	0.60	3.70	0.23
A-17	0.60	2.74	0.17
A-18	0.60	1.49	0.07
A-19	0.70	3.26	0.23
A-20	0.70	4.09	0.30
A-21	0.70	1.35	0.10
A-22	0.60	2.97	0.188
A-23	0.50	2.77	0.092
A-24	0.50	2.09	1.10
A-25	0.70	0.90	0.066
A-26	0.10	1.96	0.02
A-27	0.90	0.069	0.006
A-28	0.90	0.073	0.0068
A-29	0.90	.0187	0.018
A-30	0.90	0.12	0.011
A-31	0.90	0.018	0.0016

Table 5.3 Sub Basin Peak Flow Calculations

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Manning's Equation

Manning's equation is used to calculate the average velocity in in open channels with gravity flow. The formula is listed below:

$$\boldsymbol{v = (k_n/n) * R_h{}^{2/3} * S^{1/2}}$$

Where,

v = cross sectional avg. velocity m/s)
k$_n$ = constant of 1.00
n = Manning coefficient of roughness (-)
R$_h$ = hydraulic radius (ft)
S = channel slope (ft/ft)

The hydraulic radius can be calculated using the formula below.

$$\boldsymbol{R_h = A \,/\, P_w}$$

Where,

A = cross sectional area (ft^2)
P$_w$ = wetted perimeter (ft)

The cross-sectional area and wetted perimeter are dependent on channel geometry.

Finally, the continuity equation may be used to model channel parameters with relation to the peak flow, using the substitution below.

1. $v = (k_n/n) * R_h{}^{2/3} * S^{1/2}$
2. $v = Q * A$
3. $Q_p = \frac{((k_n/n) * \left(\frac{A}{P_W}\right)^{\frac{2}{3}} * S^{\frac{1}{2}})}{A}$

Design Constraints

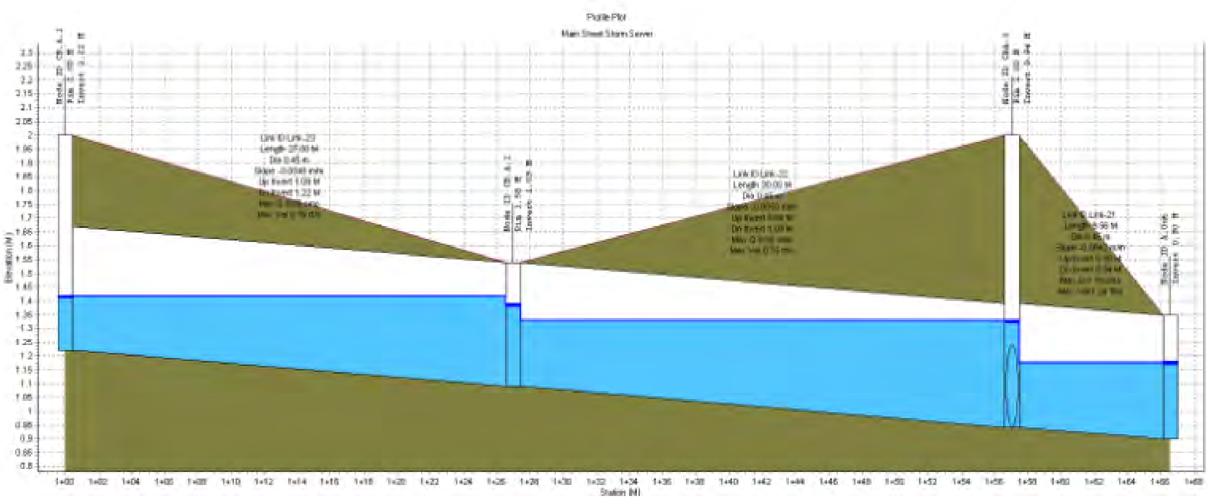
Each drainage system was modelled in Autodesk Storm and Sanitary Analysis to meet the following constraints.

1. Lateral Pipes 300 mm minimum, V = 1.5 m/s maximum
2. Trunk Pipes 450 mm minimum, V= 2.4 m/s maximum.
3. Inspection holes every 30 mts on pipes.
4. Gravity flowing pipes flowing half full.

5.2 Drainage Systems Design

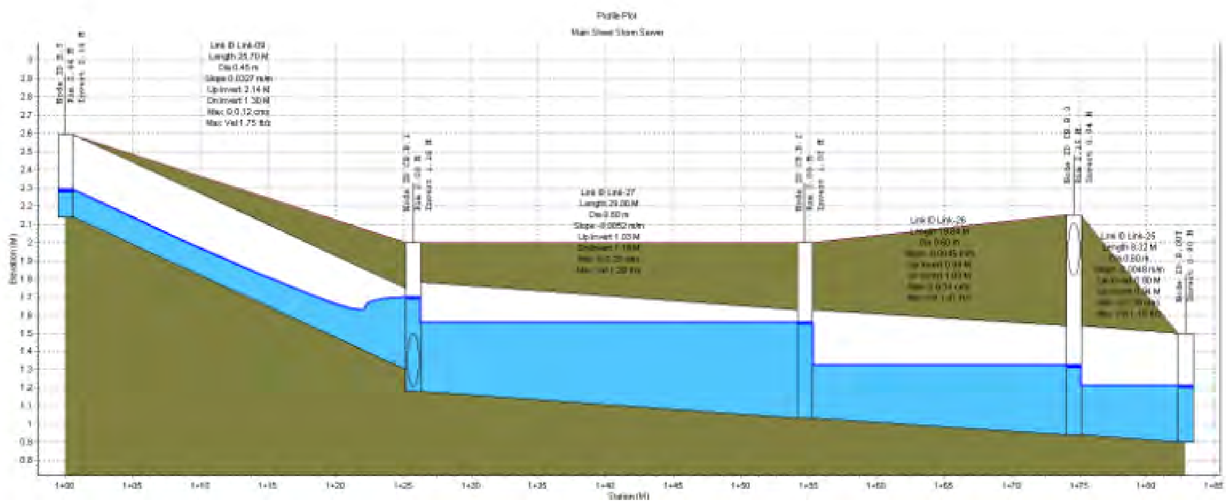
The parameters and velocities for each system are outlined in the following reports. Refer to Appendix B for a full Storm and Sanitary Analysis Model report.

Line A – Area 23,24 & 25



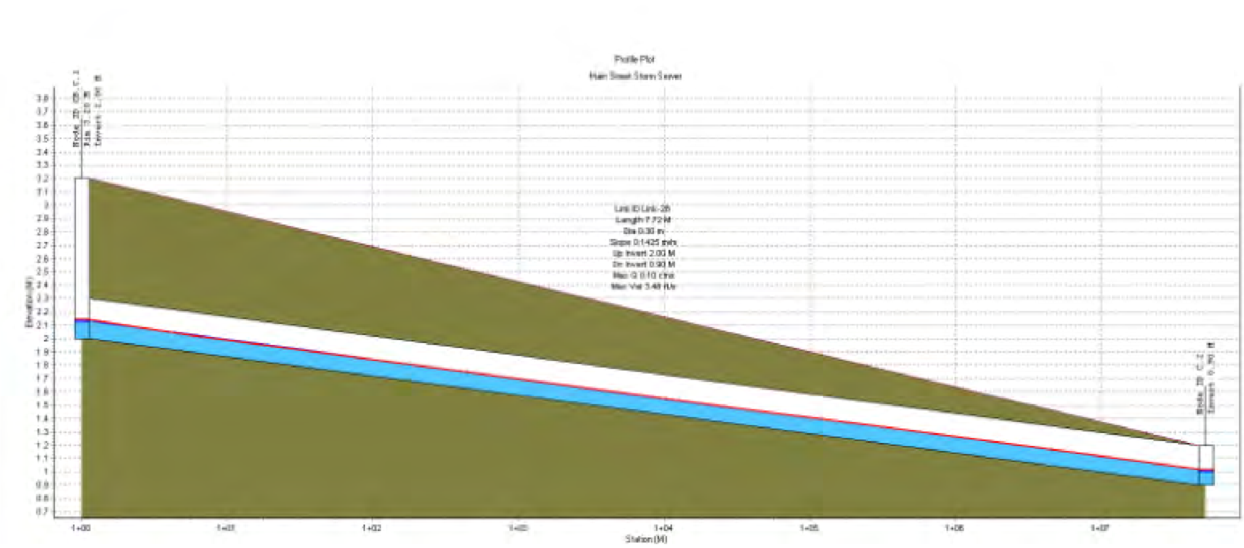
Node ID:	CB.A.1	CB.A.2	CBA.3	A1. Out
Rim (M):	2	1.5	2	
Invert (M):	1.22	1.09	0.94	0.9
Min Pipe Cover (m):	0.33	0	0.61	
Max HGL (ft):	1.42	1.39	1.33	1.18
Link ID:	Link-23	Link-22	Link-21	
Length (M):	27	30	9.56	
Dia (m):	0.45	0.45	0.45	
Slope (m/m):	-0.0048	-0.005	-0.0042	
Up Invert (M):	1.09	0.94	0.9	
Dn Invert (M):	1.22	1.09	0.94	
Max Q (cms):	0.05	0.09	0.16	
Max Vel (ft/s):	0.76	0.75	1.24	
Max Depth (m):	0.25	0.35	0.33	

Line B – Areas 15, 21,22 & 24



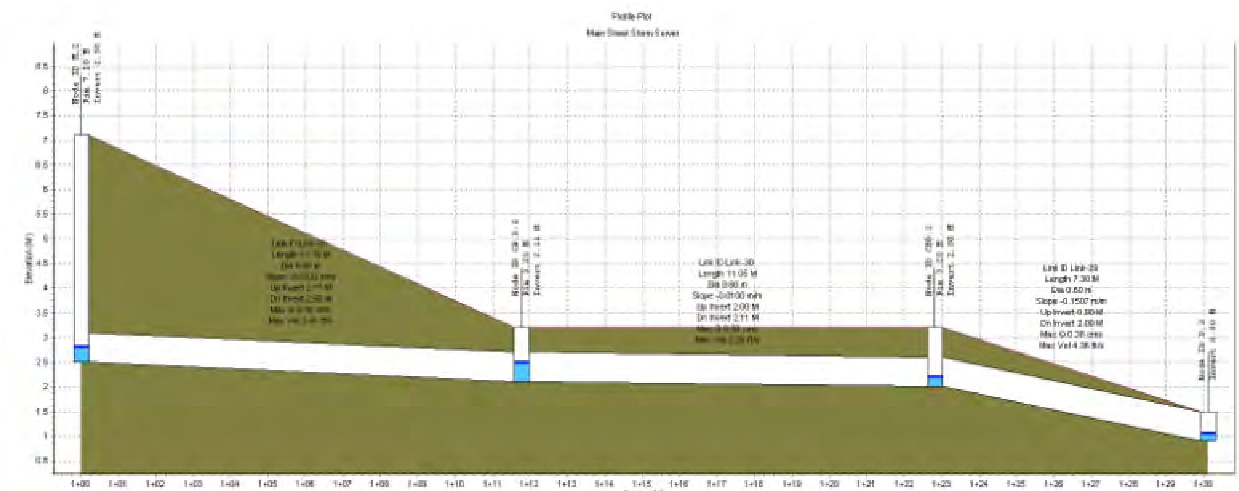
Node ID:	B.5	CB.B.1	CB.B.2	CB.B.3	B.1 OUT
Rim (M):	2.44	2	2	2.15	
Invert (M):	2.14	1.18	1.03	0.94	0.9
Min Pipe Cover (m):	0	0.22	0.37	0.04	
Max HGL (ft):	2.31	1.7	1.56	1.32	1.21
Link ID:	Link-09	Link-27	Link-26	Link-25	
Length (M):	25.7	29	19.84	8.32	
Dia (m):	0.45	0.6	0.6	0.6	
Slope (m/m):	0.0327	-0.0052	-0.0045	-0.0048	
Up Invert (M):	2.14	1.03	0.94	0.9	
Dn Invert (M):	1.3	1.18	1.03	0.94	
Max Q (cms):	0.12	0.29	0.34	0.39	
Max Vel (ft/s):	1.75	1.29	1.47	1.15	
Max Depth (m):	0.28	0.53	0.46	0.35	

Line C – Area 21



Node ID:	CB.C.1	OUT C.2
Rim (M):	3.2	
Invert (M):	2	0.9
Min Pipe Cover (m):	0.9	
Max HGL (ft):	2.15	1.02
Link ID:	Link-28	
Length (M):	7.72	
Dia (m):	0.3	
Slope (m/m):	0.1425	
Up Invert (M):	2	
Dn Invert (M):	0.9	
Max Q (cms):	0.1	
Max Vel (ft/s):	3.48	
Max Depth (m):	0.13	

Line D – Area 20



Node ID:	M.2	CB.D.1	CBD.2	OUT D.3
Rim (M):	7.1	3.2	3.2	
Invert (M):	2.5	2.11	2	0.9
Min Pipe Cover (m):	4	0.49	0.6	
Max HGL (ft):	2.89	2.59	2.25	1.08
Link ID:	Link-31	Link-30	Link-29	
Length (M):	11.76	11.05	7.3	
Dia (m):	0.6	0.6	0.6	
Slope (m/m):	-0.0332	-0.01	-0.1507	
Up Invert (M):	2.11	2	0.9	
Dn Invert (M):	2.5	2.11	2	
Max Q (cms):	0.38	0.38	0.38	
Max Vel (ft/s):	2.41	2.26	4.36	
Max Depth (m):	0.35	0.3	0.18	

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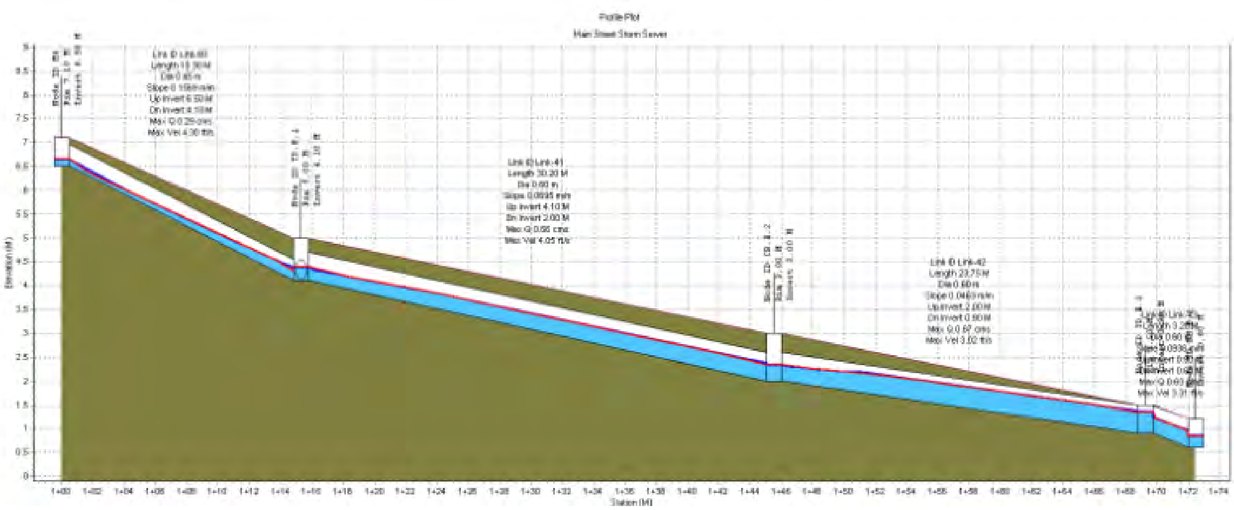
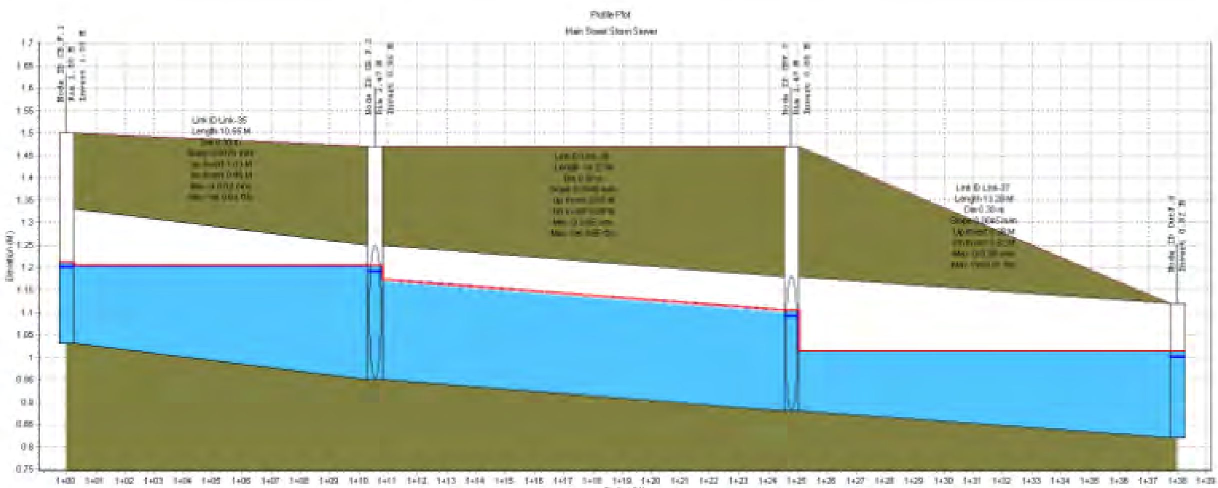
Line E – Area 5 & 6



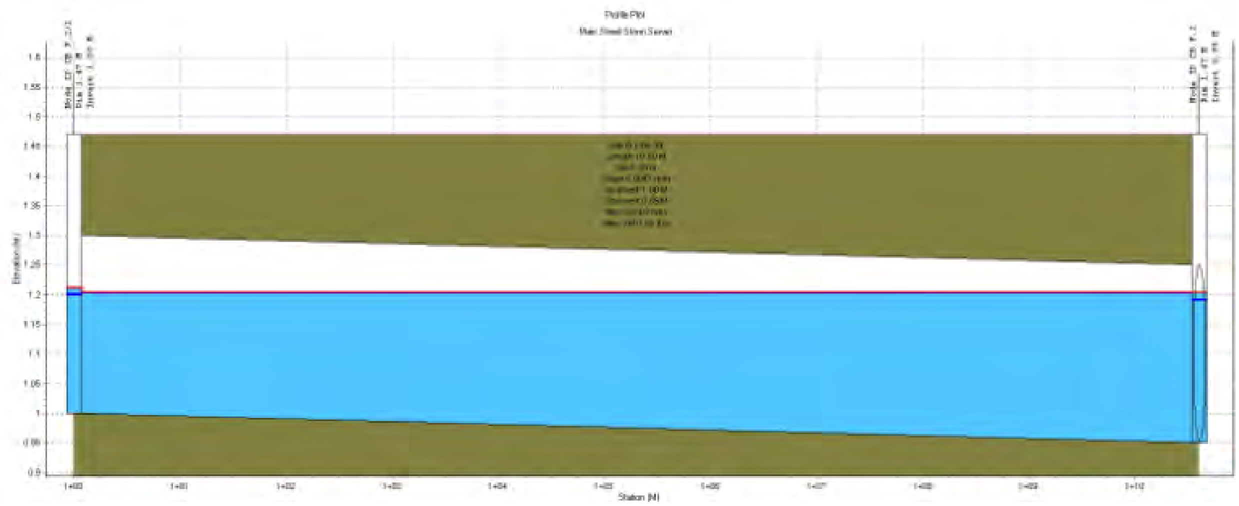
Node ID:	M4	TD.E.1	CB.E.2	TD.E.3	BH.B.1
Rim (M):	7.1	5	3	1.5	
Invert (M):	6.5	4.1	2	0.9	0.6
Min Pipe Cover (m):	0.15	0.3	0.4	0	
Max HGL (ft):	6.71	4.47	2.43	1.41	0.86
Link ID:	Link-60	Link-41	Link-42	Link-43	
Length (M):	15.3	30.2	23.75	3.2	
Dia (m):	0.45	0.6	0.6	0.6	
Slope (m/m):	0.1569	0.0695	0.0463	0.0938	
Up Invert (M):	6.5	4.1	2	0.9	
Dn Invert (M):	4.1	2	0.9	0.6	
Max Q (cms):	0.29	0.66	0.67	0.63	
Max Vel (ft/s):	4.3	4.05	3.02	3.31	
Max Depth (m):	0.22	0.31	0.4	0.34	

Line F – Area 1



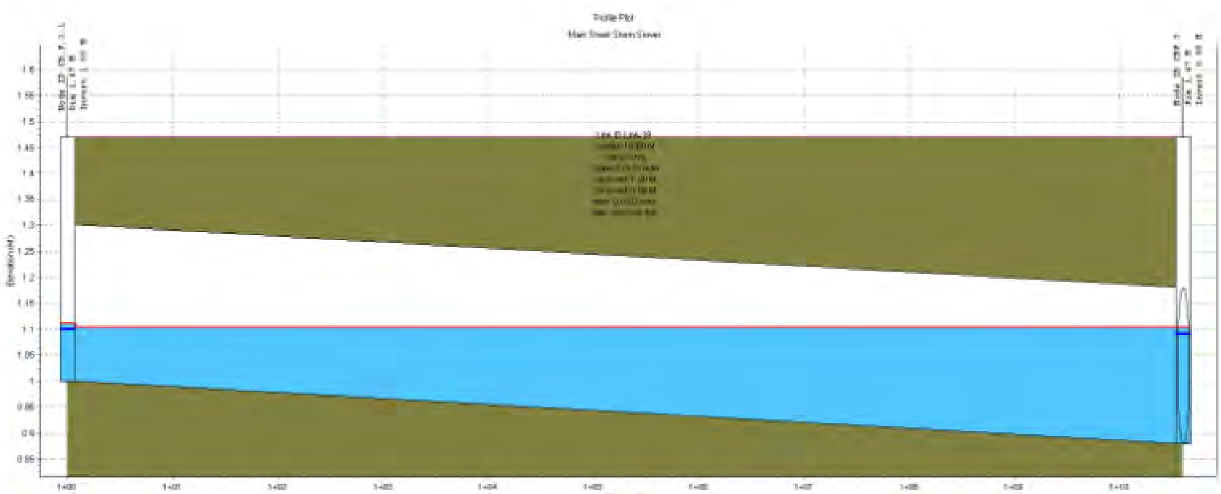
Node ID:	CB.F.1	CB.F.2	CBF.3	OutF.4
Rim (M):	1.5	1.47	1.47	
Invert (M):	1.03	0.95	0.88	0.82
Min Pipe Cover (m):	0.17	0.22	0.29	
Max HGL (ft):	1.21	1.2	1.1	1.01
Link ID:	Link-35	Link-36	Link-37	
Length (M):	10.55	14.23	13.2	
Dia (m):	0.3	0.3	0.3	
Slope (m/m):	0.0076	0.0049	0.0045	
Up Invert (M):	1.03	0.95	0.88	
Dn Invert (M):	0.95	0.88	0.82	
Max Q (cms):	0.02	0.05	0.09	
Max Vel (ft/s):	0.64	0.85	0.81	
Max Depth (m):	0.22	0.24	0.21	

Line F.2.1 – Area 1



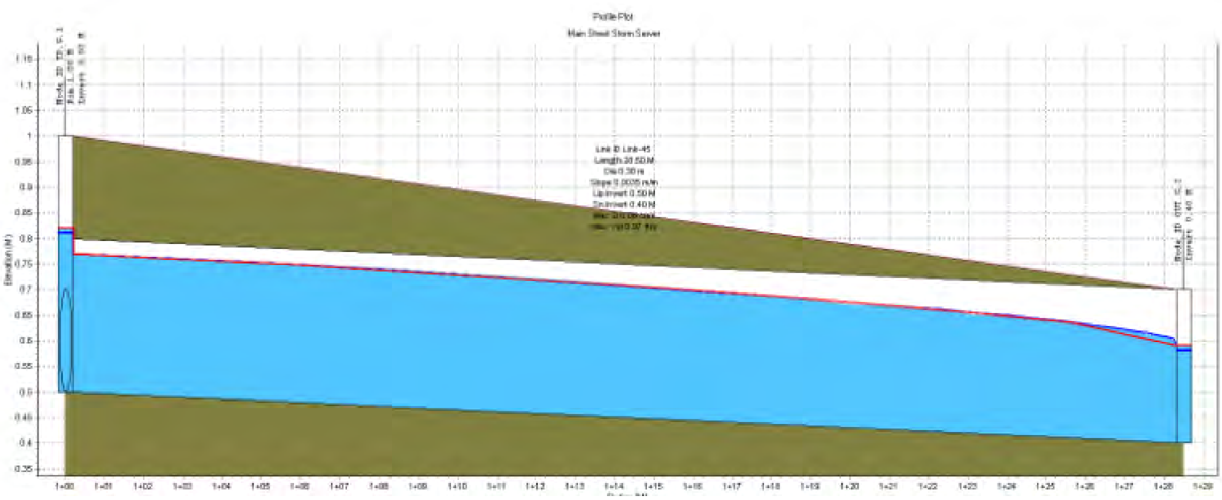
Node ID:	CB.F.2.1	CB.F.2
Rim (M):	1.47	1.47
Invert (M):	1	0.95
Min Pipe Cover (m):	0.17	0.22
Max HGL (ft):	1.21	1.2
Link ID:	Link-39	
Length (M):	10.6	
Dia (m):	0.3	
Slope (m/m):	0.0047	
Up Invert (M):	1	
Dn Invert (M):	0.95	
Max Q (cms):	0.02	
Max Vel (ft/s):	0.55	
Max Depth (m):	0.23	

Line F.2.1 – Area 1



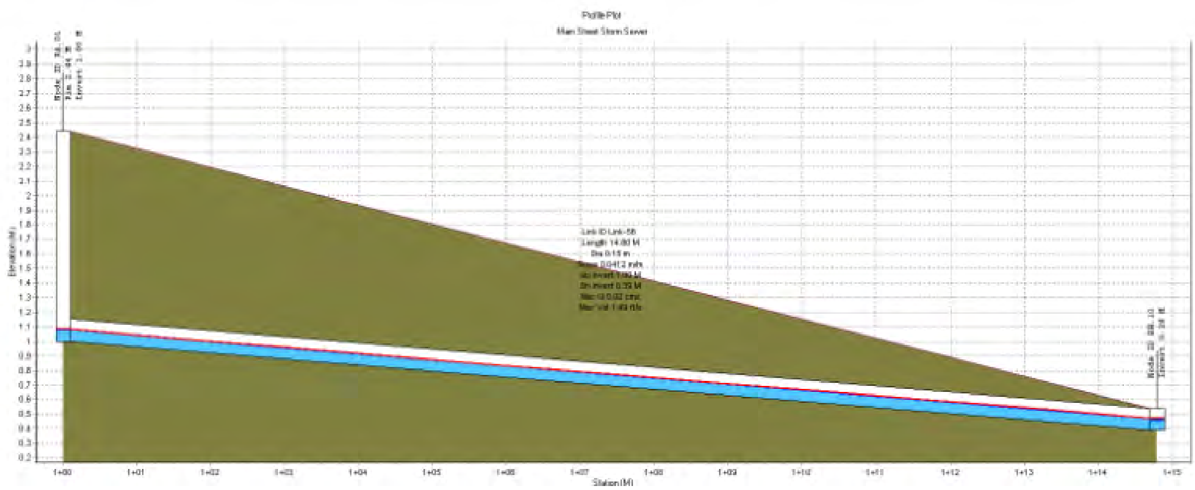
Node ID:	CB.F.3.1	CBF.3
Rim (M):	1.47	1.47
Invert (M):	1	0.88
Min Pipe Cover (m):	0.17	0.29
Max HGL (ft):	1.11	1.1
Link ID:	Link-38	
Length (M):	10.6	
Dia (m):	0.3	
Slope (m/m):	0.0113	
Up Invert (M):	1	
Dn Invert (M):	0.88	
Max Q (cms):	0.02	
Max Vel (ft/s):	0.88	
Max Depth (m):	0.17	

Line G– Area 2



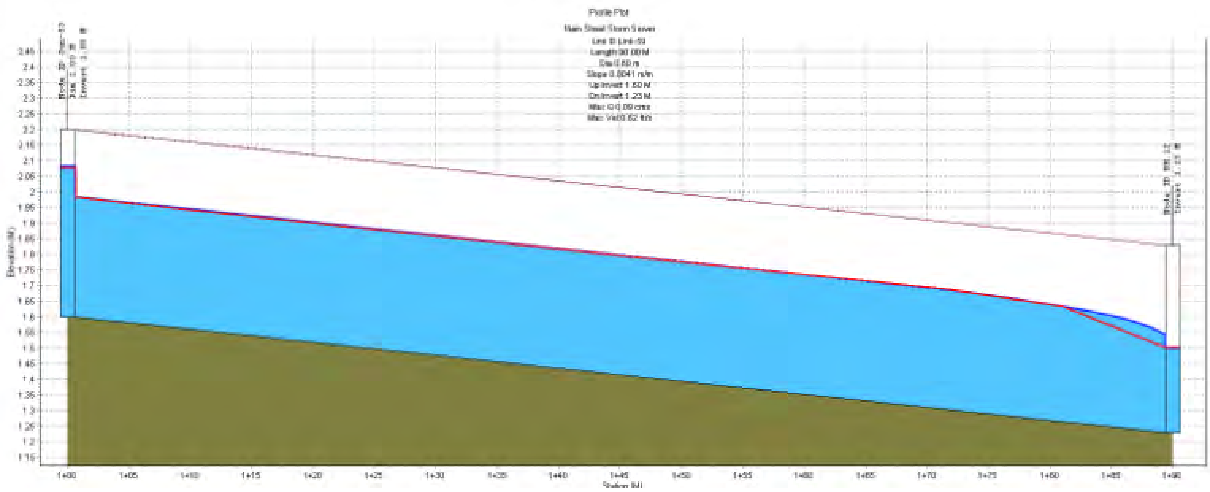
Node ID:	TD.G.1	OUT.G.2
Rim (M):	1	
Invert (M):	0.5	0.4
Min Pipe Cover (m):	0.2	
Max HGL (ft):	0.82	0.59
Link ID:	Link-45	
Length (M):	28.5	
Dia (m):	0.3	
Slope (m/m):	0.0035	
Up Invert (M):	0.5	
Dn Invert (M):	0.4	
Max Q (cms):	0.06	
Max Vel (ft/s):	0.97	
Max Depth (m):	0.25	

Line RA – Area 9



Node ID:	RA.01	BH.10
Rim (M):	2.44	
Invert (M):	1	0.39
Min Pipe Cover (m):	1.29	
Max HGL (ft):	1.09	0.47
Link ID:	Link-56	
Length (M):	14.8	
Dia (m):	0.15	
Slope (m/m):	0.0412	
Up Invert (M):	1	
Dn Invert (M):	0.39	
Max Q (cms):	0.02	
Max Vel (ft/s):	1.49	
Max Depth (m):	0.08	

Line Swales– Villas and Pond (10 & 11)



Node ID:	6/1/1953	BH.12
Rim (M):	2	
Invert (M):	1.6	1.23
Min Pipe Cover (m):	0	
Max HGL (ft):	2.09	1.51
Link ID:	Link-59	
Length (M):	90	
Dia (m):	0.6	
Slope (m/m):	0.0041	
Up Invert (M):	1.6	
Dn Invert (M):	1.23	
Max Q (cms):	0.09	
Max Vel (ft/s):	0.62	
Max Depth (m):	0.38	

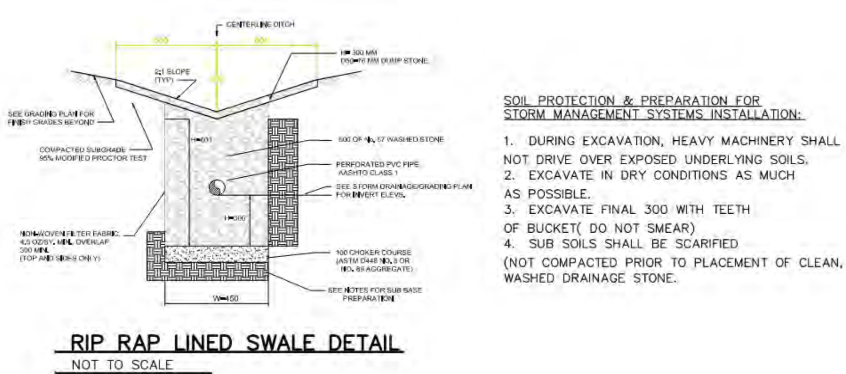
6. Stromwater management Strategy

The following section describe the stormwater management strategy and element of low impact design incorporated to the project. Low Impact Development or LID practices manage stormwater by minimizing impervious cover and by using natural or man-made systems to filter and recharge stormwater into the ground. Roads, parking lots, and other types of impervious cover are the most significant contributors to stormwater runoff. There is a direct relationship between the amount of impervious cover and the biological and physical condition of downstream receiving water. The goal of LID is to reduce runoff and to mimic a site's predevelopment hydrology by minimizing disturbed areas and impervious cover and then infiltrating, filtering, storing, evaporating, and detaining stormwater runoff close to its source. LID practices included at the proposed Nikki Beach Resort and Branded Residences such as improved undeveloped open space with landscape elements that promote infiltration, evaporation and transpiration, biofiltration using naturally shape swales with minimum slopes and filtration strips. Using soakaway inlet structures at landscape areas to promote infiltration and ground water recharge. Connection of impervious surfaces from roof and roads are to bore hole structures to inject runoff to the water table reducing peak flows and recharging the groundwater levels.

6.1 Runoff management and disposal

Below a brief description and examples of LID methods used on the proposed stormwater management systems:

Figure 6.1 Rip Rap Lined Swales



Swales – Rip Rap Lined swale with 0.5% slopes designed to
reduce velocities allow runoff to slowly move along the swales promoting filtration and infiltration into the subsoil. The installation of an infiltration trench with a perforated pipe will increase the runoff capture volume preventing surface ponding for extended periods of time.

Catch Basin Soakaway Type - Located at landscape and grassed areas the soakaway structures allow portions of the runoff capture on the conventional drainage systems to percolate to the sub soil by providing a bottomless structure follow by an inverted stone filtering system.

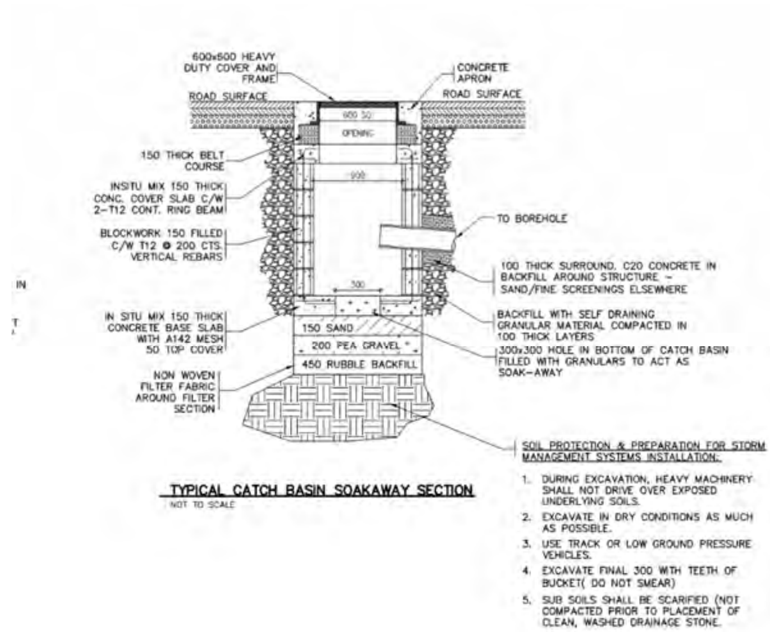


Figure 6.2 Soakaway Catch Basin

2 Sun Ct. • Peachtree Corners, Georgia 30093 • (404) 266-1400 • Fax (404) 364-0895

Boreholes – Boreholes are the core of the proposed stormwater management system allowing to reduce peak runoff volumes generated at impervious surfaces by injection runoff water back to the ground.

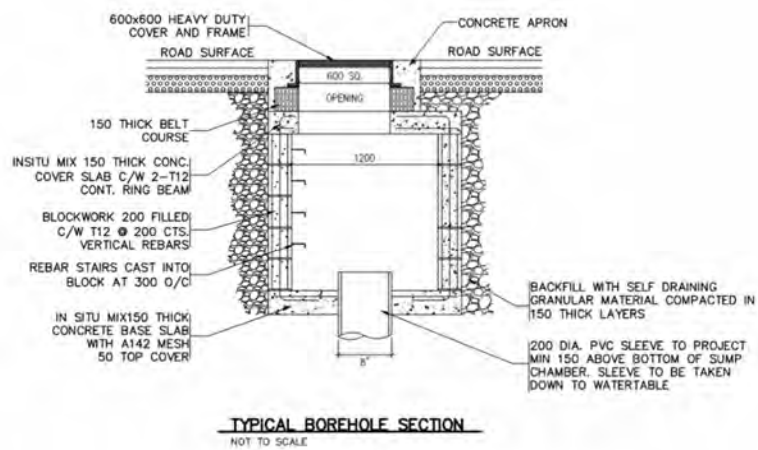
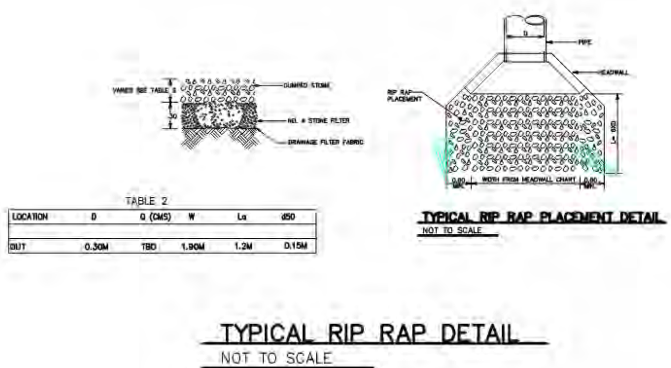


Figure 6.3 Borehole structure

Outlet Protection – Outlet protection will be provided at the end of every daylighted storm pipe to ensure outlet velocities stay below 1.5 m/s to prevent erosion and transportation of sediments downstream.



LOCATION	D	Q (CMS)	W	La	d50
OUT	0.30M	TBD	1.90M	1.2M	0.15M

7. Erosion Control

Erosion control BMP's will be established during the construction phase by the design documentation and will require the general contractor to establish these controls prior to the demolition, clearing and grubbing and mass grading works. The perimeter BMP's will follow the phase I ESPC requirements establish by the State of Georgia and identify in the 2016 Field Manual for Erosion and Sediment Control in Georgia. The BMP's included on the design documents are:

- Du – Dust control on disturbed areas by installing a dust tarp around the perimeter construction fence.
- Ds1 – Disturb area stabilization with mulch – Apply to all areas disturbed and idle for 7 days
- Ds 2 – Disturbed area stabilization with temporary seeding – All areas disturbed and idle for more than 14.
- Ds3 – Permanent vegetation following the landscape plan and the ESPC – All areas disturbed and idle for more than 30 days as well as all final grade areas.
- SS – Slope stabilization mats using a biodegradable amt with seeding on all slopes 2(H):1(V).
- Cd Check Dams – Hay Bale Dams along the perimeter silt fence to reduce runoff velocities and storage sediments preventing them to migrate the from site.
- Co Construction Entrance – stone revetment area to clean vehicle tires prior leaving the construction site.
- Sd1 – Sediment barrier along the perimeter of the site.

Methods and References

Hydrologic / Hydraulic Methods: Rational Method

Urban Hydrology for Small Watersheds TR -55 Method

Hydraflow Express 2023 extension for AutoCAD Civil 3D

Autodesk Storm and Sanitary Analysis 2023

CN and C Values: Antigua & Barbuda Drainage Code and Guidelines

Topography: Survey by Ato D Kentish October 2023

Rainfall Intensity: ` NOOA Atlas 14 Puerto Rico and USA VI

Development Density Plan: Proposed Site Plan by HKS Inc

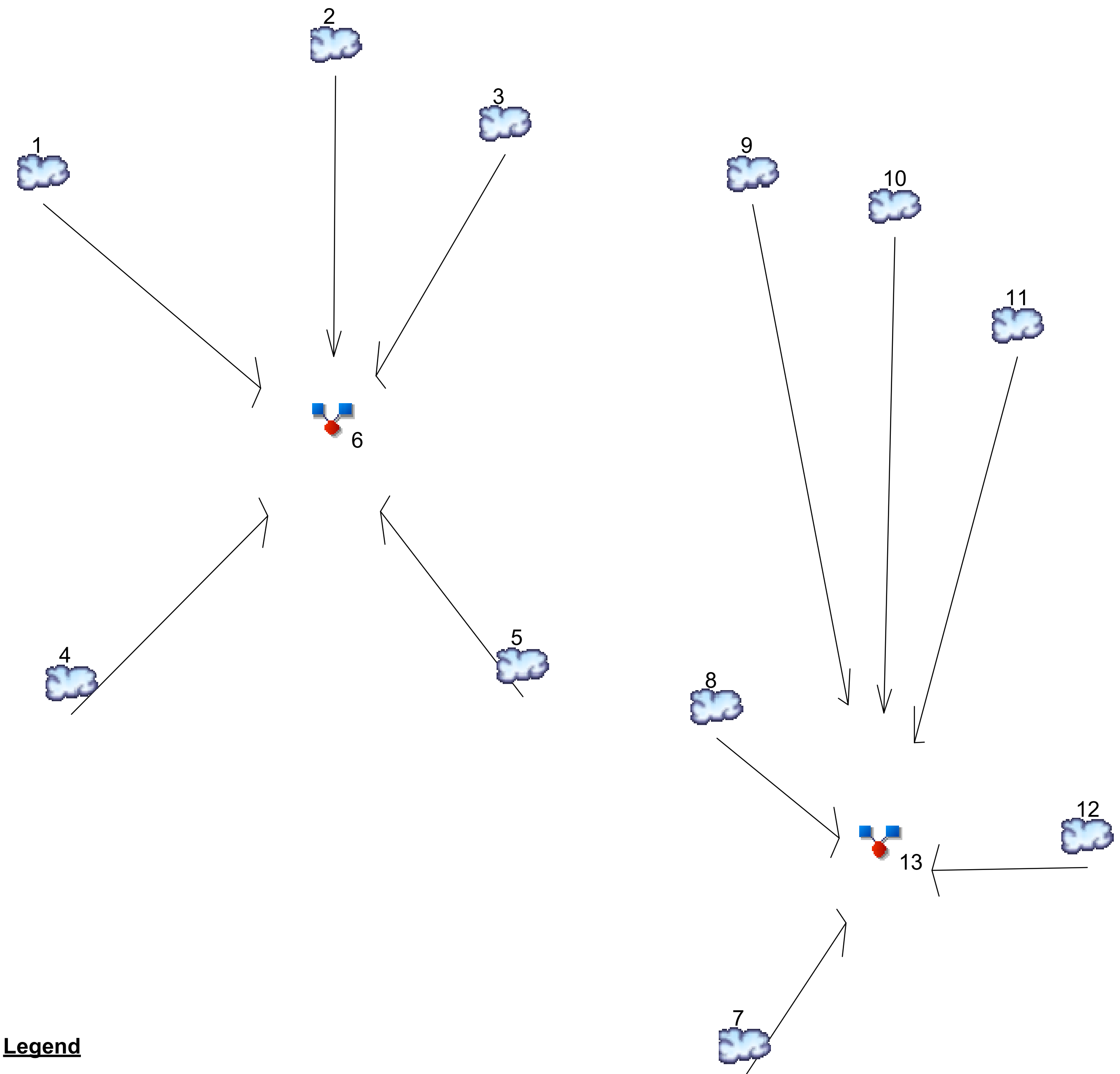
Rip Rap Sizing Minnesota Stormwater Manual

Erosion Control BMP's 2016 Field Manual for Erosion and Sediment Control in Georgia

APPENDIX

APPENDIX A
Hydraflow Extensions 2023 Report

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Pre Development Area 1 To Harbor
2	SCS Runoff	Pre Development Area 2 Low Point
3	SCS Runoff	Pre Development Area 3 to Low Point
4	SCS Runoff	Pre Devvelopment Area 5 to Offsite
5	SCS Runoff	Pre Development Area 4 to Flushing Channel
6	Combine	Combine Peak Flow Pre Dev
7	SCS Runoff	Post Development Area 1
8	SCS Runoff	Post Development Area 2
9	SCS Runoff	Post Development Area 3
10	SCS Runoff	Post Development Area 4
11	SCS Runoff	Post Development Area 5
12	SCS Runoff	Post Development Area 6
13	Combine	Combine Post Dev

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cms)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	-------	-------	-------	0.839	1.178	1.470	-------	Pre Development Area 1 To Harbor
2	SCS Runoff	------	-------	-------	-------	-------	2.404	3.289	4.050	-------	Pre Development Area 2 Low Point
3	SCS Runoff	------	-------	-------	-------	-------	1.529	2.108	2.605	-------	Pre Development Area 3 to Low Point
4	SCS Runoff	------	-------	-------	-------	-------	0.047	0.064	0.078	-------	Pre Devvelopment Area 5 to Offsite
5	SCS Runoff	------	-------	-------	-------	-------	0.387	0.521	0.637	-------	Pre Development Area 4 to Flushing
6	Combine	1, 2, 3, 4, 5	-------	-------	-------	-------	4.914	6.766	8.359	-------	Combine Peak Flow Pre Dev
7	SCS Runoff	------	-------	-------	-------	-------	0.636	0.850	1.034	-------	Post Development Area 1
8	SCS Runoff	------	-------	-------	-------	-------	0.912	1.262	1.563	-------	Post Development Area 2
9	SCS Runoff	------	-------	-------	-------	-------	2.274	3.100	3.810	-------	Post Development Area 3
10	SCS Runoff	------	-------	-------	-------	-------	0.368	0.502	0.617	-------	Post Development Area 4
11	SCS Runoff	------	-------	-------	-------	-------	0.023	0.032	0.040	-------	Post Development Area 5
12	SCS Runoff	------	-------	-------	-------	-------	1.370	1.861	2.283	-------	Post Development Area 6
13	Combine	7, 8, 9, 10, 11, 12	-------	-------	-------	-------	5.486	7.480	9.194	-------	Combine Post Dev

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Hyd. No.	Hydrograph type (origin)	Peak flow (cms)	Time interval (min)	Time to Peak (min)	Hyd. volume (cum)	Inflow hyd(s)	Maximum elevation (m)	Total strge used (cum)	Hydrograph Description
1	SCS Runoff	0.839	2	724	2,669.7	------	------	------	Pre Development Area 1 To Harbor
2	SCS Runoff	2.404	2	716	5,191.4	------	------	------	Pre Development Area 2 Low Point
3	SCS Runoff	1.529	2	716	3,264.4	------	------	------	Pre Development Area 3 to Low Point
4	SCS Runoff	0.047	2	716	104.1	------	------	------	Pre Devvelopment Area 5 to Offsite
5	SCS Runoff	0.387	2	718	966.1	------	------	------	Pre Development Area 4 to Flushing
6	Combine	4.914	2	716	12,195.8	1, 2, 3, 4, 5	------	------	Combine Peak Flow Pre Dev
7	SCS Runoff	0.636	2	720	1,819.5	------	------	------	Post Development Area 1
8	SCS Runoff	0.912	2	716	1,936.5	------	------	------	Post Development Area 2
9	SCS Runoff	2.274	2	716	4,940.2	------	------	------	Post Development Area 3
10	SCS Runoff	0.368	2	716	799.4	------	------	------	Post Development Area 4
11	SCS Runoff	0.023	2	716	48.0	------	------	------	Post Development Area 5
12	SCS Runoff	1.370	2	716	2,994.1	------	------	------	Post Development Area 6
13	Combine	5.486	2	716	12,537.6	7, 8, 9, 10, 11, 12	------	------	Combine Post Dev

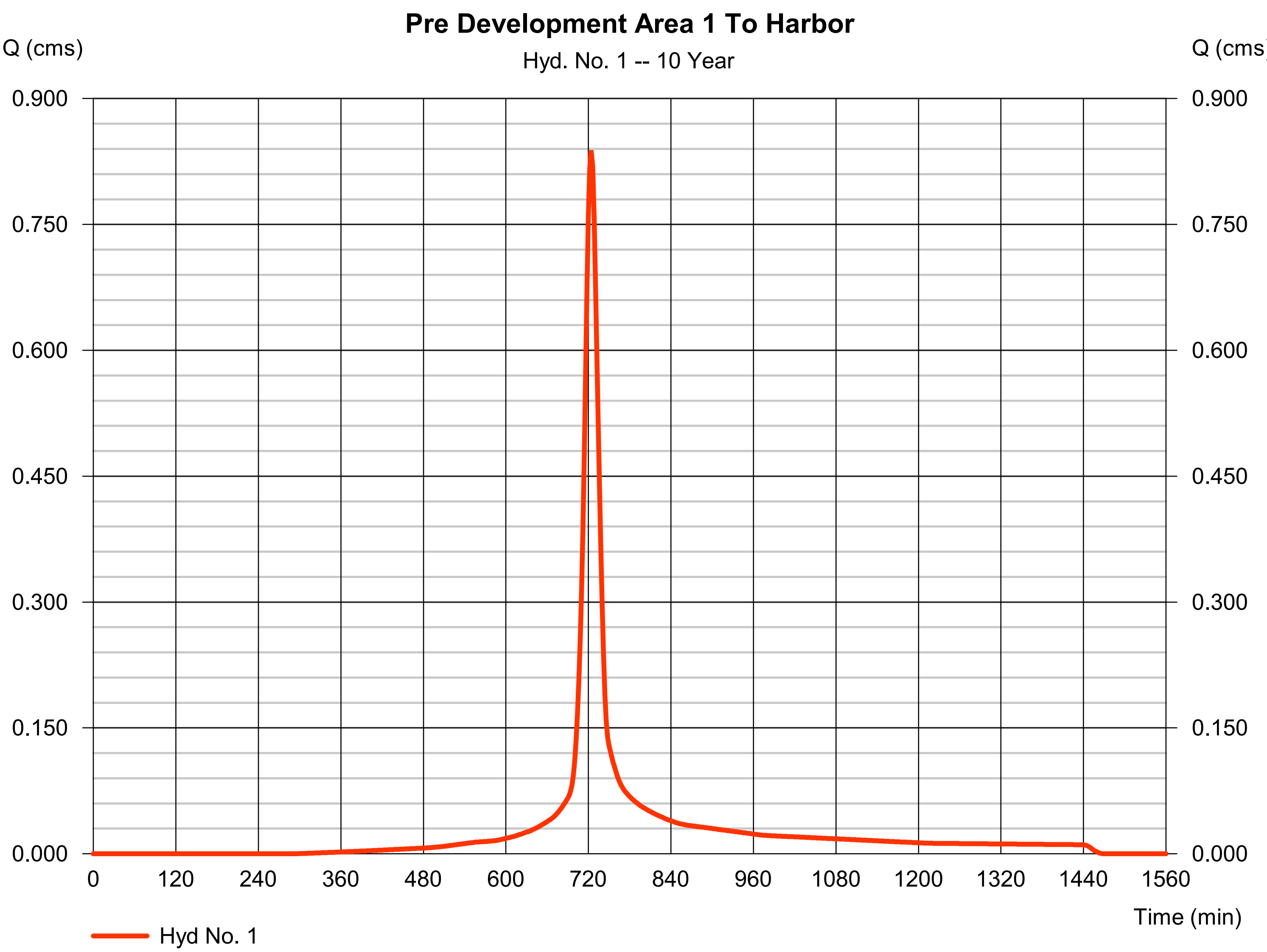
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023 Sunday, 08 / 18 / 2024

Hyd. No. 1

Pre Development Area 1 To Harbor

Hydrograph type	= SCS Runoff	Peak discharge	= 0.839 cms
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 2,669.7 cum
Drainage area	= 1.562 hectare	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 m
Tc method	= TR55	Time of conc. (Tc)	= 19.50 min
Total precip.	= 236.22 mm	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Hyd. No.	Hydrograph type (origin)	Peak flow (cms)	Time interval (min)	Time to Peak (min)	Hyd. volume (cum)	Inflow hyd(s)	Maximum elevation (m)	Total strge used (cum)	Hydrograph Description
1	SCS Runoff	1.178	2	724	3,809.0	------	------	------	Pre Development Area 1 To Harbor
2	SCS Runoff	3.289	2	716	7,259.1	------	------	------	Pre Development Area 2 Low Point
3	SCS Runoff	2.108	2	716	4,600.7	------	------	------	Pre Development Area 3 to Low Point
4	SCS Runoff	0.064	2	716	144.0	------	------	------	Pre Devvelopment Area 5 to Offsite
5	SCS Runoff	0.521	2	718	1,326.0	------	------	------	Pre Development Area 4 to Flushing
6	Combine	6.766	2	716	17,138.7	1, 2, 3, 4, 5	------	------	Combine Peak Flow Pre Dev
7	SCS Runoff	0.850	2	720	2,470.7	------	------	------	Post Development Area 1
8	SCS Runoff	1.262	2	716	2,740.2	------	------	------	Post Development Area 2
9	SCS Runoff	3.100	2	716	6,881.4	------	------	------	Post Development Area 3
10	SCS Runoff	0.502	2	716	1,113.5	------	------	------	Post Development Area 4
11	SCS Runoff	0.032	2	716	68.5	------	------	------	Post Development Area 5
12	SCS Runoff	1.861	2	716	4,154.7	------	------	------	Post Development Area 6
13	Combine	7.480	2	716	17,429.0	7, 8, 9, 10, 11, 12	------	------	Combine Post Dev

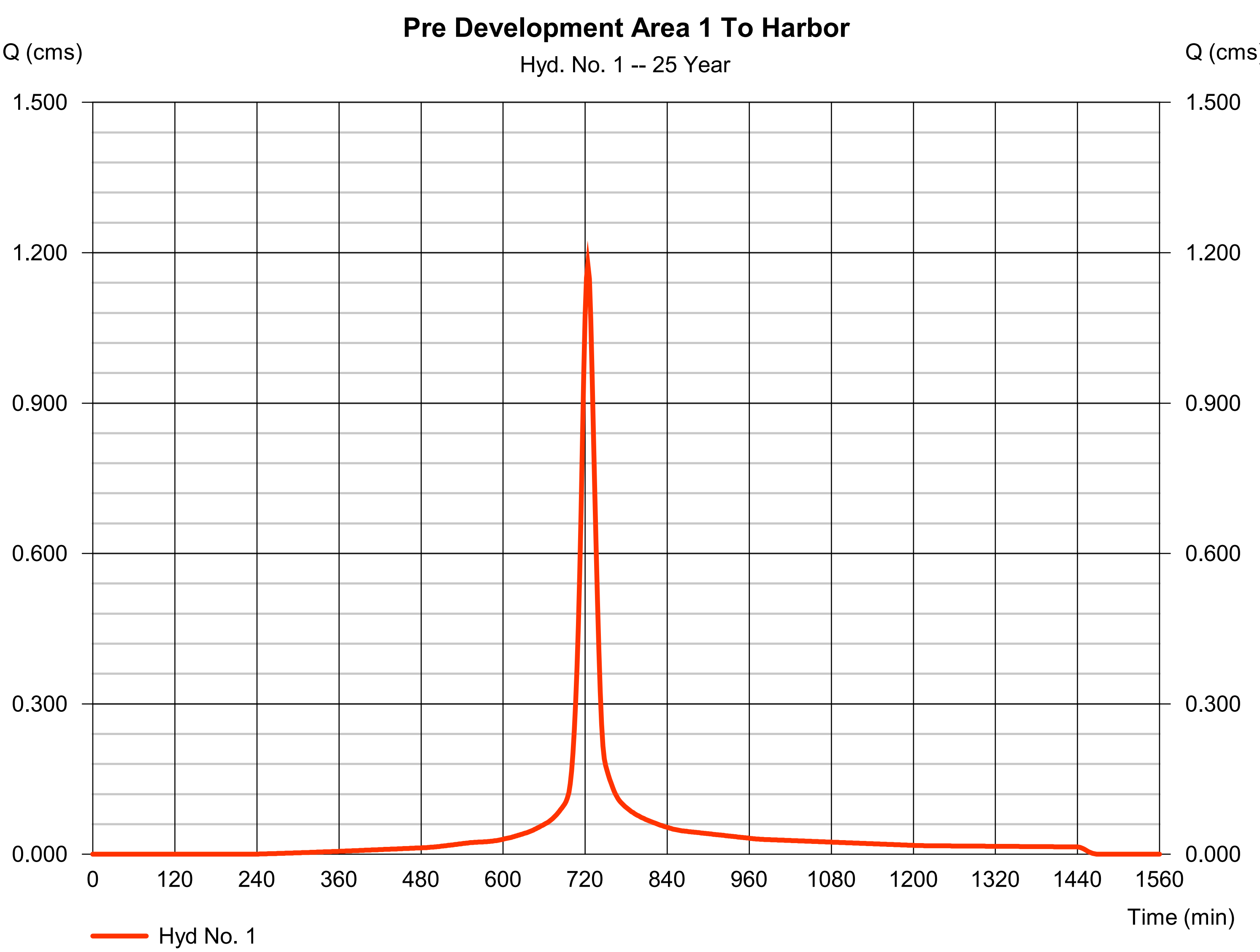
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023 Sunday, 08 / 18 / 2024

Hyd. No. 1

Pre Development Area 1 To Harbor

Hydrograph type	= SCS Runoff	Peak discharge	= 1.178 cms
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 3,809.0 cum
Drainage area	= 1.562 hectare	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 m
Tc method	= TR55	Time of conc. (Tc)	= 19.50 min
Total precip.	= 312.42 mm	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023

Hyd. No.	Hydrograph type (origin)	Peak flow (cms)	Time interval (min)	Time to Peak (min)	Hyd. volume (cum)	Inflow hyd(s)	Maximum elevation (m)	Total strge used (cum)	Hydrograph Description
1	SCS Runoff	1.470	2	724	4,810.9	------	------	------	Pre Development Area 1 To Harbor
2	SCS Runoff	4.050	2	716	9,066.3	------	------	------	Pre Development Area 2 Low Point
3	SCS Runoff	2.605	2	716	5,771.2	------	------	------	Pre Development Area 3 to Low Point
4	SCS Runoff	0.078	2	716	178.7	------	------	------	Pre Devvelopment Area 5 to Offsite
5	SCS Runoff	0.637	2	718	1,639.0	------	------	------	Pre Development Area 4 to Flushing
6	Combine	8.359	2	716	21,466.2	1, 2, 3, 4, 5	------	------	Combine Peak Flow Pre Dev
7	SCS Runoff	1.034	2	720	3,036.4	------	------	------	Post Development Area 1
8	SCS Runoff	1.563	2	716	3,445.1	------	------	------	Post Development Area 2
9	SCS Runoff	3.810	2	716	8,576.3	------	------	------	Post Development Area 3
10	SCS Runoff	0.617	2	716	1,387.7	------	------	------	Post Development Area 4
11	SCS Runoff	0.040	2	716	86.5	------	------	------	Post Development Area 5
12	SCS Runoff	2.283	2	716	5,167.2	------	------	------	Post Development Area 6
13	Combine	9.194	2	716	21,699.1	7, 8, 9, 10, 11, 12	------	------	Combine Post Dev

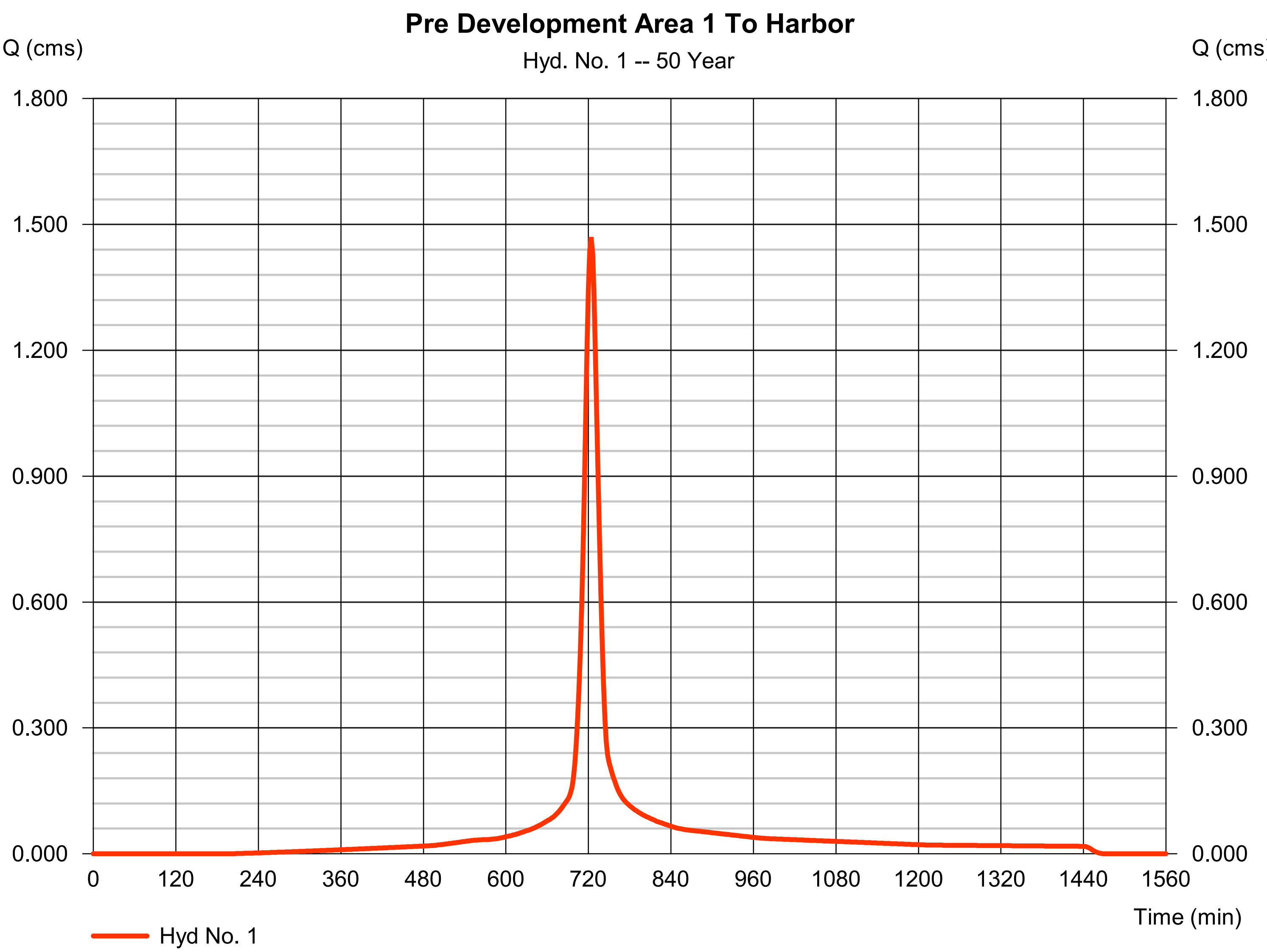
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2023 — Sunday, 08 / 18 / 2024

Hyd. No. 1

Pre Development Area 1 To Harbor

Hydrograph type	= SCS Runoff	Peak discharge	= 1.470 cms
Storm frequency	= 50 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 4,810.9 cum
Drainage area	= 1.562 hectare	Curve number	= 79
Basin Slope	= 0.0 %	Hydraulic length	= 0 m
Tc method	= TR55	Time of conc. (Tc)	= 19.50 min
Total precip.	= 378.46 mm	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	69.8703	13.1000	0.8658	--------
3	0.0000	0.0000	0.0000	--------
5	79.2597	14.6000	0.8369	--------
10	88.2351	15.5000	0.8279	--------
25	102.6072	16.5000	0.8217	--------
50	114.8193	17.2000	0.8199	--------
100	127.1596	17.8000	0.8186	--------

File name: SampleFHA.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (mm/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0	0	0	0	0	0	0	0	0	0	0	0
2	145	117	99	86	76	68	62	57	53	49	46	43
3	0	0	0	0	0	0	0	0	0	0	0	0
5	167	138	118	104	93	84	77	71	66	62	58	55
10	184	153	132	117	105	95	87	81	75	70	66	62
25	209	176	153	136	122	111	102	95	88	83	78	74
50	230	194	169	150	136	124	114	106	99	93	87	83
100	250	212	185	165	149	136	126	117	109	102	97	91

Tc = time in minutes. Values may exceed 60.

File name: T:\2023\223007- Nikki Beach Resort Antigua\Constructs\Civil\CALCULATIONS\STORM\USVI IDF DATA.pcp

Storm Distribution	Rainfall Precipitation Table (mm)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	90	122	0	184	236	312	378	450
SCS 6-Hr	66	87	0	119	144	179	207	236
Huff-1st	0	0	0	0	0	0	0	0
Huff-2nd	0	0	0	0	0	0	0	0
Huff-3rd	0	0	0	0	0	0	0	0
Huff-4th	0	0	0	0	0	0	0	0
Huff-Indy	0	0	0	0	0	0	0	0
Custom	0	0	0	0	0	0	0	0

Watershed Model Schematic 1

Hydrograph Return Period Recap 2

10 - Year
- **Summary Report** 3
- **Hydrograph Reports** 4
  - Hydrograph No. 1, SCS Runoff, Pre Development Area 1 To Harbor 4

25 - Year
- **Summary Report** 5
- **Hydrograph Reports** 6
  - Hydrograph No. 1, SCS Runoff, Pre Development Area 1 To Harbor 6

50 - Year
- **Summary Report** 7
- **Hydrograph Reports** 8
  - Hydrograph No. 1, SCS Runoff, Pre Development Area 1 To Harbor 8

IDF Report 9

APPENDIX B
Storm and Sanitary Analysis Model 2023 Report

Project Description

File Name	223007 - SSA 50 YR MODEL.SPF

Project Options

Flow Units	CMS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	0
Nodes	78
Junctions	44
Outfalls	34
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	44
Channels	3
Pipes	41
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	2 year(s)

Node Summary

SN	Element ID	Element Type	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Initial Water Elevation (m)	Surcharge Elevation (m)	Ponded Area (m²)	Peak Inflow (cms)	Max HGL Elevation Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	O (day
1	B.4	Junction	3.05	3.65	3.05	0.00	0.00	0.09	3.20	0.00	0.45	
2	B.5	Junction	2.14	2.44	2.14	0.00	0.00	0.11	2.31	0.00	0.28	
3	BC.1	Junction	1.20	1.50	1.20	0.00	0.00	0.01	1.25	0.00	0.25	
4	BC.2	Junction	1.20	1.50	1.20	0.00	0.00	0.01	1.25	0.00	0.25	
5	BS.01	Junction	1.00	2.44	1.00	0.00	0.00	0.11	1.27	0.00	1.17	
6	CB.A.1	Junction	1.22	2.00	1.22	0.00	0.00	0.05	1.42	0.00	0.58	
7	CB.A.2	Junction	1.09	1.50	1.09	0.00	0.00	0.09	1.39	0.00	0.15	
8	CB.B.1	Junction	1.18	2.00	1.18	0.00	0.00	0.30	1.70	0.00	0.30	
9	CB.B.2	Junction	1.03	2.00	1.03	0.00	0.00	0.34	1.56	0.00	0.44	
10	CB.B.3	Junction	0.94	2.15	0.94	0.00	0.00	0.39	1.32	0.00	0.83	
11	CB.C.1	Junction	2.00	3.20	2.00	0.00	0.00	0.10	2.15	0.00	1.05	
12	CB.D.1	Junction	2.11	3.20	2.11	0.00	0.00	0.37	2.59	0.00	0.61	
13	CB.E.2	Junction	2.00	3.00	2.00	0.00	0.00	0.66	2.43	0.00	0.57	
14	CB.F.1	Junction	1.03	1.50	1.03	0.00	0.00	0.02	1.21	0.00	0.29	
15	CB.F.2	Junction	0.95	1.47	0.95	0.00	0.00	0.05	1.20	0.00	0.27	
16	CB.F.2.1	Junction	1.00	1.47	0.00	0.00	0.00	0.02	1.21	0.00	0.26	
17	CB.F.3.1	Junction	1.00	1.47	1.00	0.00	0.00	0.02	1.11	0.00	0.36	
18	CBA.3	Junction	0.94	2.00	0.94	0.00	0.00	0.16	1.33	0.00	0.67	
19	CBD.2	Junction	2.00	3.20	2.00	0.00	0.00	0.38	2.25	0.00	0.95	
20	CBF.3	Junction	0.88	1.47	0.88	0.00	0.00	0.08	1.10	0.00	0.37	
21	GH.1	Junction	1.00	1.50	1.00	0.00	0.00	0.03	1.14	0.00	0.36	
22	HG.1	Junction	1.00	2.44	1.00	0.00	0.00	0.06	1.29	0.00	1.15	
23	HGTEE	Junction	0.93	6.93	0.93	6.93	0.00	0.12	1.21	0.00	5.72	
24	3-Jun	Junction	1.84	2.44	1.84	0.00	0.00	0.07	2.01	0.00	0.43	
25	6-Jun	Junction	1.84	2.44	1.84	0.00	0.00	0.05	2.06	0.00	0.38	
26	Jun-45	Junction	2.00	2.44	2.00	0.00	0.00	0.09	2.16	0.00	0.28	
27	Jun-46	Junction	1.50	2.44	1.50	0.00	0.00	0.09	1.67	0.00	0.77	
28	Jun-51	Junction	1.52	1.82	1.52	0.00	0.00	0.09	2.00	0.00	0.12	
29	Jun-52	Junction	1.52	1.82	1.52	0.00	0.00	0.09	1.73	0.00	0.39	
30	Jun-53	Junction	1.60	2.00	1.60	0.00	0.00	0.09	2.09	0.00	0.11	
31	M.2	Junction	2.50	7.10	2.50	0.00	0.00	0.30	2.89	0.00	4.21	
32	M3	Junction	6.10	7.10	6.10	0.00	0.00	0.31	6.39	0.00	0.71	
33	M4	Junction	6.50	7.10	6.50	0.00	0.00	0.23	6.71	0.00	0.39	
34	PB.01	Junction	1.00	1.89	1.00	0.00	0.00	0.11	1.89	0.00	0.00	
35	PO.01	Junction	1.00	1.50	1.00	0.00	0.00	0.00	1.02	0.00	0.48	
36	RA.01	Junction	1.00	2.44	1.00	0.00	0.00	0.02	1.09	0.00	1.35	
37	RB	Junction	1.00	2.44	1.00	0.00	0.00	0.06	1.33	0.00	1.11	
38	SPA.1	Junction	1.50	2.44	1.50	0.00	0.00	0.14	1.73	0.00	0.71	
39	SPA.2	Junction	1.50	2.44	0.50	0.00	0.00	0.12	1.74	0.00	0.70	
40	TD.E.1	Junction	4.10	5.00	4.10	0.00	0.00	0.67	4.47	0.00	0.53	
41	TD.E.3	Junction	0.90	1.50	0.90	0.00	0.00	0.66	1.41	0.00	0.09	
42	TD.G.1	Junction	0.50	1.00	0.50	0.00	0.00	0.06	0.82	0.00	0.18	
43	WS.01	Junction	1.00	1.50	1.00	0.00	0.00	0.01	1.05	0.00	0.45	
44	WS.02	Junction	1.00	1.50	1.00	0.00	0.00	0.01	1.06	0.00	0.44	

Node Summary

SN	Element ID	Element Type	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Initial Water Elevation (m)	Surcharge Elevation (m)	Ponded Area (m²)	Peak Inflow (cms)	Max HGL Elevation Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	O (day
71	BOUT.1	Outfall	0.90					0.01	0.94			
72	C.2	Outfall	0.90					0.10	1.02			
73	D.3	Outfall	0.90					0.38	1.07			
74	OUT.G.2	Outfall	0.40					0.06	0.59			
75	OutF.4	Outfall	0.82					0.08	1.01			
76	PO.02	Outfall	0.90					0.00	0.92			
77	WS.03	Outfall	0.90					0.01	0.94			
78	WS.04	Outfall	0.90					0.01	0.94			

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (m)	Inlet Invert Elevation (m)	Outlet Invert Elevation (m)	Average Slope (%)	Diameter or Height (m)	Manning's Roughness	Peak Flow (cms)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Tot Surc
1	BH.17A	Pipe	Jun-45	BH.17.A	37.99	2.00	0.30	4.4700	0.300	0.0150	0.09	0.18	0.49	2.39	0.15	0.51	
2	Link-01	Pipe	BC.1	BOUT.1	2.00	1.20	0.90	15.0000	0.150	0.0150	0.01	0.05	0.18	1.86	0.05	0.32	
3	Link-02	Pipe	BC.2	BC0UT.2	2.00	1.20	0.90	15.0000	0.150	0.0150	0.01	0.05	0.18	1.86	0.05	0.32	
4	Link-06	Pipe	6-Jun	CB.B.3	3.00	1.84	1.81	1.0000	0.300	0.0150	0.05	0.08	0.60	1.05	0.19	0.64	
5	Link-08	Pipe	B.4	CB.B.1	30.50	3.05	1.20	6.0700	0.300	0.0150	0.10	0.21	0.48	2.04	0.22	0.74	
6	Link-09	Pipe	B.5	CB.B.1	25.70	2.14	1.30	3.2700	0.450	0.0150	0.12	0.45	0.27	1.74	0.28	0.61	
7	Link-16	Pipe	PO.01	PO.02	1.00	1.00	0.90	10.0000	0.150	0.0150	0.00	0.04	0.04	1.00	0.02	0.15	
8	Link-17	Pipe	WS.01	WS.03	1.00	1.00	0.90	10.0000	0.150	0.0150	0.01	0.04	0.15	1.35	0.05	0.31	
9	Link-18	Pipe	WS.02	WS.04	1.00	1.00	0.90	10.0000	0.150	0.0150	0.01	0.04	0.16	1.36	0.05	0.33	
10	Link-21	Pipe	A.Out	CBA.3	9.56	0.90	0.94	-0.4200	0.450	0.0150	0.16	0.16	0.98	1.24	0.33	0.74	
11	Link-22	Pipe	CBA.3	CB.A.2	30.00	0.94	1.09	-0.5000	0.450	0.0150	0.09	0.17	0.53	0.75	0.35	0.77	
12	Link-23	Pipe	CB.A.2	CB.A.1	27.00	1.09	1.22	-0.4800	0.450	0.0150	0.05	0.17	0.28	0.76	0.25	0.55	
13	Link-24	Pipe	3-Jun	CBA.3	13.70	1.84	0.94	6.5700	0.300	0.0150	0.08	0.21	0.37	2.97	0.21	0.69	
14	Link-25	Pipe	B.OUT	CB.B.3	8.32	0.90	0.94	-0.4800	0.600	0.0150	0.39	0.74	0.53	1.15	0.35	0.58	
15	Link-26	Pipe	CB.B.3	CB.B.2	19.84	0.94	1.03	-0.4500	0.600	0.0150	0.34	0.36	0.95	1.47	0.46	0.76	
16	Link-27	Pipe	CB.B.2	CB.B.1	29.00	1.03	1.18	-0.5200	0.600	0.0150	0.29	0.38	0.76	1.29	0.53	0.88	
17	Link-28	Pipe	CB.C.1	C.2	7.72	2.00	0.90	14.2500	0.300	0.0150	0.10	0.32	0.33	3.48	0.13	0.44	
18	Link-29	Pipe	D.3	CBD.2	7.30	0.90	2.00	-15.0700	0.600	0.0150	0.38	2.07	0.19	4.36	0.18	0.35	
19	Link-30	Pipe	CBD.2	CB.D.1	11.05	2.00	2.11	-1.0000	0.600	0.0150	0.38	0.53	0.71	2.26	0.30	0.58	
20	Link-31	Pipe	CB.D.1	M.2	11.76	2.11	2.50	-3.3200	0.600	0.0150	0.37	0.97	0.39	2.41	0.35	0.64	
21	Link-35	Pipe	CB.F.1	CB.F.2	10.55	1.03	0.95	0.7600	0.300	0.0150	0.02	0.07	0.25	0.64	0.22	0.72	
22	Link-36	Pipe	CB.F.2	CBF.3	14.23	0.95	0.88	0.4900	0.300	0.0150	0.05	0.06	0.87	0.85	0.24	0.80	
23	Link-37	Pipe	CBF.3	OutF.4	13.20	0.88	0.82	0.4500	0.300	0.0150	0.09	0.11	0.75	0.81	0.21	0.70	
24	Link-38	Pipe	CB.F.3.1	CBF.3	10.60	1.00	0.88	1.1300	0.302	0.0150	0.02	0.09	0.21	0.88	0.17	0.56	
25	Link-39	Pipe	CB.F.2.1	CB.F.2	10.60	1.00	0.95	0.4700	0.300	0.0150	0.02	0.06	0.31	0.55	0.23	0.78	
26	Link-40	Pipe	M3	TD.E.1	15.50	6.10	4.10	12.9000	0.450	0.0150	0.39	0.89	0.44	4.36	0.25	0.62	
27	Link-41	Pipe	TD.E.1	CB.E.2	30.20	4.10	2.00	6.9500	0.600	0.0150	0.66	1.40	0.47	4.05	0.31	0.60	
28	Link-42	Pipe	CB.E.2	TD.E.3	23.75	2.00	0.90	4.6300	0.600	0.0150	0.67	1.15	0.58	3.02	0.40	0.74	

Junction Input

SN	Element ID	Invert Elevation (m)	Ground/Rim (Max) Elevation (m)	Ground/Rim (Max) Offset (m)	Initial Water Elevation (m)	Initial Water Depth (m)	Surcharge Elevation (m)	Surcharge Depth (m)	Ponded Area (m²)	Minimum Pipe Cover (m)
1	B.4	3.05	3.65	0.60	3.05	0.00	0.00	-3.65	0.00	0.30
2	B.5	2.14	2.44	0.30	2.14	0.00	0.00	-2.44	0.00	0.00
3	BC.1	1.20	1.50	0.30	1.20	0.00	0.00	-1.50	0.00	0.15
4	BC.2	1.20	1.50	0.30	1.20	0.00	0.00	-1.50	0.00	0.15
5	BS.01	1.00	2.44	1.44	1.00	0.00	0.00	-2.44	0.00	1.14
6	CB.A.1	1.22	2.00	0.78	1.22	0.00	0.00	-2.00	0.00	0.33
7	CB.A.2	1.09	1.50	0.41	1.09	0.00	0.00	-1.50	0.00	0.00
8	CB.B.1	1.18	2.00	0.82	1.18	0.00	0.00	-2.00	0.00	0.22
9	CB.B.2	1.03	2.00	0.97	1.03	0.00	0.00	-2.00	0.00	0.37
10	CB.B.3	0.94	2.15	1.21	0.94	0.00	0.00	-2.15	0.00	0.04
11	CB.C.1	2.00	3.20	1.20	2.00	0.00	0.00	-3.20	0.00	0.90
12	CB.D.1	2.11	3.20	1.09	2.11	0.00	0.00	-3.20	0.00	0.49
13	CB.E.2	2.00	3.00	1.00	2.00	0.00	0.00	-3.00	0.00	0.40
14	CB.F.1	1.03	1.50	0.47	1.03	0.00	0.00	-1.50	0.00	0.17
15	CB.F.2	0.95	1.47	0.52	0.95	0.00	0.00	-1.47	0.00	0.22
16	CB.F.2.1	1.00	1.47	0.47	0.00	-1.00	0.00	-1.47	0.00	0.17
17	CB.F.3.1	1.00	1.47	0.47	1.00	0.00	0.00	-1.47	0.00	0.17
18	CBA.3	0.94	2.00	1.06	0.94	0.00	0.00	-2.00	0.00	0.61
19	CBD.2	2.00	3.20	1.20	2.00	0.00	0.00	-3.20	0.00	0.60
20	CBF.3	0.88	1.47	0.59	0.88	0.00	0.00	-1.47	0.00	0.29
21	GH.1	1.00	1.50	0.50	1.00	0.00	0.00	-1.50	0.00	0.30
22	HG.1	1.00	2.44	1.44	1.00	0.00	0.00	-2.44	0.00	1.14
23	HGTEE	0.93	6.93	6.00	0.93	0.00	6.93	0.00	0.00	5.55
24	3-Jun	1.84	2.44	0.60	1.84	0.00	0.00	-2.44	0.00	0.30
25	6-Jun	1.84	2.44	0.60	1.84	0.00	0.00	-2.44	0.00	0.30
26	Jun-45	2.00	2.44	0.44	2.00	0.00	0.00	-2.44	0.00	0.14
27	Jun-46	1.50	2.44	0.94	1.50	0.00	0.00	-2.44	0.00	0.64
28	Jun-51	1.52	1.82	0.30	1.52	0.00	0.00	-1.82	0.00	0.00
29	Jun-52	1.52	1.82	0.30	1.52	0.00	0.00	-1.82	0.00	0.00
30	Jun-53	1.60	2.00	0.40	1.60	0.00	0.00	-2.00	0.00	0.00
31	M.2	2.50	7.10	4.60	2.50	0.00	0.00	-7.10	0.00	4.00
32	M3	6.10	7.10	1.00	6.10	0.00	0.00	-7.10	0.00	0.55
33	M4	6.50	7.10	0.60	6.50	0.00	0.00	-7.10	0.00	0.15
34	PB.01	1.00	1.89	0.89	1.00	0.00	0.00	-1.89	0.00	0.59
35	PO.01	1.00	1.50	0.50	1.00	0.00	0.00	-1.50	0.00	0.35
36	RA.01	1.00	2.44	1.44	1.00	0.00	0.00	-2.44	0.00	1.29
37	RB	1.00	2.44	1.44	1.00	0.00	0.00	-2.44	0.00	1.14
38	SPA.1	1.50	2.44	0.94	1.50	0.00	0.00	-2.44	0.00	0.49
39	SPA.2	1.50	2.44	0.94	0.50	-1.00	0.00	-2.44	0.00	0.64
40	TD.E.1	4.10	5.00	0.90	4.10	0.00	0.00	-5.00	0.00	0.30
41	TD.E.3	0.90	1.50	0.60	0.90	0.00	0.00	-1.50	0.00	0.00
42	TD.G.1	0.50	1.00	0.50	0.50	0.00	0.00	-1.00	0.00	0.20
43	WS.01	1.00	1.50	0.50	1.00	0.00	0.00	-1.50	0.00	0.35
44	WS.02	1.00	1.50	0.50	1.00	0.00	0.00	-1.50	0.00	0.35

Junction Results

SN	Element ID	Peak Inflow (cms)	Peak Lateral Inflow (cms)	Max HGL Elevation Attained (m)	Max HGL Depth Attained (m)	Max Surcharge Depth Attained (m)	Min Freeboard Attained (m)	Average HGL Elevation Attained (m)	Average HGL Depth Attained (m)	Time of Max HGL Occurrence (days hh:mm)	Tim F Floo Occurre (days hh:r
1	B.4	0.09	0.09	3.20	0.15	0.00	0.45	3.19	0.14	0 00:00	0 0
2	B.5	0.11	0.11	2.31	0.17	0.00	0.28	2.29	0.15	0 00:00	0 0
3	BC.1	0.01	0.01	1.25	0.05	0.00	0.25	1.25	0.05	0 00:02	0 0
4	BC.2	0.01	0.01	1.25	0.05	0.00	0.25	1.25	0.05	0 00:02	0 0
5	BS.01	0.11	0.11	1.27	0.27	0.00	1.17	1.25	0.25	0 00:00	0 0
6	CB.A.1	0.05	0.05	1.42	0.20	0.00	0.58	1.42	0.20	0 00:30	0 0
7	CB.A.2	0.09	0.05	1.39	0.30	0.00	0.15	1.39	0.30	0 00:30	0 0
8	CB.B.1	0.30	0.09	1.70	0.52	0.00	0.30	1.70	0.52	0 00:18	0 0
9	CB.B.2	0.34	0.05	1.56	0.53	0.00	0.44	1.56	0.53	0 00:17	0 0
10	CB.B.3	0.39	0.00	1.32	0.38	0.00	0.83	1.32	0.38	0 00:17	0 0
11	CB.C.1	0.10	0.10	2.15	0.15	0.00	1.05	2.14	0.14	0 00:00	0 0
12	CB.D.1	0.37	0.00	2.59	0.48	0.00	0.61	2.50	0.39	0 00:00	0 0
13	CB.E.2	0.66	0.00	2.43	0.43	0.00	0.57	2.34	0.34	0 00:00	0 0
14	CB.F.1	0.02	0.02	1.21	0.18	0.00	0.29	1.21	0.18	0 00:24	0 0
15	CB.F.2	0.05	0.02	1.20	0.25	0.00	0.27	1.20	0.25	0 00:25	0 0
16	CB.F.2.1	0.02	0.02	1.21	0.21	0.00	0.26	1.21	0.21	0 00:24	0 0
17	CB.F.3.1	0.02	0.02	1.11	0.11	0.00	0.36	1.11	0.11	0 00:25	0 0
18	CBA.3	0.16	0.00	1.33	0.39	0.00	0.67	1.33	0.39	0 00:30	0 0
19	CBD.2	0.38	0.00	2.25	0.25	0.00	0.95	2.21	0.21	0 00:00	0 0
20	CBF.3	0.08	0.02	1.10	0.22	0.00	0.37	1.10	0.22	0 00:24	0 0
21	GH.1	0.03	0.03	1.14	0.14	0.00	0.36	1.14	0.14	0 00:11	0 0
22	HG.1	0.06	0.06	1.29	0.29	0.00	1.15	1.28	0.28	0 00:00	0 0
23	HGTEE	0.12	0.00	1.21	0.28	0.00	5.72	1.21	0.28	0 00:01	0 0
24	3-Jun	0.07	0.07	2.01	0.17	0.00	0.43	1.95	0.11	0 00:00	0 0
25	6-Jun	0.05	0.05	2.06	0.22	0.00	0.38	2.06	0.22	0 00:02	0 0
26	Jun-45	0.09	0.09	2.16	0.16	0.00	0.28	2.16	0.16	0 00:00	0 0
27	Jun-46	0.09	0.09	1.67	0.17	0.00	0.77	1.67	0.17	0 00:00	0 0
28	Jun-51	0.09	0.09	2.00	0.48	0.00	0.12	2.00	0.48	0 00:26	0 0
29	Jun-52	0.09	0.09	1.73	0.21	0.00	0.39	1.73	0.21	0 00:35	0 0
30	Jun-53	0.09	0.09	2.09	0.49	0.00	0.11	2.08	0.48	0 00:39	0 0
31	M.2	0.30	0.30	2.89	0.39	0.00	4.21	2.81	0.31	0 00:00	0 0
32	M3	0.31	0.31	6.39	0.29	0.00	0.71	6.30	0.20	0 00:00	0 0
33	M4	0.23	0.23	6.71	0.21	0.00	0.39	6.65	0.15	0 00:00	0 0
34	PB.01	0.11	0.11	1.89	0.89	0.00	0.00	1.43	0.43	0 00:00	0 0
35	PO.01	0.00	0.00	1.02	0.02	0.00	0.48	1.02	0.02	0 00:05	0 0
36	RA.01	0.02	0.02	1.09	0.09	0.00	1.35	1.09	0.09	0 00:01	0 0
37	RB	0.06	0.06	1.33	0.33	0.00	1.11	1.32	0.32	0 00:00	0 0
38	SPA.1	0.14	0.14	1.73	0.23	0.00	0.71	1.71	0.21	0 00:00	0 0
39	SPA.2	0.12	0.12	1.74	0.24	0.00	0.70	1.72	0.22	0 00:00	0 0
40	TD.E.1	0.67	0.00	4.47	0.37	0.00	0.53	4.39	0.29	0 00:00	0 0
41	TD.E.3	0.66	0.00	1.41	0.51	0.00	0.09	1.35	0.45	0 00:00	0 0
42	TD.G.1	0.06	0.03	0.82	0.32	0.00	0.18	0.82	0.32	0 00:11	0 0
43	WS.01	0.01	0.01	1.05	0.05	0.00	0.45	1.05	0.05	0 00:03	0 0
44	WS.02	0.01	0.01	1.06	0.06	0.00	0.44	1.06	0.06	0 00:03	0 0

Channel Input

SN	Element ID	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Shape	Height (m)	Width (m)	Manning's Roughness	Entrance Losses
1	Link-57	61.00	1.52	0.00	1.29	0.00	0.23	0.3800	Triangular	0.600	1.200	0.0320	0.5000
2	Link-58	79.00	1.52	0.00	1.23	0.00	0.29	0.3700	Rectangular	0.600	1.200	0.0320	0.5000
3	Link-59	90.00	1.60	0.00	1.23	0.00	0.37	0.4100	Triangular	0.600	1.200	0.0320	0.5000

Channel Results

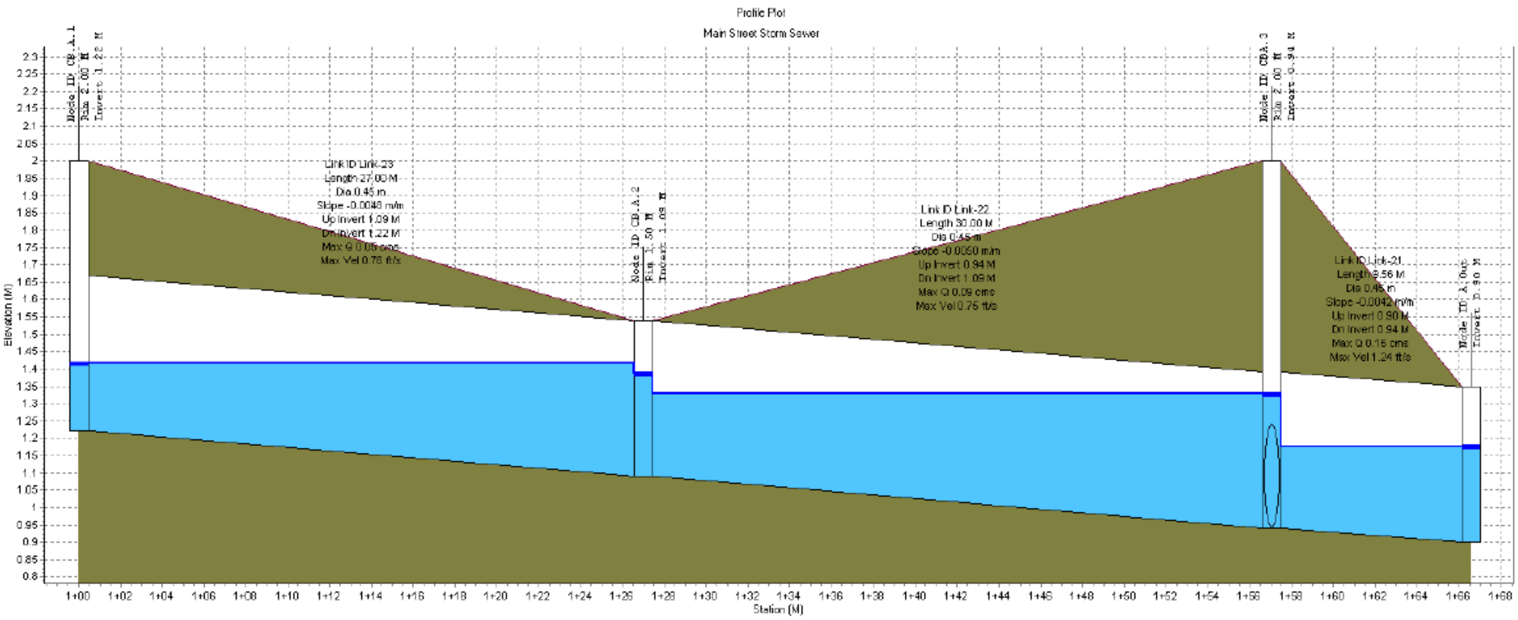
SN	Element ID	Peak Flow (cms)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Travel Time (min)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froud Numbe
1	Link-57	0.09	0 00:26	0.25	0.37	0.63	1.61	0.38	0.63	0.00	
2	Link-58	0.09	0 00:35	0.61	0.15	0.52	2.53	0.15	0.24	0.00	
3	Link-59	0.09	0 00:39	0.26	0.35	0.62	2.42	0.38	0.64	0.00	

Pipe Input

SN	Element ID	Length (m)	Inlet Invert Elevation (m)	Inlet Invert Offset (m)	Outlet Invert Elevation (m)	Outlet Invert Offset (m)	Total Drop (m)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (m)	Pipe Width (m)	Manning's Roughness	Entr Lo
1	BH.17A	37.99	2.00	0.00	0.30	0.00	1.70	4.4700	CIRCULAR	0.300	0.300	0.0150	0.
2	Link-01	2.00	1.20	0.00	0.90	0.00	0.30	15.0000	CIRCULAR	0.150	0.150	0.0150	0.
3	Link-02	2.00	1.20	0.00	0.90	0.00	0.30	15.0000	CIRCULAR	0.150	0.150	0.0150	0.
4	Link-06	3.00	1.84	0.00	1.81	0.87	0.03	1.0000	CIRCULAR	0.300	0.300	0.0150	0.
5	Link-08	30.50	3.05	0.00	1.20	0.02	1.85	6.0700	CIRCULAR	0.300	0.300	0.0150	0.
6	Link-09	25.70	2.14	0.00	1.30	0.12	0.84	3.2700	CIRCULAR	0.450	0.450	0.0150	0.
7	Link-16	1.00	1.00	0.00	0.90	0.00	0.10	10.0000	CIRCULAR	0.150	0.150	0.0150	0.
8	Link-17	1.00	1.00	0.00	0.90	0.00	0.10	10.0000	CIRCULAR	0.150	0.150	0.0150	0.
9	Link-18	1.00	1.00	0.00	0.90	0.00	0.10	10.0000	CIRCULAR	0.150	0.150	0.0150	0.
10	Link-21	9.56	0.90	0.00	0.94	0.00	-0.04	-0.4200	CIRCULAR	0.450	0.450	0.0150	0.
11	Link-22	30.00	0.94	0.00	1.09	0.00	-0.15	-0.5000	CIRCULAR	0.450	0.450	0.0150	0.
12	Link-23	27.00	1.09	0.00	1.22	0.00	-0.13	-0.4800	CIRCULAR	0.450	0.450	0.0150	0.
13	Link-24	13.70	1.84	0.00	0.94	0.00	0.90	6.5700	CIRCULAR	0.300	0.300	0.0150	0.
14	Link-25	8.32	0.90	0.00	0.94	0.00	-0.04	-0.4800	CIRCULAR	0.600	0.600	0.0150	0.
15	Link-26	19.84	0.94	0.00	1.03	0.00	-0.09	-0.4500	CIRCULAR	0.600	0.600	0.0150	0.
16	Link-27	29.00	1.03	0.00	1.18	0.00	-0.15	-0.5200	CIRCULAR	0.600	0.600	0.0150	0.
17	Link-28	7.72	2.00	0.00	0.90	0.00	1.10	14.2500	CIRCULAR	0.300	0.300	0.0150	0.
18	Link-29	7.30	0.90	0.00	2.00	0.00	-1.10	-15.0700	CIRCULAR	0.600	0.600	0.0150	0.
19	Link-30	11.05	2.00	0.00	2.11	0.00	-0.11	-1.0000	CIRCULAR	0.600	0.600	0.0150	0.
20	Link-31	11.76	2.11	0.00	2.50	0.00	-0.39	-3.3200	CIRCULAR	0.600	0.600	0.0150	0.
21	Link-35	10.55	1.03	0.00	0.95	0.00	0.08	0.7600	CIRCULAR	0.300	0.300	0.0150	0.
22	Link-36	14.23	0.95	0.00	0.88	0.00	0.07	0.4900	CIRCULAR	0.300	0.300	0.0150	0.
23	Link-37	13.20	0.88	0.00	0.82	0.00	0.06	0.4500	CIRCULAR	0.300	0.300	0.0150	0.
24	Link-38	10.60	1.00	0.00	0.88	0.00	0.12	1.1300	CIRCULAR	0.300	0.300	0.0150	0.
25	Link-39	10.60	1.00	0.00	0.95	0.00	0.05	0.4700	CIRCULAR	0.300	0.300	0.0150	0.
26	Link-40	15.50	6.10	0.00	4.10	0.00	2.00	12.9000	CIRCULAR	0.450	0.450	0.0150	0.
27	Link-41	30.20	4.10	0.00	2.00	0.00	2.10	6.9500	CIRCULAR	0.600	0.600	0.0150	0.
28	Link-42	23.75	2.00	0.00	0.90	0.00	1.10	4.6300	CIRCULAR	0.600	0.600	0.0150	0.
29	Link-43	3.20	0.90	0.00	0.60	0.00	0.30	9.3800	CIRCULAR	0.600	0.600	0.0150	0.
30	Link-44	23.37	1.00	0.00	0.50	0.00	0.50	2.1400	CIRCULAR	0.200	0.200	0.0150	0.
31	Link-45	28.50	0.50	0.00	0.40	0.00	0.10	0.3500	CIRCULAR	0.300	0.300	0.0150	0.
32	Link-46	6.00	1.00	0.00	0.93	0.00	0.07	1.1700	CIRCULAR	0.300	0.300	0.0150	0.
33	Link-48	6.00	0.93	0.00	0.87	0.00	0.06	1.0000	CIRCULAR	0.450	0.450	0.0150	0.
34	Link-49	16.50	1.00	0.00	0.93	0.00	0.07	0.4200	CIRCULAR	0.300	0.300	0.0150	0.
35	Link-50	14.10	1.50	0.00	0.87	0.00	0.63	4.4700	CIRCULAR	0.300	0.300	0.0150	0.
36	Link-52	34.96	1.50	0.00	0.30	0.00	1.20	3.4300	CIRCULAR	0.300	0.300	0.0150	0.
37	Link-53	33.80	1.00	0.00	0.48	0.00	0.52	1.5400	CIRCULAR	0.300	0.300	0.0150	0.
38	Link-54	22.10	1.00	0.00	0.48	0.00	0.52	2.3500	CIRCULAR	0.300	0.300	0.0150	0.
39	Link-55	12.30	1.50	0.00	1.10	0.00	0.40	3.2500	CIRCULAR	0.450	0.450	0.0150	0.
40	Link-56	14.80	1.00	0.00	0.39	0.00	0.61	4.1200	CIRCULAR	0.150	0.150	0.0150	0.
41	Link-60	15.30	6.50	0.00	4.10	0.00	2.40	15.6900	CIRCULAR	0.450	0.450	0.0150	0.

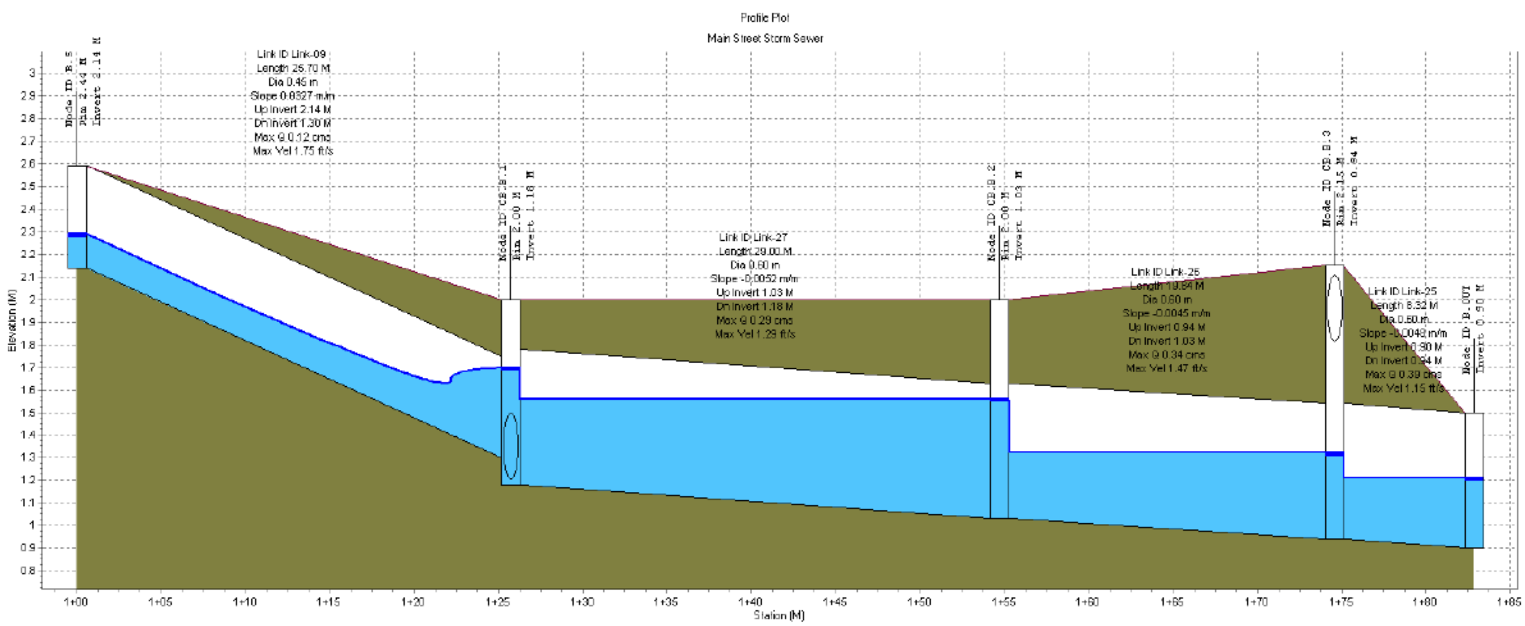
Pipe Results

SN	Element ID	Peak Flow (cms)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cms)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (m/sec)	Travel Time (min)	Peak Flow Depth (m)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froud Numbe
1	BH.17A	0.09	0 00:00	0.18	0.49	2.39	0.26	0.15	0.51	0.00	
2	Link-01	0.01	0 00:02	0.05	0.18	1.86	0.02	0.05	0.32	0.00	
3	Link-02	0.01	0 00:02	0.05	0.18	1.86	0.02	0.05	0.32	0.00	
4	Link-06	0.05	0 00:02	0.08	0.60	1.05	0.05	0.19	0.64	0.00	
5	Link-08	0.10	0 00:00	0.21	0.48	2.04	0.25	0.22	0.74	0.00	
6	Link-09	0.12	0 00:00	0.45	0.27	1.74	0.25	0.28	0.61	0.00	
7	Link-16	0.00	0 00:05	0.04	0.04	1.00	0.02	0.02	0.15	0.00	
8	Link-17	0.01	0 00:03	0.04	0.15	1.35	0.01	0.05	0.31	0.00	
9	Link-18	0.01	0 00:03	0.04	0.16	1.36	0.01	0.05	0.33	0.00	
10	Link-21	0.16	0 00:30	0.16	0.98	1.24	0.13	0.33	0.74	0.00	
11	Link-22	0.09	0 00:30	0.17	0.53	0.75	0.67	0.35	0.77	0.00	
12	Link-23	0.05	0 00:00	0.17	0.28	0.76	0.59	0.25	0.55	0.00	
13	Link-24	0.08	0 00:00	0.21	0.37	2.97	0.08	0.21	0.69	0.00	
14	Link-25	0.39	0 00:17	0.74	0.53	1.15	0.12	0.35	0.58	0.00	
15	Link-26	0.34	0 00:17	0.36	0.95	1.47	0.22	0.46	0.76	0.00	
16	Link-27	0.29	0 00:17	0.38	0.76	1.29	0.37	0.53	0.88	0.00	
17	Link-28	0.10	0 00:00	0.32	0.33	3.48	0.04	0.13	0.44	0.00	
18	Link-29	0.38	0 00:00	2.07	0.19	4.36	0.03	0.18	0.35	0.00	
19	Link-30	0.38	0 00:00	0.53	0.71	2.26	0.08	0.30	0.58	0.00	
20	Link-31	0.37	0 00:00	0.97	0.39	2.41	0.08	0.35	0.64	0.00	
21	Link-35	0.02	0 00:00	0.07	0.25	0.64	0.27	0.22	0.72	0.00	
22	Link-36	0.05	0 00:25	0.06	0.87	0.85	0.28	0.24	0.80	0.00	
23	Link-37	0.09	0 00:24	0.11	0.75	0.81	0.27	0.21	0.70	0.00	
24	Link-38	0.02	0 00:00	0.09	0.21	0.88	0.20	0.17	0.56	0.00	
25	Link-39	0.02	0 00:01	0.06	0.31	0.55	0.32	0.23	0.78	0.00	
26	Link-40	0.39	0 00:00	0.89	0.44	4.36	0.06	0.25	0.62	0.00	
27	Link-41	0.66	0 00:00	1.40	0.47	4.05	0.12	0.31	0.60	0.00	
28	Link-42	0.67	0 00:00	1.15	0.58	3.02	0.13	0.40	0.74	0.00	
29	Link-43	0.63	0 00:00	1.63	0.39	3.31	0.02	0.34	0.64	0.00	
30	Link-44	0.03	0 00:00	0.04	0.77	1.18	0.33	0.17	0.85	0.00	
31	Link-45	0.06	0 00:11	0.05	1.21	0.97	0.49	0.25	0.82	0.00	
32	Link-46	0.08	0 00:00	0.09	0.89	1.69	0.06	0.28	0.93	0.00	
33	Link-48	0.12	0 00:01	0.25	0.49	1.32	0.08	0.25	0.56	0.00	
34	Link-49	0.06	0 00:00	0.05	1.11	0.87	0.32	0.29	0.97	0.00	
35	Link-50	0.13	0 00:00	0.18	0.72	2.43	0.10	0.20	0.71	0.00	
36	Link-52	0.09	0 00:00	0.16	0.56	2.16	0.27	0.16	0.56	0.00	
37	Link-53	0.11	0 00:00	0.10	1.06	1.61	0.35	0.28	0.93	0.00	
38	Link-54	0.11	0 00:00	0.13	0.89	1.88	0.20	0.23	0.81	0.00	
39	Link-55	0.15	0 00:00	0.45	0.34	2.23	0.09	0.19	0.45	0.00	
40	Link-56	0.02	0 00:01	0.03	0.56	1.49	0.17	0.08	0.55	0.00	
41	Link-60	0.29	0 00:00	0.98	0.29	4.30	0.06	0.22	0.57	0.00	



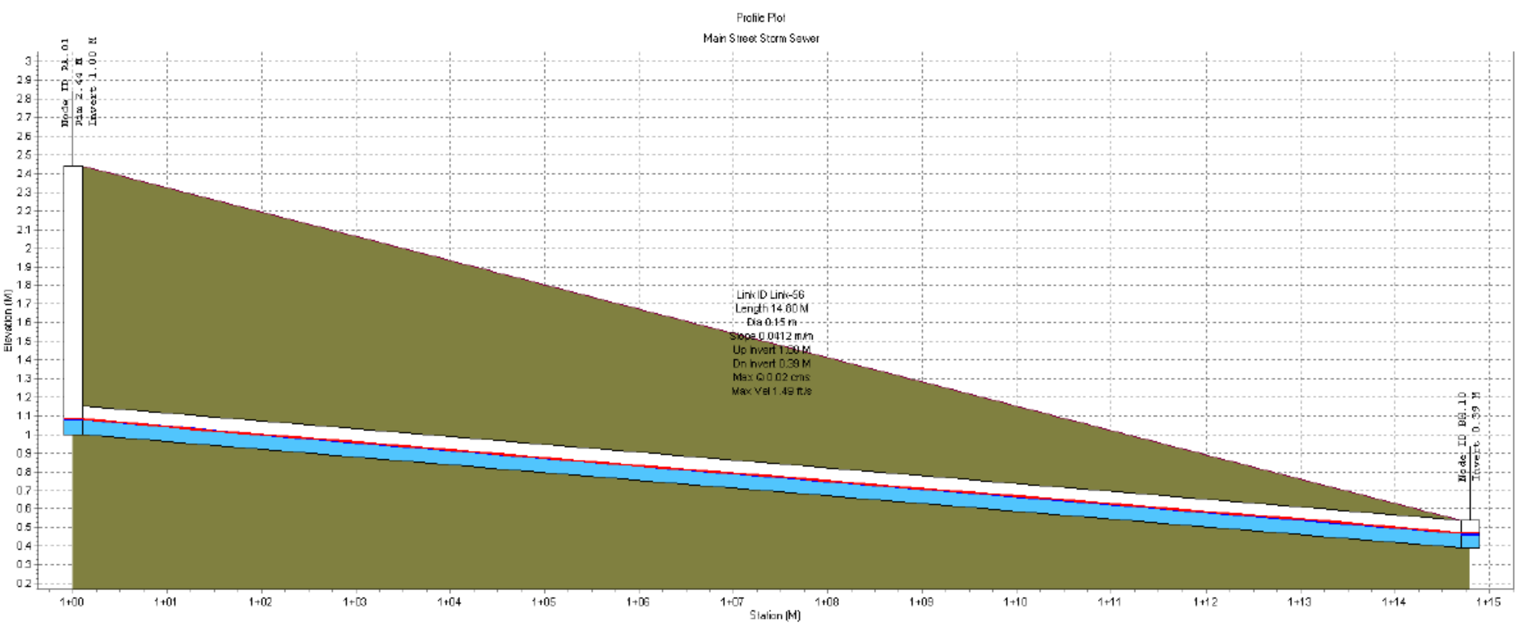
Node ID:	CB.A.1	CB.A.2	CBA.3	A.Out
Rim (M):	2.00	1.50	2.00	
Invert (M):	1.22	1.09	0.94	0.90
Min Pipe Cover (m):	0.33	0.00	0.61	
Max HGL (ft):	1.42	1.39	1.33	1.18

Link ID:	Link-23	Link-22	Link-21
Length (M):	27.00	30.00	9.56
Dia (m):	0.45	0.45	0.45
Slope (m/m):	-0.0048	-0.0050	-0.0042
Up Invert (M):	1.09	0.94	0.90
Dn Invert (M):	1.22	1.09	0.94
Max Q (cms):	0.05	0.09	0.16
Max Vel (ft/s):	0.76	0.75	1.24
Max Depth (m):	0.25	0.35	0.33

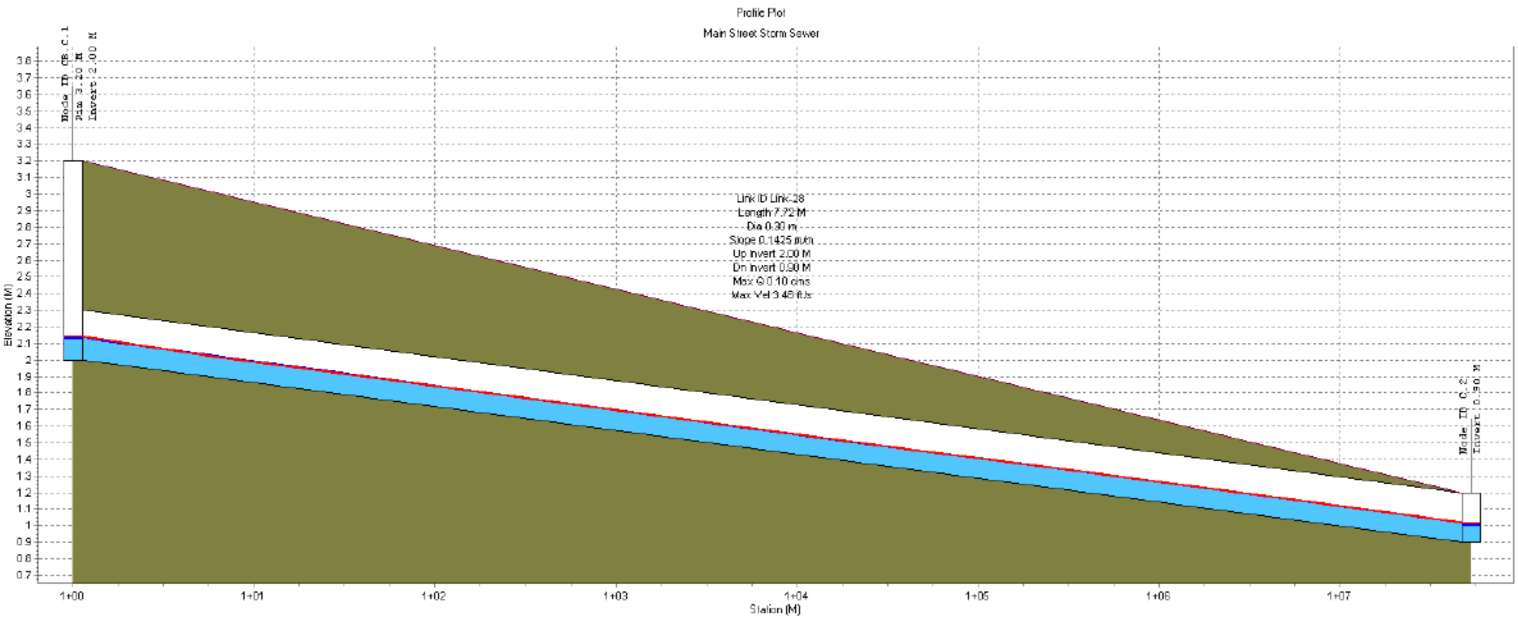


Node ID:	B.5	CB.B.1	CB.B.2	CB.B.3	B.OUT
Rim (M):	2.44	2.00	2.00	2.15	
Invert (M):	2.14	1.18	1.03	0.94	0.90
Min Pipe Cover (m):	0.00	0.22	0.37	0.04	
Max HGL (ft):	2.31	1.70	1.56	1.32	1.21

Link ID:	Link-09	Link-27	Link-26	Link-25
Length (M):	25.70	29.00	19.84	8.32
Dia (m):	0.45	0.60	0.60	0.60
Slope (m/m):	0.0327	-0.0052	-0.0045	-0.0048
Up Invert (M):	2.14	1.03	0.94	0.90
Dn Invert (M):	1.30	1.18	1.03	0.94
Max Q (cms):	0.12	0.29	0.34	0.39
Max Vel (ft/s):	1.75	1.29	1.47	1.15
Max Depth (m):	0.28	0.53	0.46	0.35



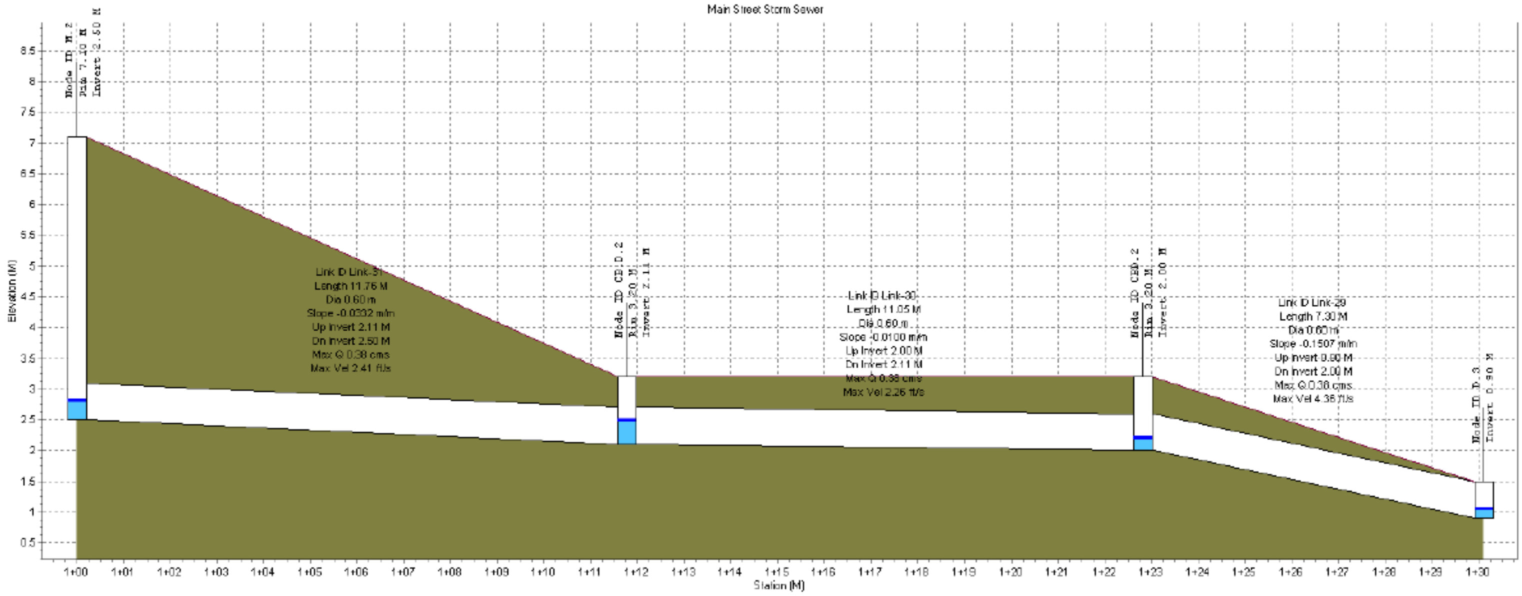
Node ID:	RA.01	BH.10
Rim (M):	2.44	
Invert (M):	1.00	0.39
Min Pipe Cover (m):	1.29	
Max HGL (ft):	1.09	0.47
Link ID:	Link-56	
Length (M):	14.80	
Dia (m):	0.15	
Slope (m/m):	0.0412	
Up Invert (M):	1.00	
Dn Invert (M):	0.39	
Max Q (cms):	0.02	
Max Vel (ft/s):	1.49	
Max Depth (m):	0.08	



Node ID:	CB.C.1	C.2
Rim (M):	3.20	
Invert (M):	2.00	0.90
Min Pipe Cover (m):	0.90	
Max HGL (ft):	2.15	1.02
Link ID:	Link-28	
Length (M):	7.72	
Dia (m):	0.30	
Slope (m/m):	0.1425	
Up Invert (M):	2.00	
Dn Invert (M):	0.90	
Max Q (cms):	0.10	
Max Vel (ft/s):	3.48	
Max Depth (m):	0.13	

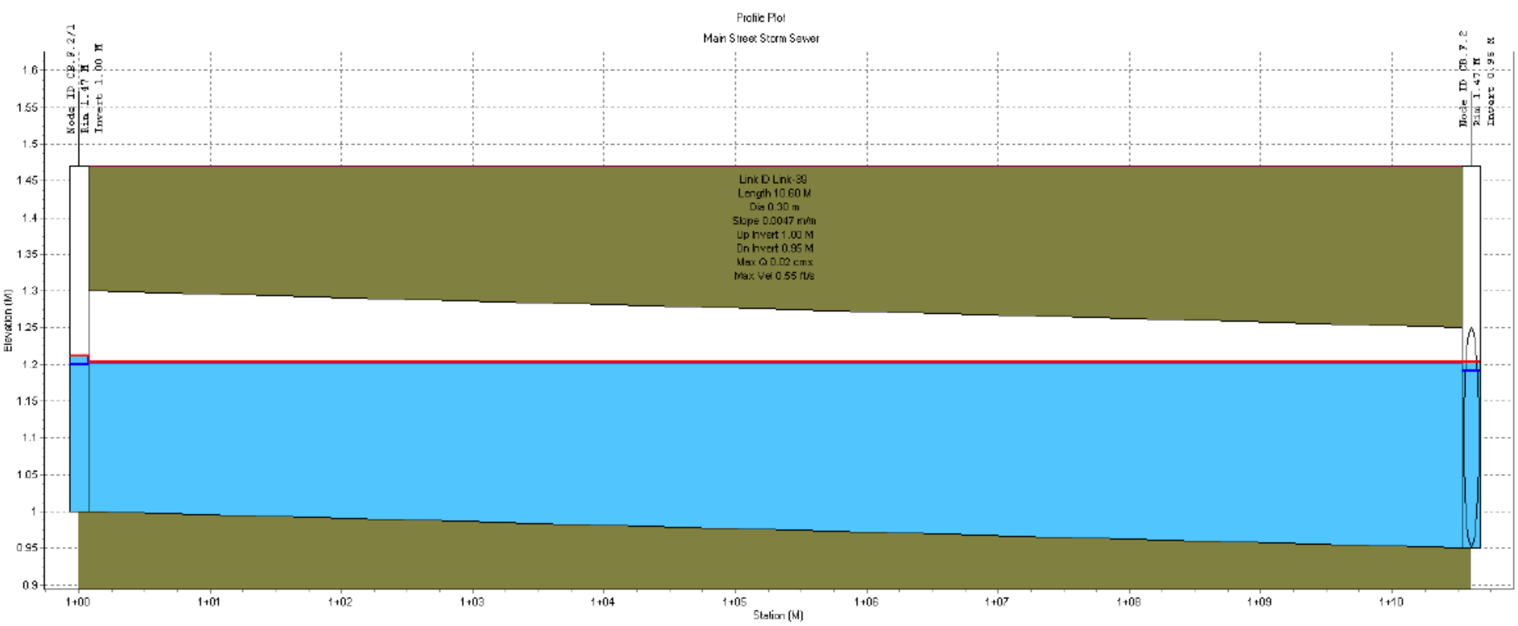
Profile Plot

Main Street Storm Sewer



Node ID:	M.2	CB.D.2	CBD.2	D.3
Rim (M):	7.10	3.20	3.20	
Invert (M):	2.50	2.11	2.00	0.90
Min Pipe Cover (m):	4.00	0.49	0.60	
Max HGL (ft):	2.89	2.59	2.25	1.08

Link ID:	Link-31	Link-30	Link-29
Length (M):	11.76	11.05	7.30
Dia (m):	0.60	0.60	0.60
Slope (m/m):	-0.0332	-0.0100	-0.1507
Up Invert (M):	2.11	2.00	0.90
Dn Invert (M):	2.50	2.11	2.00
Max Q (cms):	0.38	0.38	0.38
Max Vel (ft/s):	2.41	2.26	4.36
Max Depth (m):	0.35	0.30	0.18

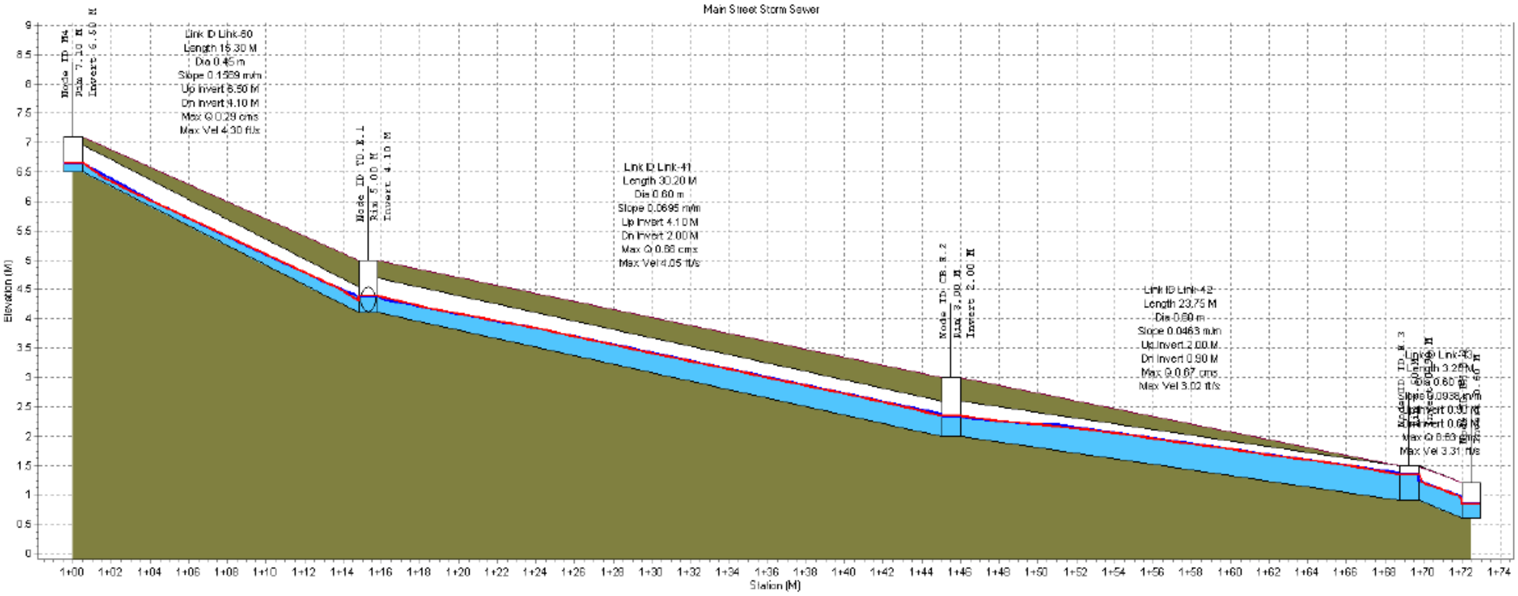


Node ID:	CB.F.2/1	CB.F.2
Rim (M):	1.47	1.47
Invert (M):	1.00	0.95
Min Pipe Cover (m):	0.17	0.22
Max HGL (ft):	1.21	1.20

Link ID:	Link-39
Length (M):	10.60
Dia (m):	0.30
Slope (m/m):	0.0047
Up Invert (M):	1.00
Dn Invert (M):	0.95
Max Q (cms):	0.02
Max Vel (ft/s):	0.55
Max Depth (m):	0.23

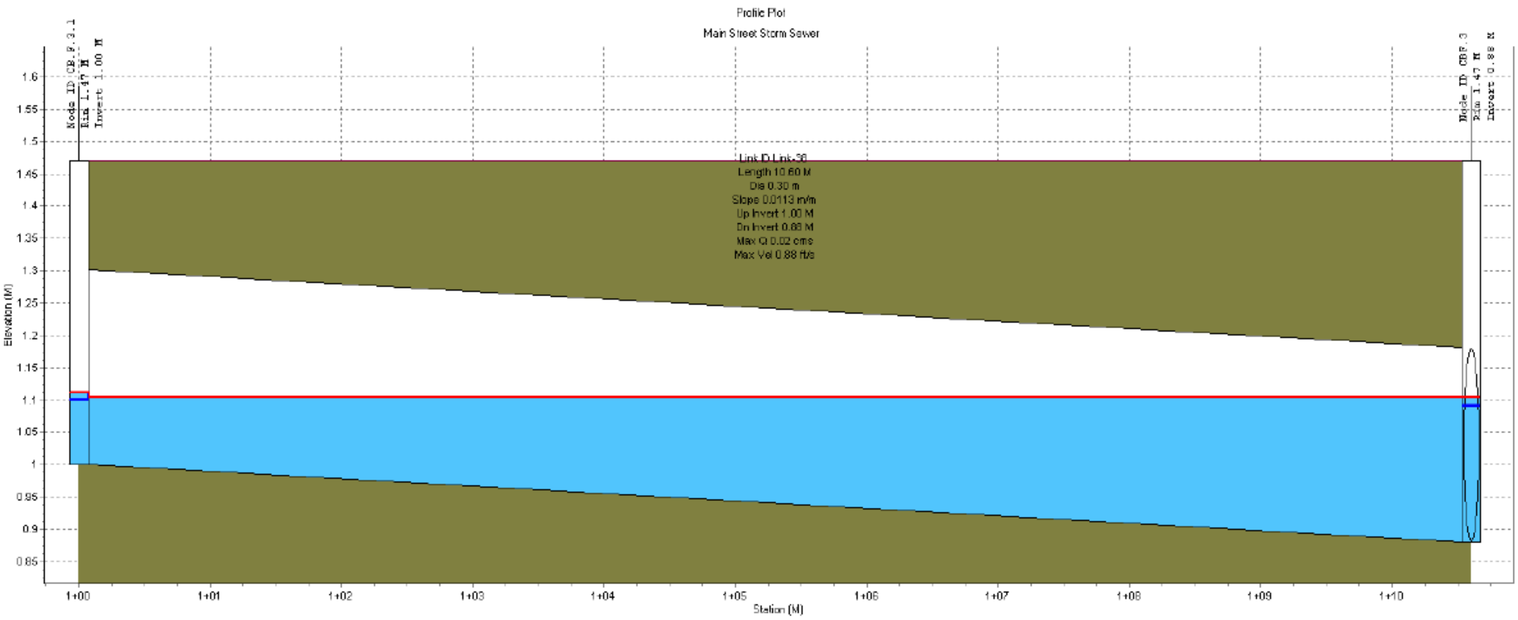
Profile Plot

Main Street Storm Sewer



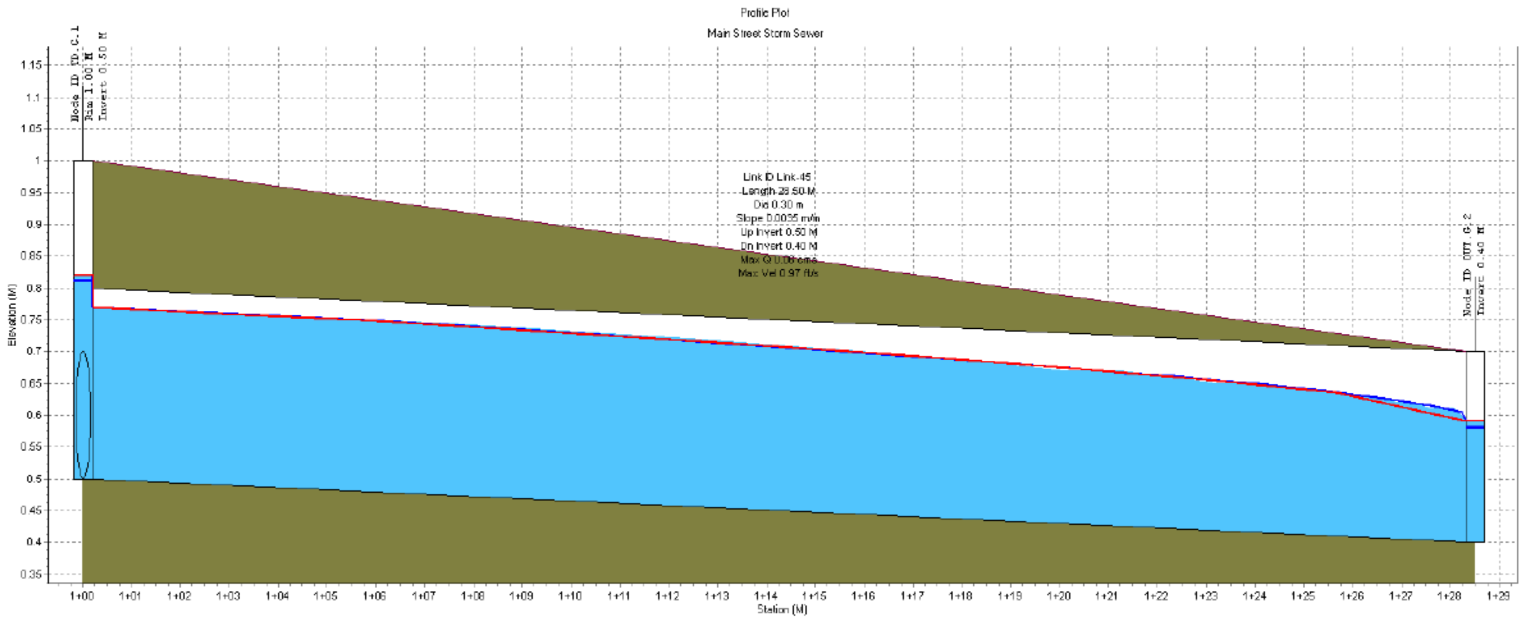
Node ID:	M4	TD.E.1	CB.E.2	TD.E.3	BH.B.1
Rim (M):	7.10	5.00	3.00	1.50	
Invert (M):	6.50	4.10	2.00	0.90	0.60
Min Pipe Cover (m):	0.15	0.30	0.40	0.00	
Max HGL (ft):	6.71	4.47	2.43	1.41	0.86

Link ID:	Link-60	Link-41	Link-42	Link-43
Length (M):	15.30	30.20	23.75	3.20
Dia (m):	0.45	0.60	0.60	0.60
Slope (m/m):	0.1569	0.0695	0.0463	0.0938
Up Invert (M):	6.50	4.10	2.00	0.90
Dn Invert (M):	4.10	2.00	0.90	0.60
Max Q (cms):	0.29	0.66	0.67	0.63
Max Vel (ft/s):	4.30	4.05	3.02	3.31
Max Depth (m):	0.22	0.31	0.40	0.34



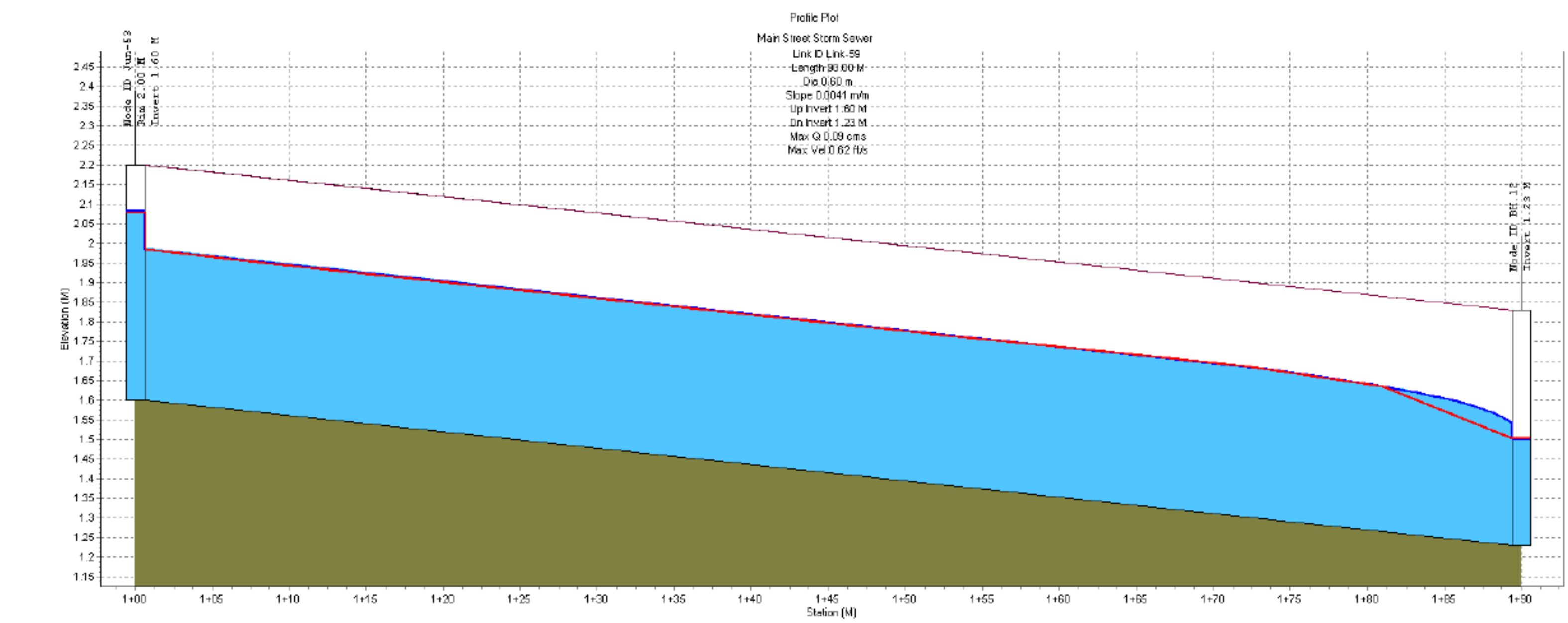
Node ID:	CB.F.3.1	CBF.3
Rim (M):	1.47	1.47
Invert (M):	1.00	0.88
Min Pipe Cover (m):	0.17	0.29
Max HGL (ft):	1.11	1.10

Link ID:	Link-38
Length (M):	10.60
Dia (m):	0.30
Slope (m/m):	0.0113
Up Invert (M):	1.00
Dn Invert (M):	0.88
Max Q (cms):	0.02
Max Vel (ft/s):	0.88
Max Depth (m):	0.17



Node ID:	TD.G.1	OUT.G.2
Rim (M):	1.00	
Invert (M):	0.50	0.40
Min Pipe Cover (m):	0.20	
Max HGL (ft):	0.82	0.59

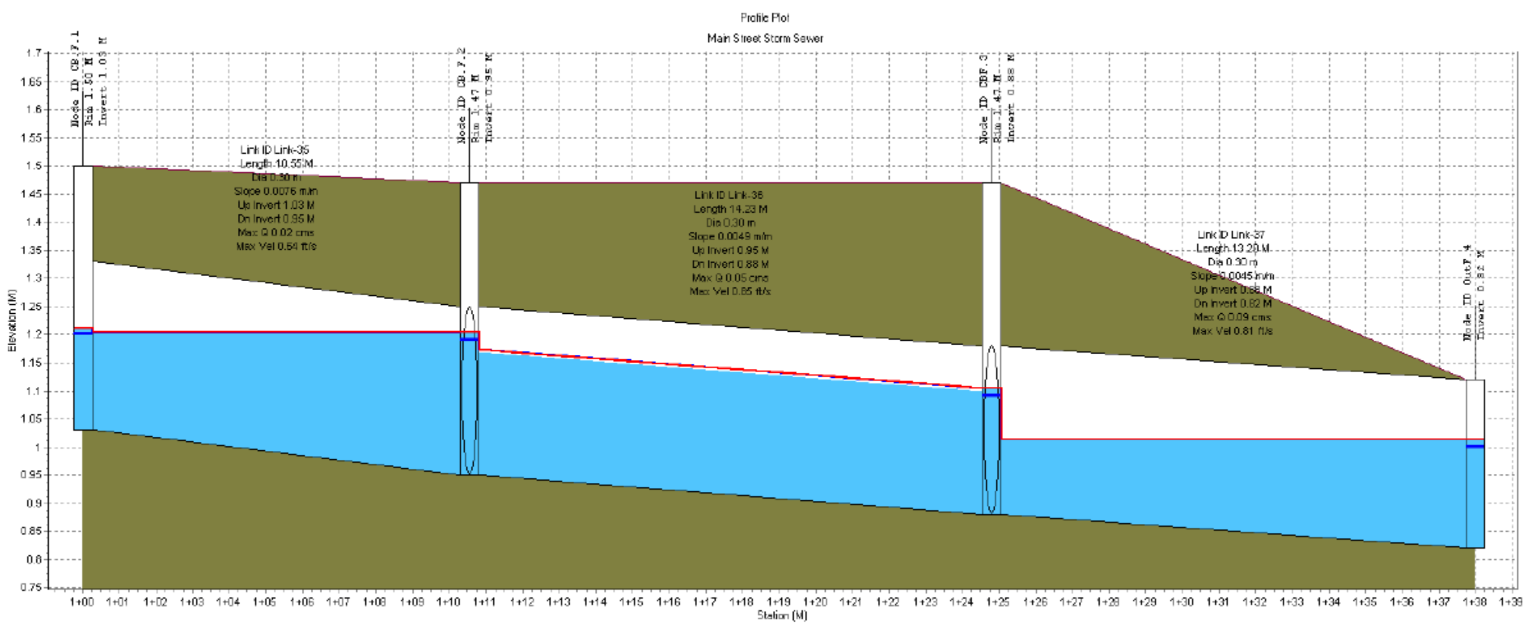
Link ID:	Link-45
Length (M):	28.50
Dia (m):	0.30
Slope (m/m):	0.0035
Up Invert (M):	0.50
Dn Invert (M):	0.40
Max Q (cms):	0.06
Max Vel (ft/s):	0.97
Max Depth (m):	0.25



Node ID:	Jun-53	BH 12
Rim (M):	2.00	
Invert (M):	1.60	1.23
Min Pipe Cover (m):	0.00	
Max HGL (ft):	2.09	1.51

Link ID:	Link-59
Length (M):	90.00
Dia (m):	0.60
Slope (m/m):	0.0041
Up Invert (M):	1.60
Dn Invert (M):	1.23
Max Q (cms):	0.09
Max Vel (ft/s):	0.62
Max Depth (m):	0.38

Autodesk Storm and Sanitary Analysis

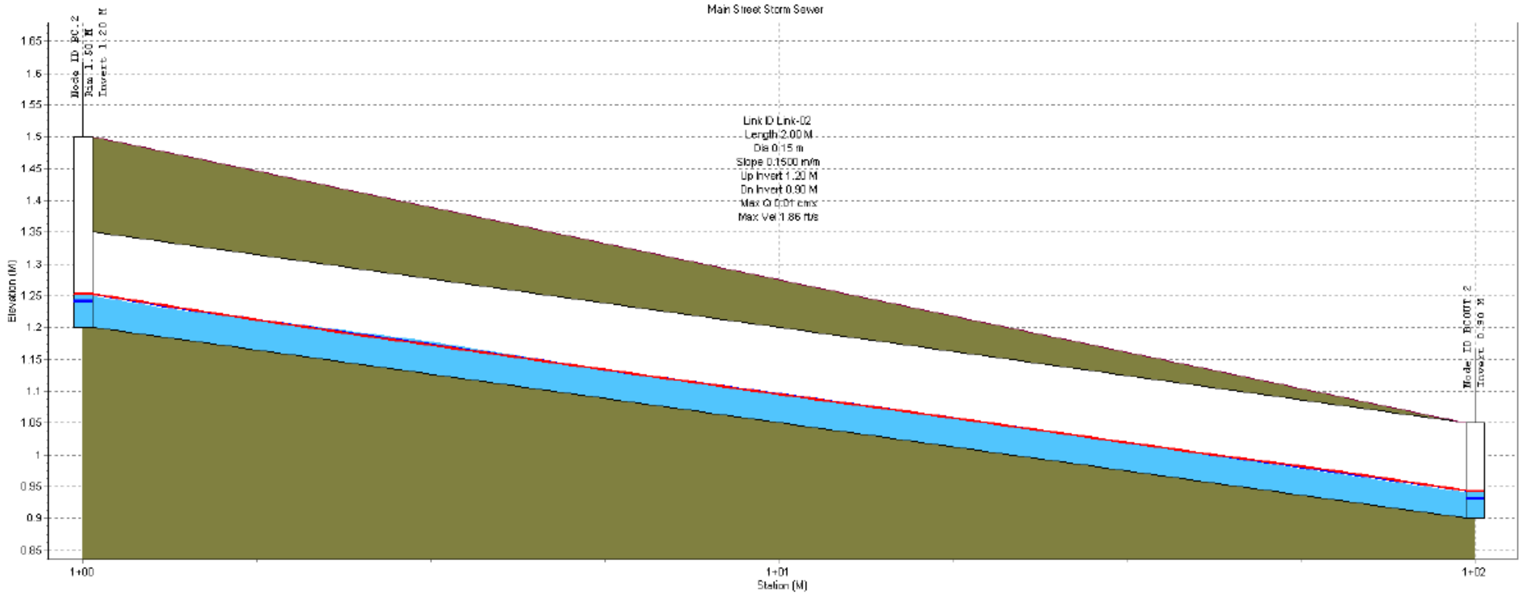


Node ID:	CB.F.1	CB.F.2	CBF.3	OutF.4
Rim (M):	1.50	1.47	1.47	
Invert (M):	1.03	0.95	0.88	0.82
Min Pipe Cover (m):	0.17	0.22	0.29	
Max HGL (ft):	1.21	1.20	1.10	1.01

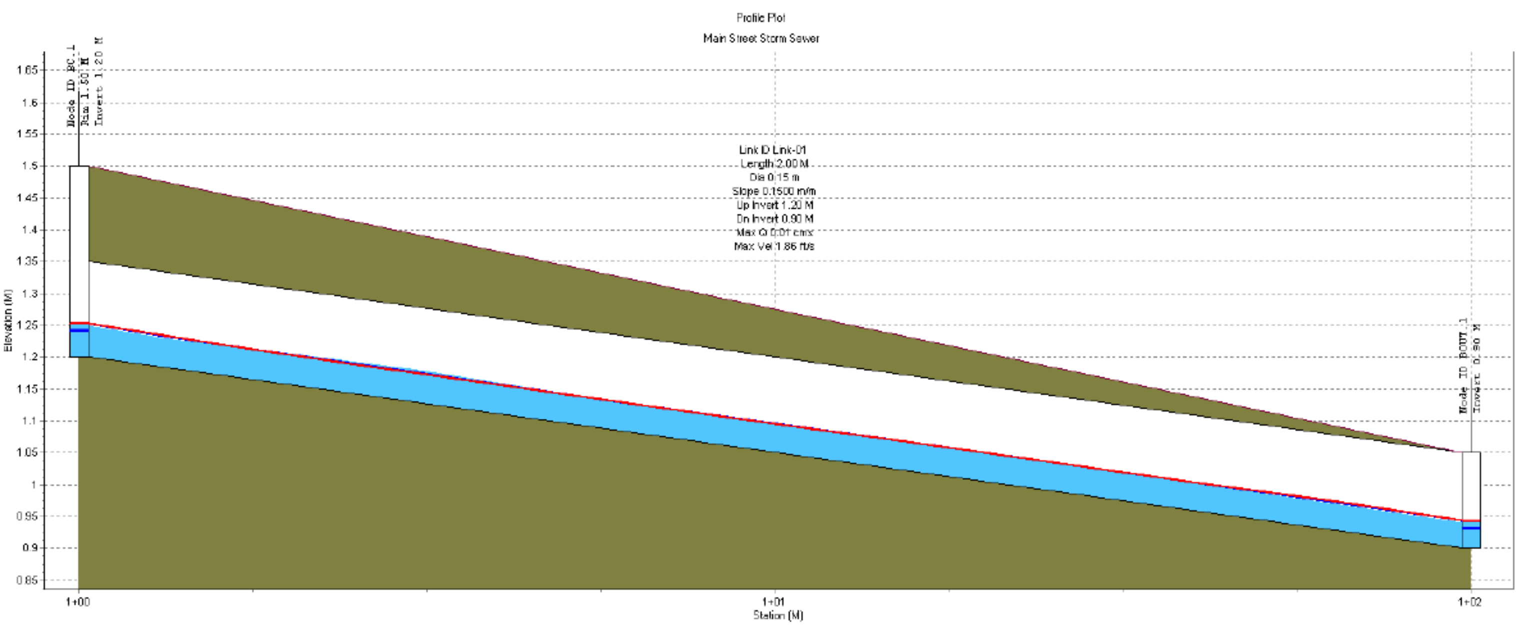
Link ID:	Link-35	Link-36	Link-37
Length (M):	10.55	14.23	13.20
Dia (m):	0.30	0.30	0.30
Slope (m/m):	0.0076	0.0049	0.0045
Up Invert (M):	1.03	0.95	0.88
Dn Invert (M):	0.95	0.88	0.82
Max Q (cms):	0.02	0.05	0.09
Max Vel (ft/s):	0.64	0.85	0.81
Max Depth (m):	0.22	0.24	0.21

Profile Plot

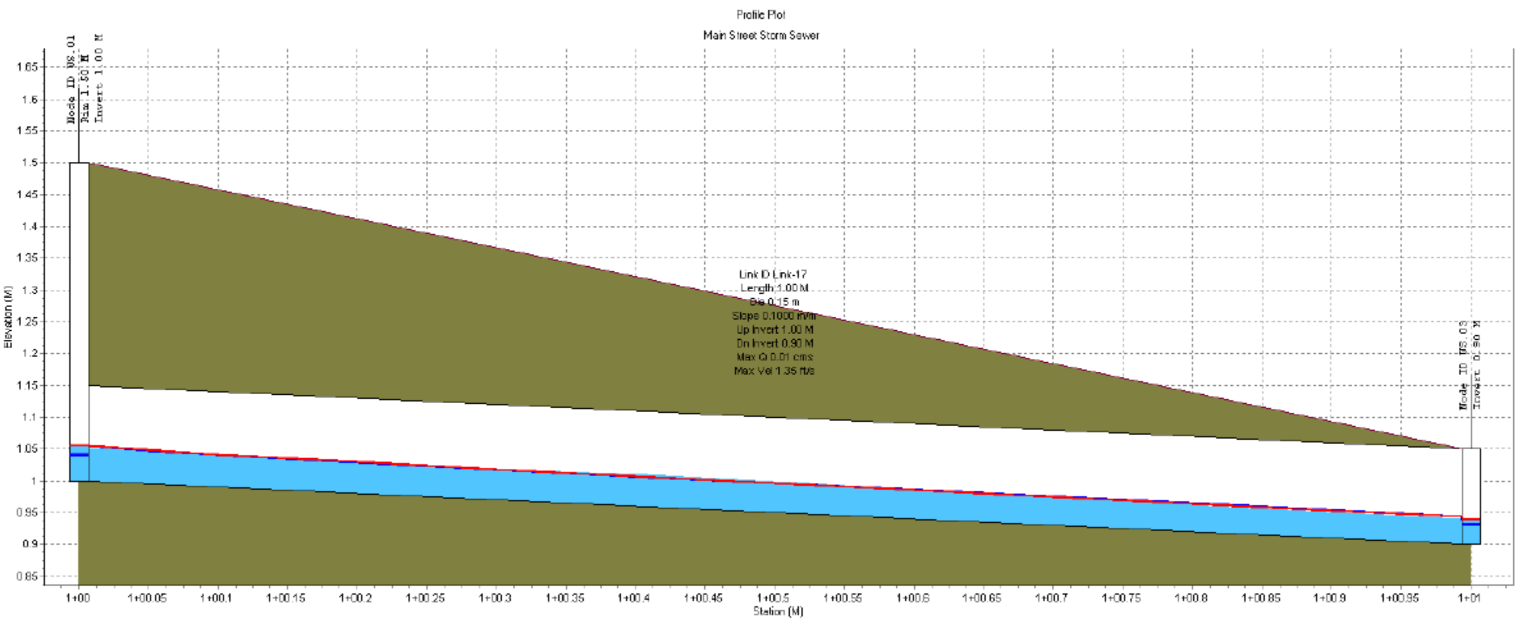
Main Street Storm Sewer



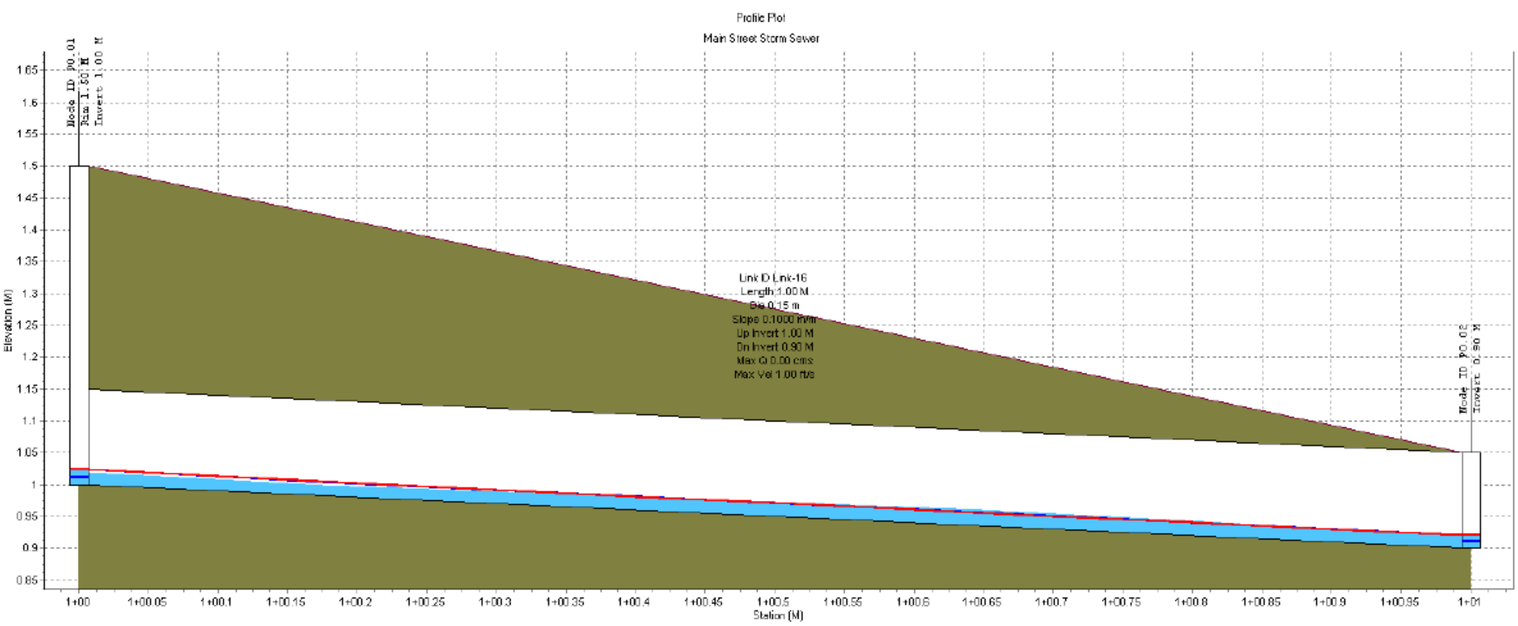
Node ID:	BC.2	BCOUT.2
Rim (M):	1.50	
Invert (M):	1.20	0.90
Min Pipe Cover (m):	0.15	
Max HGL (ft):	1.25	0.94
Link ID:	Link-02	
Length (M):	2.00	
Dia (m):	0.15	
Slope (m/m):	0.1500	
Up Invert (M):	1.20	
Dn Invert (M):	0.90	
Max Q (cms):	0.01	
Max Vel (ft/s):	1.86	
Max Depth (m):	0.05	



Node ID:	BC.1		BOUT.1
Rim (M):	1.50		
Invert (M):	1.20		0.90
Min Pipe Cover (m):	0.15		
Max HGL (ft):	1.25		0.94
Link ID:		Link-01	
Length (M):		2.00	
Dia (m):		0.15	
Slope (m/m):		0.1500	
Up Invert (M):		1.20	
Dn Invert (M):		0.90	
Max Q (cms):		0.01	
Max Vel (ft/s):		1.86	
Max Depth (m):		0.05	

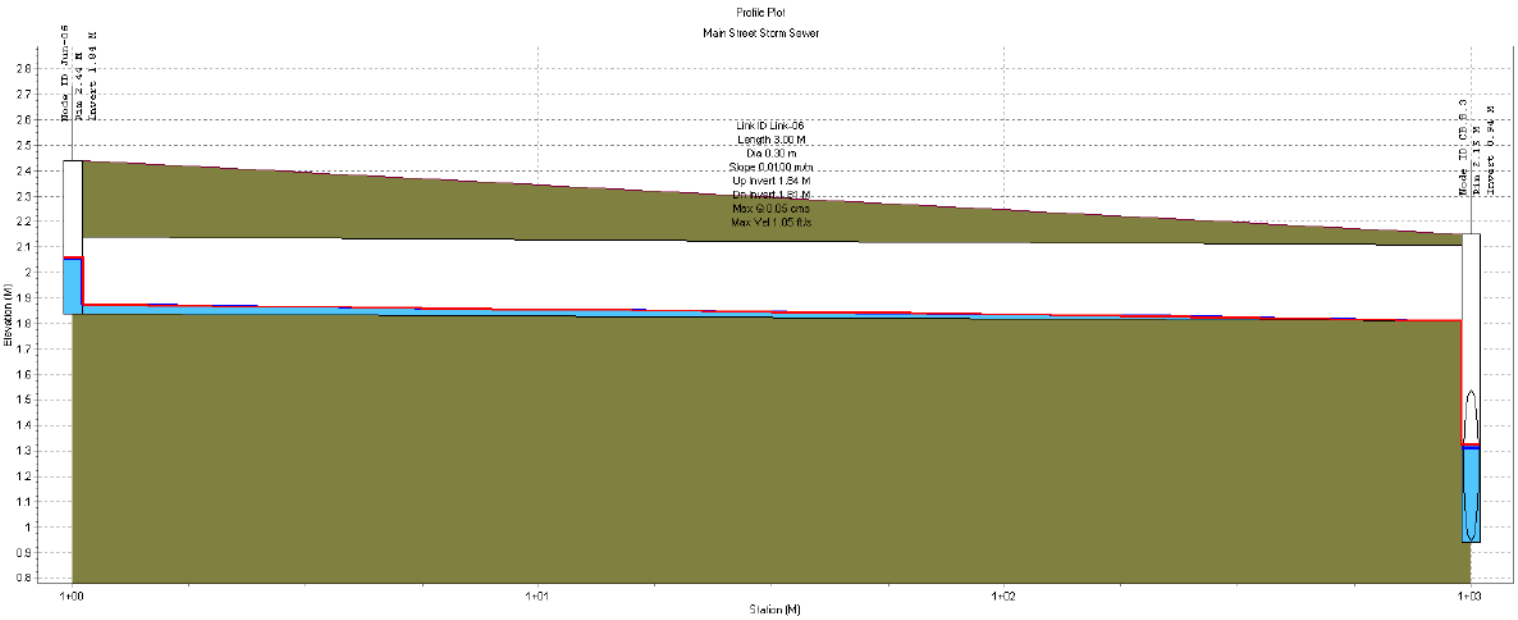


Node ID:	WS.01		WS.03
Rim (M):	1.50		
Invert (M):	1.00		0.90
Min Pipe Cover (m):	0.35		
Max HGL (ft):	1.05		0.94
Link ID:		Link-17	
Length (M):		1.00	
Dia (m):		0.15	
Slope (m/m):		0.1000	
Up Invert (M):		1.00	
Dn Invert (M):		0.90	
Max Q (cms):		0.01	
Max Vel (ft/s):		1.35	
Max Depth (m):		0.05	

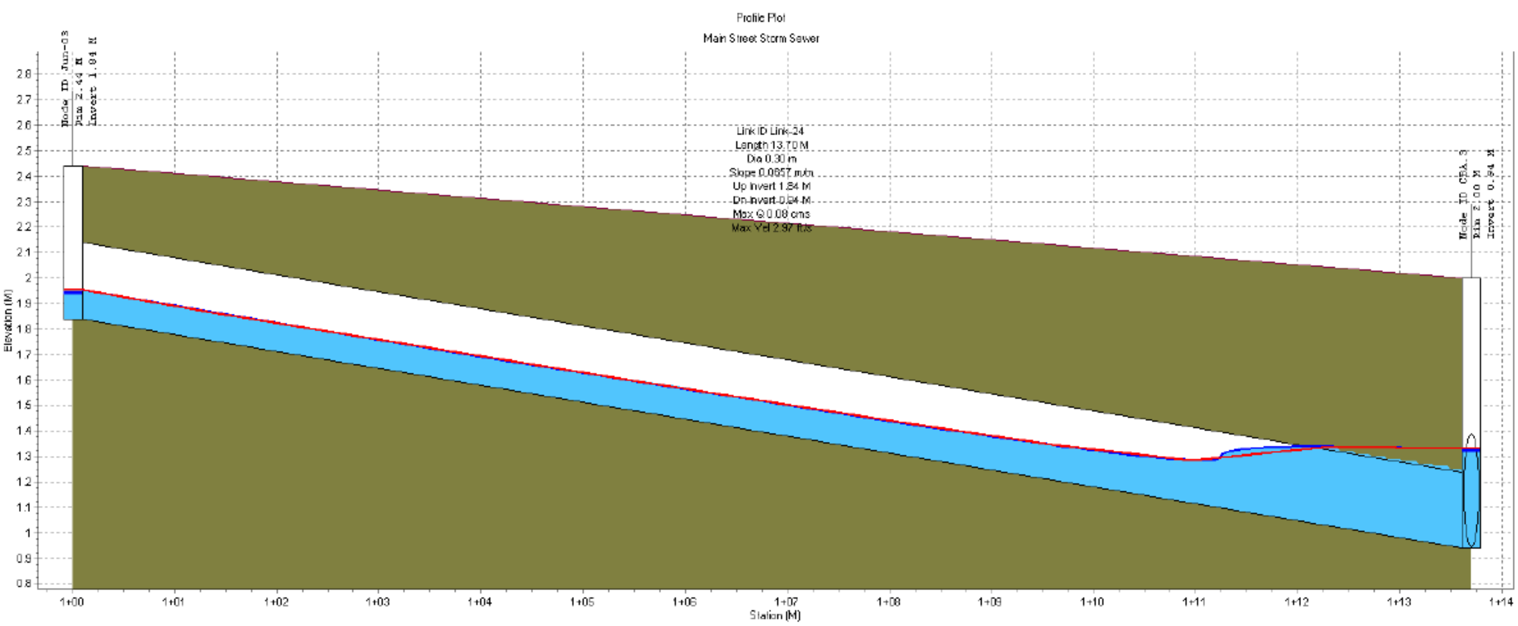


Node ID:	P0.01	P0.02
Rim (M):	1.50	
Invert (M):	1.00	0.90
Min Pipe Cover (m):	0.35	
Max HGL (ft):	1.02	0.92

Link ID:	Link-16
Length (M):	1.00
Dia (m):	0.15
Slope (m/m):	0.1000
Up Invert (M):	1.00
Dn Invert (M):	0.90
Max Q (cms):	0.00
Max Vel (ft/s):	1.00
Max Depth (m):	0.02

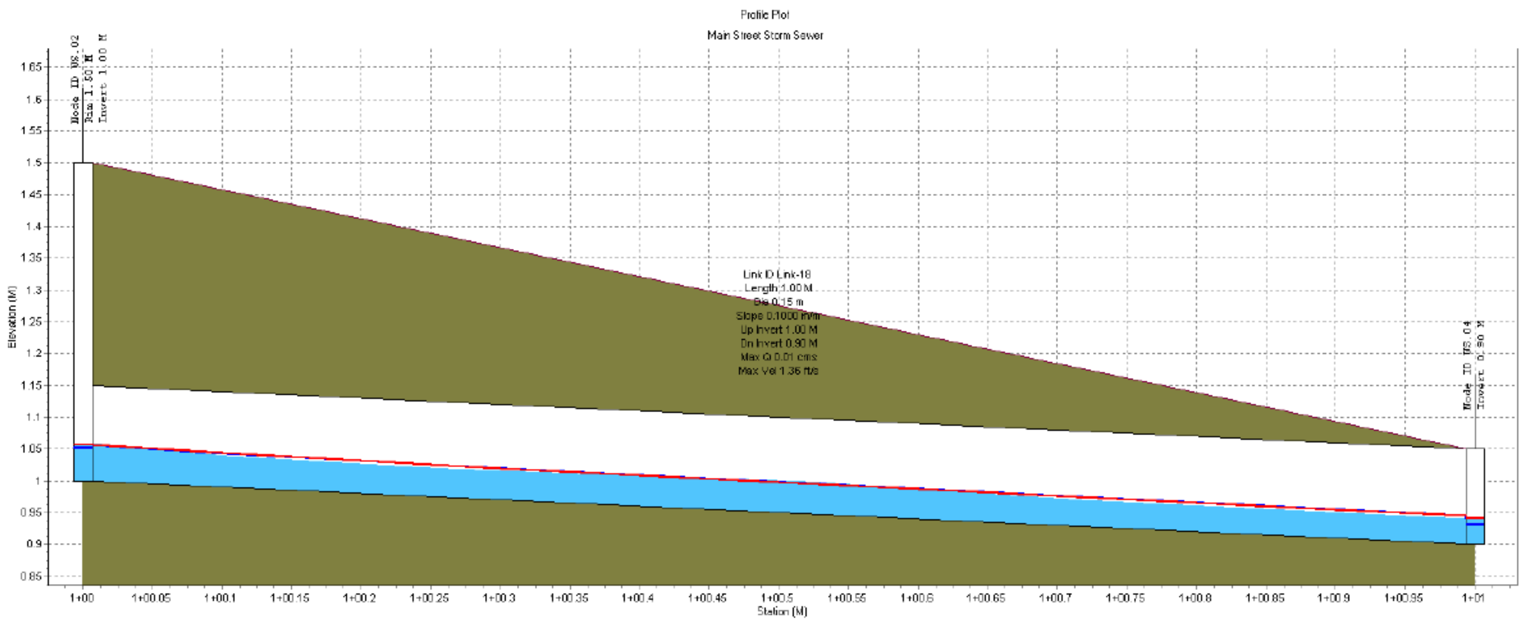


	Jun-06		CB.B.3
Node ID:	Jun-06		CB.B.3
Rim (M):	2.44		2.15
Invert (M):	1.84		0.94
Min Pipe Cover (m):	0.30		0.04
Max HGL (ft):	2.06		1.32
Link ID:		Link-06	
Length (M):		3.00	
Dia (m):		0.30	
Slope (m/m):		0.0100	
Up Invert (M):		1.84	
Dn Invert (M):		1.81	
Max Q (cms):		0.05	
Max Vel (ft/s):		1.05	
Max Depth (m):		0.19	



	Jun-03		CBA.3
Node ID:	Jun-03		CBA.3
Rim (M):	2.44		2.00
Invert (M):	1.84		0.94
Min Pipe Cover (m):	0.30		0.61
Max HGL (ft):	2.01		1.33
Link ID:		Link-24	
Length (M):		13.70	
Dia (m):		0.30	
Slope (m/m):		0.0657	
Up Invert (M):		1.84	
Dn Invert (M):		0.94	
Max Q (cms):		0.08	
Max Vel (ft/s):		2.97	
Max Depth (m):		0.21	

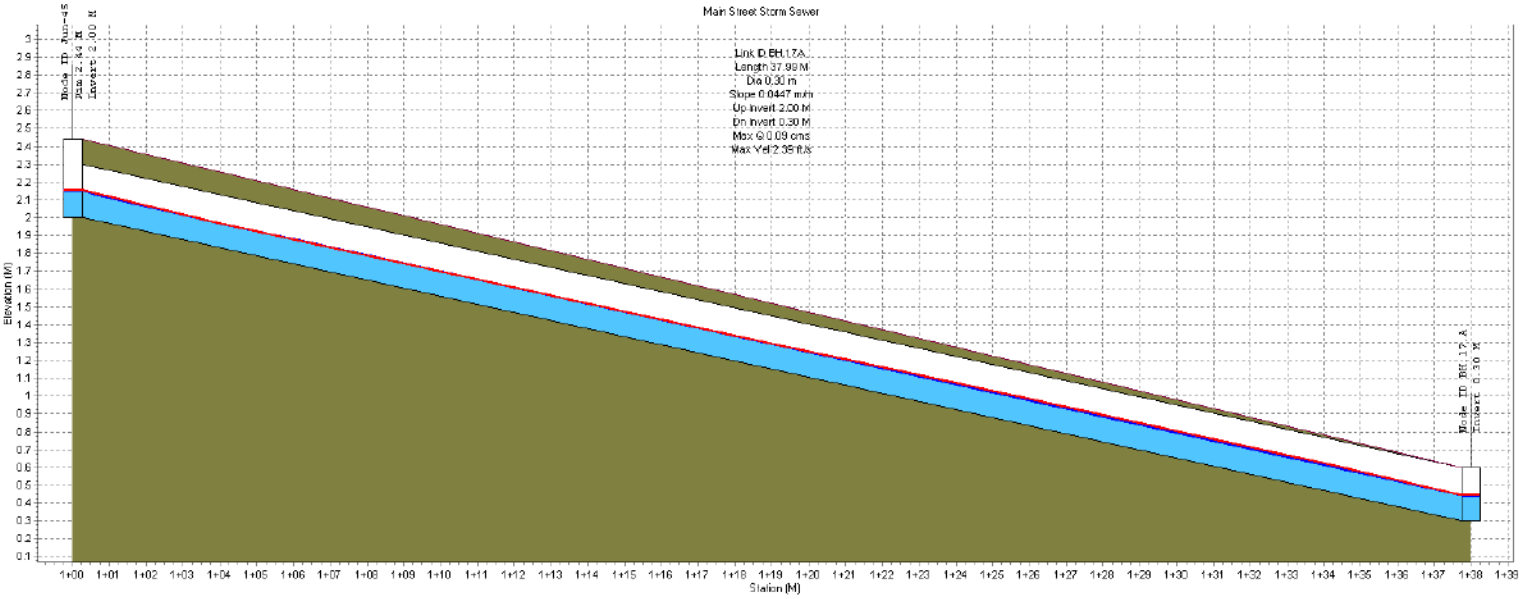
Autodesk Storm and Sanitary Analysis



Node ID:	WS.02		WS.04
Rim (M):	1.50		
Invert (M):	1.00		0.90
Min Pipe Cover (m):	0.35		
Max HGL (ft):	1.06		0.94
Link ID:		Link-18	
Length (M):		1.00	
Dia (m):		0.15	
Slope (m/m):		0.1000	
Up Invert (M):		1.00	
Dn Invert (M):		0.90	
Max Q (cms):		0.01	
Max Vel (ft/s):		1.36	
Max Depth (m):		0.05	

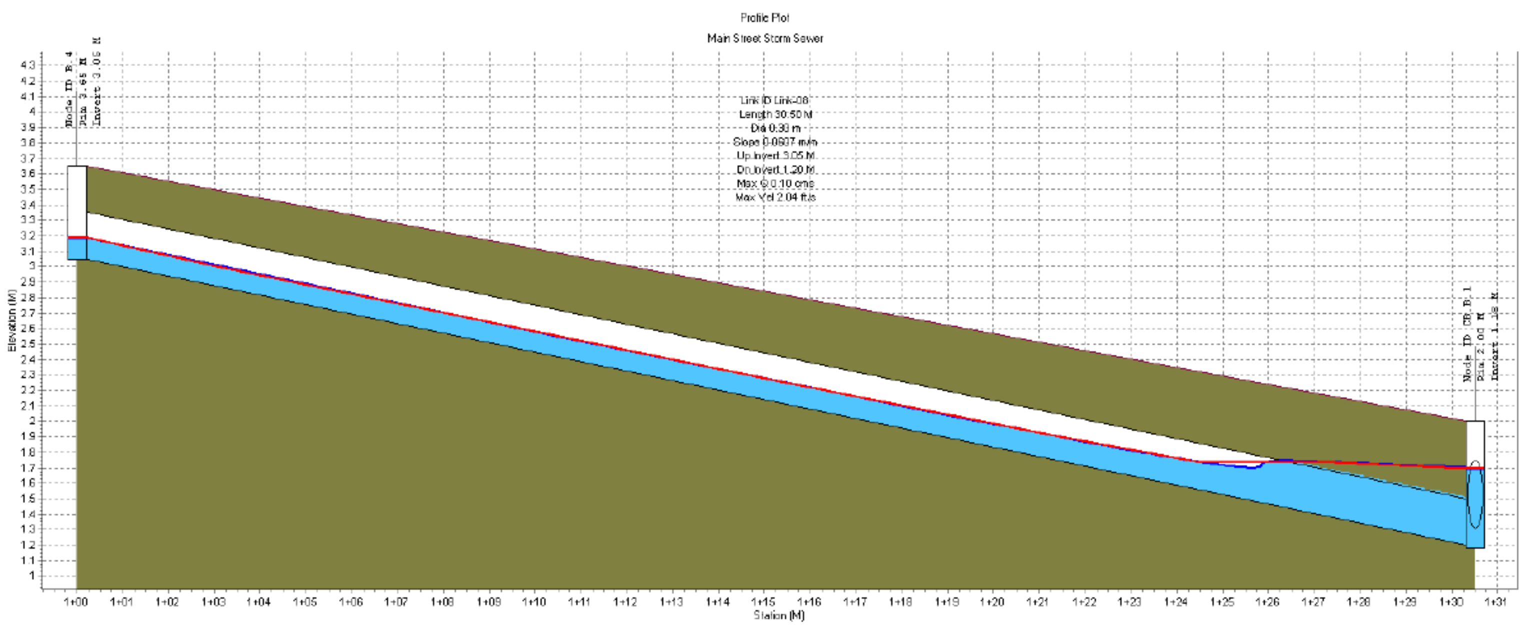
Profile Plot

Main Street Storm Sewer



Node ID:	Jun-45	BH.17.A
Rim (M):	2.44	
Invert (M):	2.00	0.30
Min Pipe Cover (m):	0.14	
Max HGL (ft):	2.16	0.45
Link ID:	BH.17A	
Length (M):	37.99	
Dia (m):	0.30	
Slope (m/m):	0.0447	
Up Invert (M):	2.00	
Dn Invert (M):	0.30	
Max Q (cms):	0.09	
Max Vel (ft/s):	2.39	
Max Depth (m):	0.15	

Autodesk Storm and Sanitary Analysis

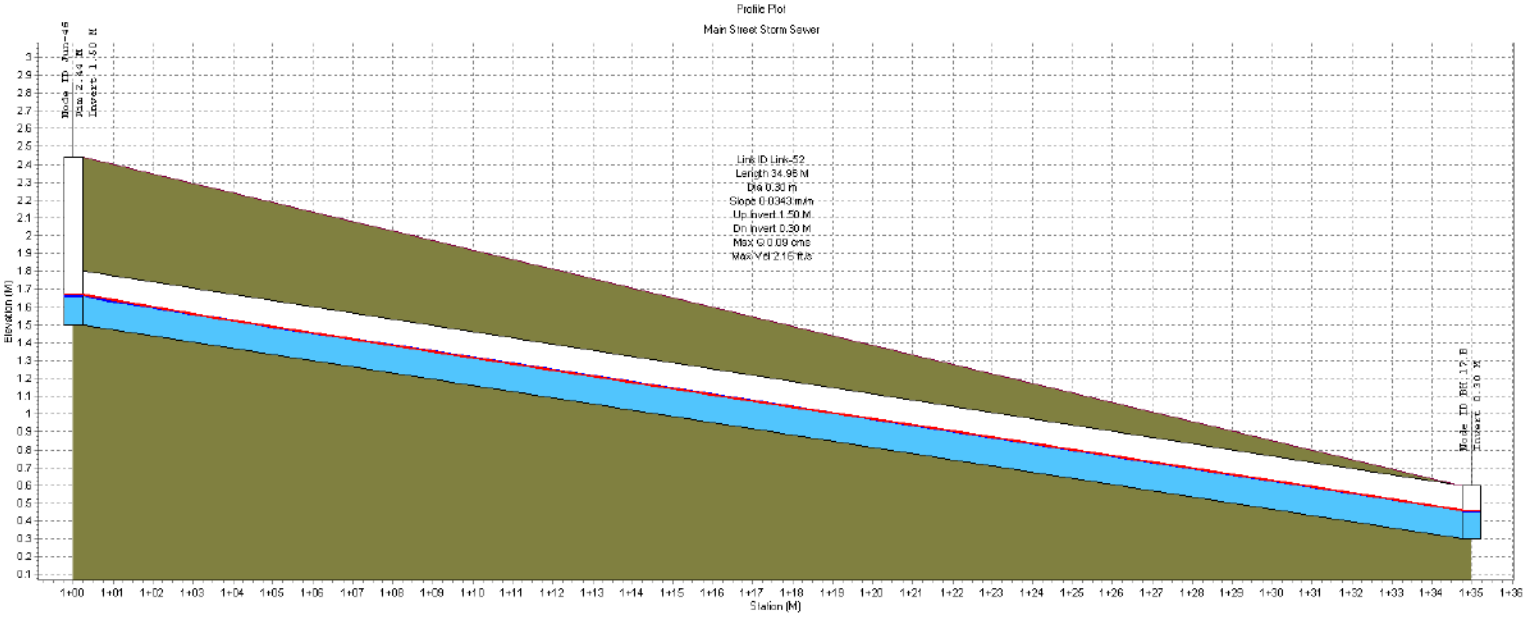


Node ID:	B.4	CB.B.1
Rim (M):	3.65	2.00
Invert (M):	3.05	1.18
Min Pipe Cover (m):	0.30	0.22
Max HGL (ft):	3.20	1.70

Link ID:	Link-08
Length (M):	30.50
Dia (m):	0.30
Slope (m/m):	0.0607
Up Invert (M):	3.05
Dn Invert (M):	1.20
Max Q (cms):	0.10
Max Vel (ft/s):	2.04
Max Depth (m):	0.22

Profile Plot

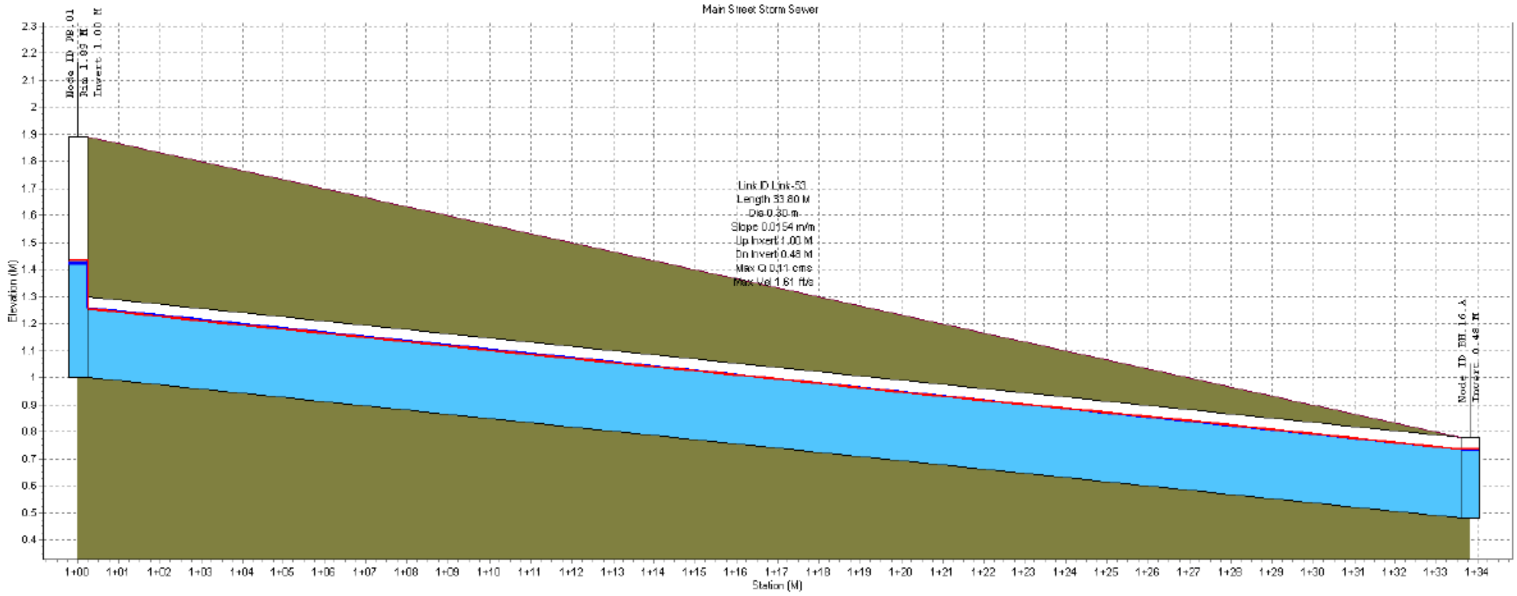
Main Street Storm Sewer



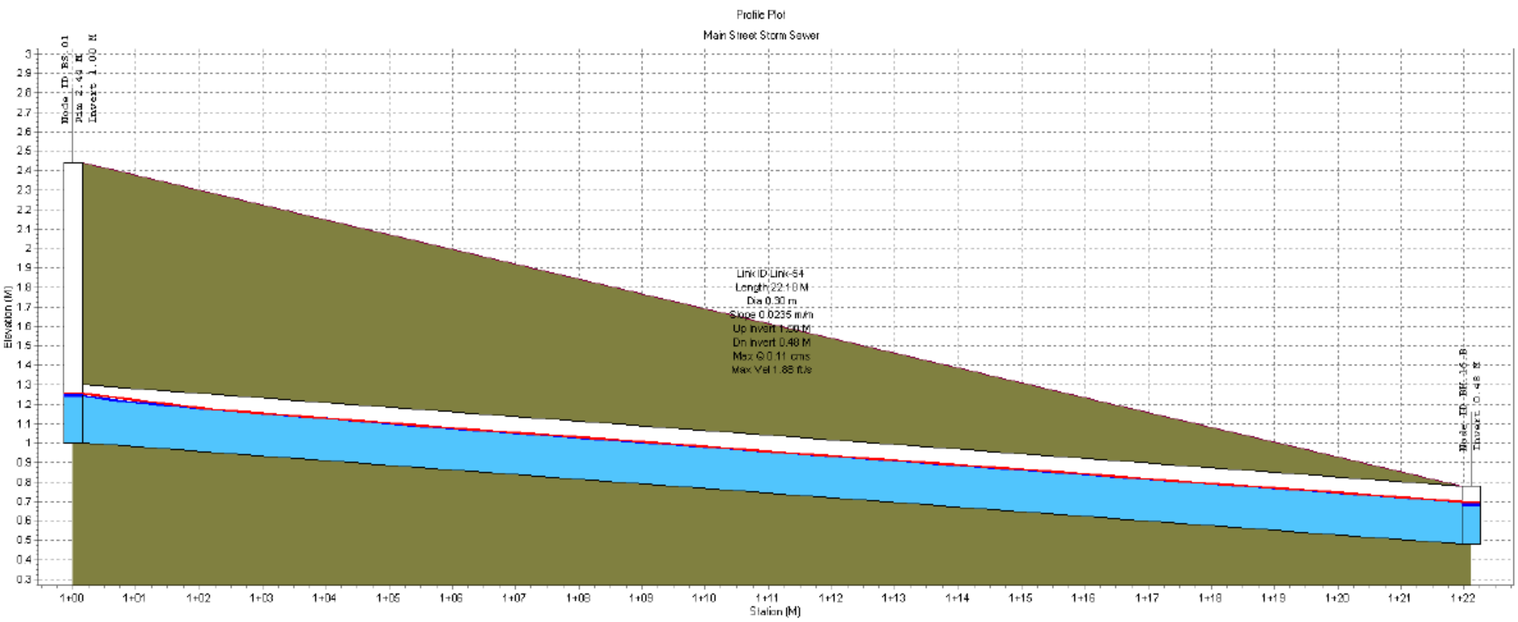
Node ID:	Jun-46	BH 17.B
Rim (M):	2.44	
Invert (M):	1.50	0.30
Min Pipe Cover (m):	0.64	
Max HGL (ft):	1.67	0.46
Link ID:	Link-52	
Length (M):	34.96	
Dia (m):	0.30	
Slope (m/m):	0.0343	
Up Invert (M):	1.50	
Dn Invert (M):	0.30	
Max Q (cms):	0.09	
Max Vel (ft/s):	2.16	
Max Depth (m):	0.16	

Profile Plot

Main Street Storm Sewer

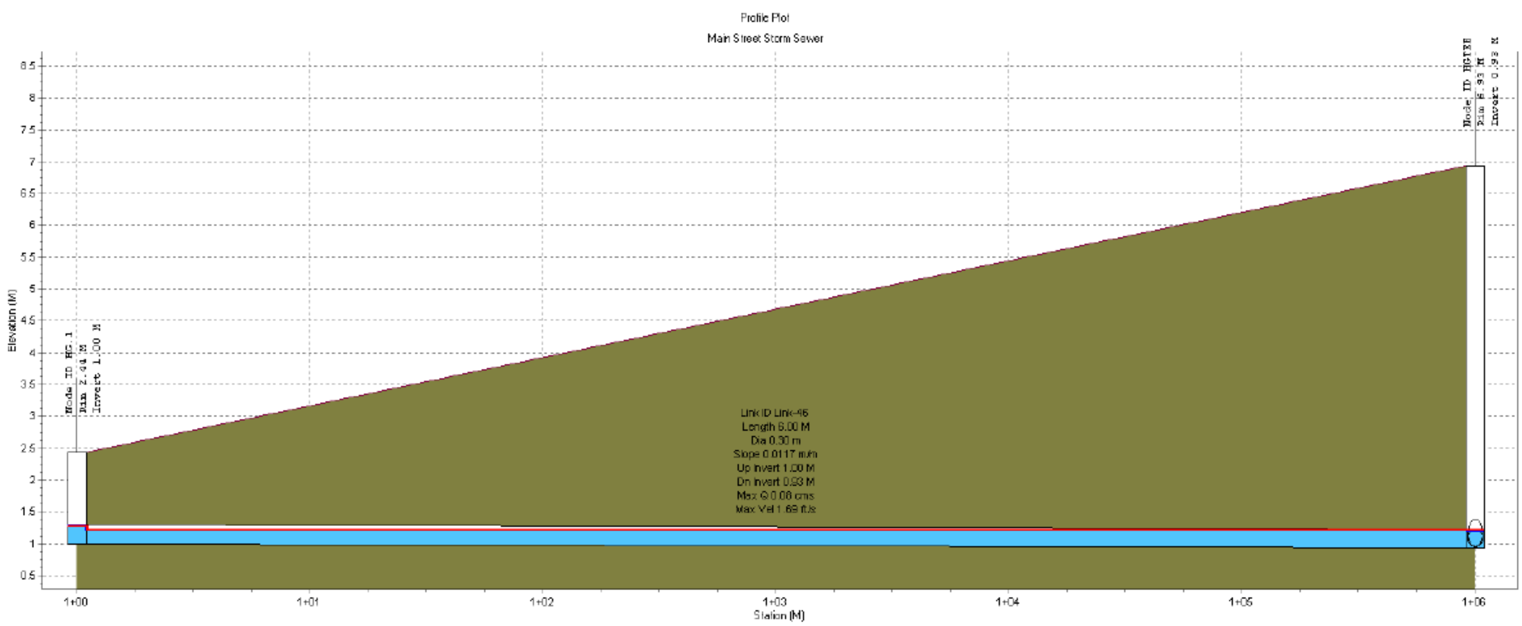


Node ID:	PB.01	BH.16.A
Rim (M):	1.89	
Invert (M):	1.00	0.48
Min Pipe Cover (m):	0.59	
Max HGL (ft):	1.89	0.74
Link ID:	Link-53	
Length (M):	33.80	
Dia (m):	0.30	
Slope (m/m):	0.0154	
Up Invert (M):	1.00	
Dn Invert (M):	0.48	
Max Q (cms):	0.11	
Max Vel (ft/s):	1.61	
Max Depth (m):	0.28	



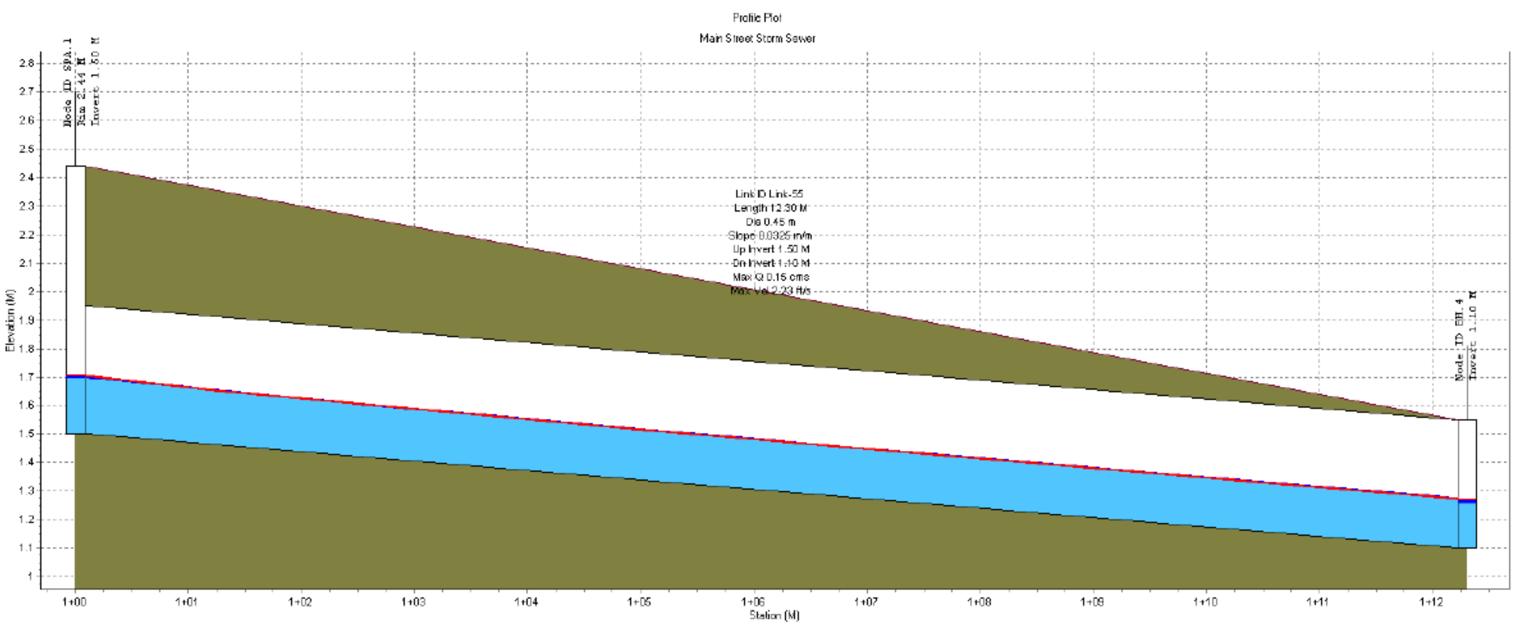
Node ID:	BS.01	BH.16.B
Rim (M):	2.44	
Invert (M):	1.00	0.48
Min Pipe Cover (m):	1.14	
Max HGL (ft):	1.27	0.70

Link ID:	Link-54
Length (M):	22.10
Dia (m):	0.30
Slope (m/m):	0.0235
Up Invert (M):	1.00
Dn Invert (M):	0.48
Max Q (cms):	0.11
Max Vel (ft/s):	1.88
Max Depth (m):	0.23



Node ID:	HG.1	HGTEE
Rim (M):	2.44	6.93
Invert (M):	1.00	0.93
Min Pipe Cover (m):	1.14	5.55
Max HGL (ft):	1.29	1.21

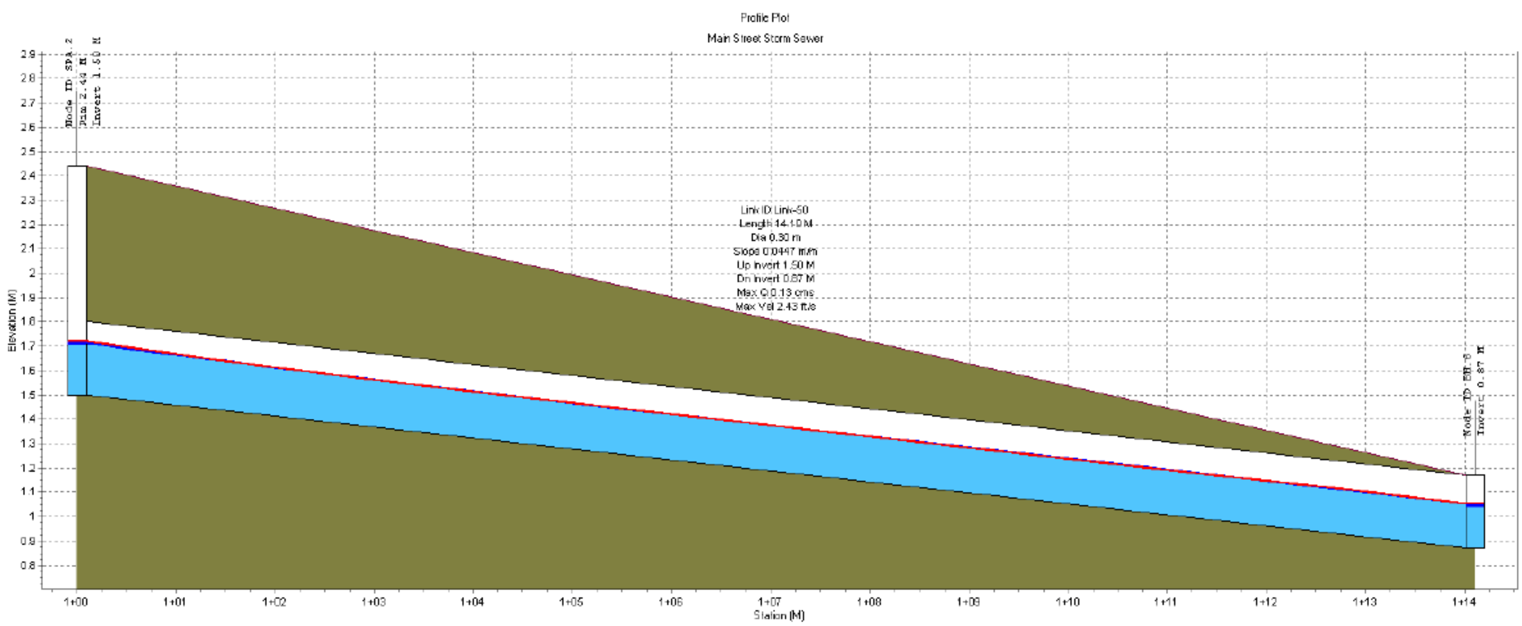
Link ID:	Link-46
Length (M):	6.00
Dia (m):	0.30
Slope (m/m):	0.0117
Up Invert (M):	1.00
Dn Invert (M):	0.93
Max Q (cms):	0.08
Max Vel (ft/s):	1.69
Max Depth (m):	0.28



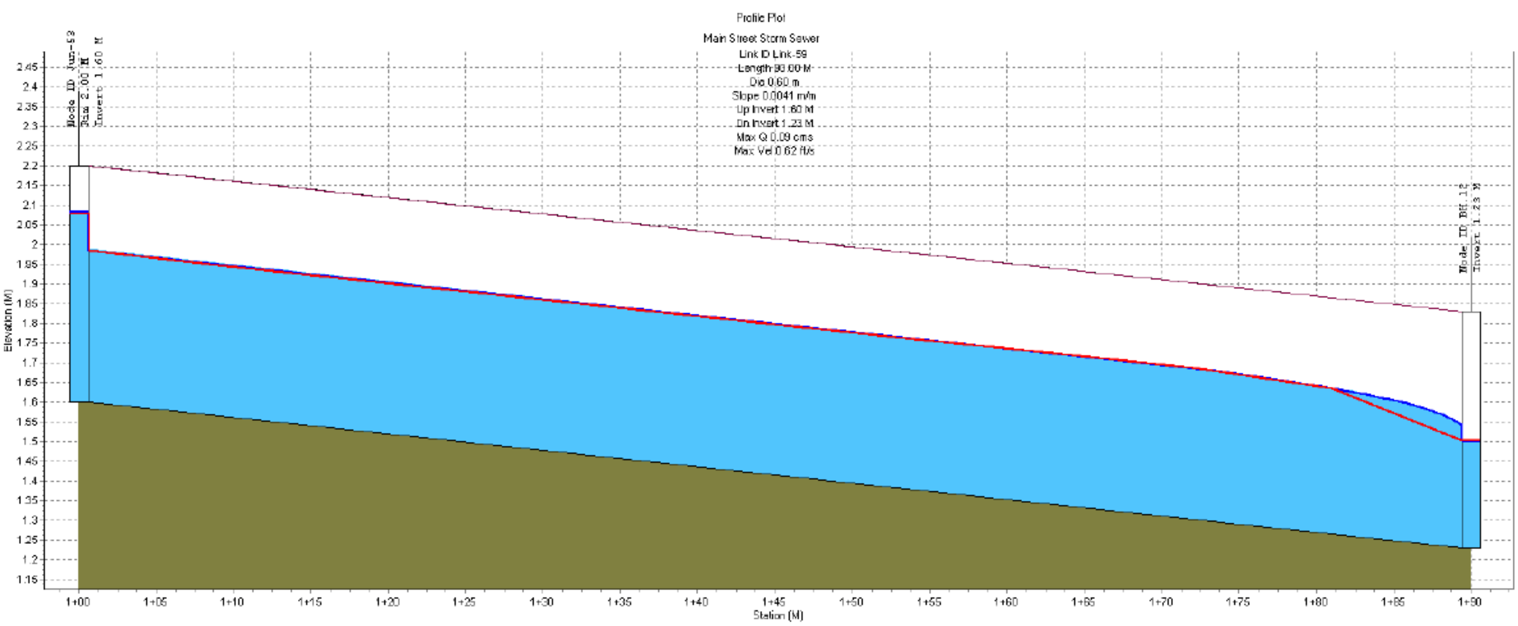
Node ID:	SPA.1	BH 4
Rim (M):	2.44	
Invert (M):	1.50	1.10
Min Pipe Cover (m):	0.49	
Max HGL (ft):	1.73	1.28

Link ID:	Link-55
Length (M):	12.30
Dia (m):	0.45
Slope (m/m):	0.0325
Up Invert (M):	1.50
Dn Invert (M):	1.10
Max Q (cms):	0.15
Max Vel (ft/s):	2.23
Max Depth (m):	0.19

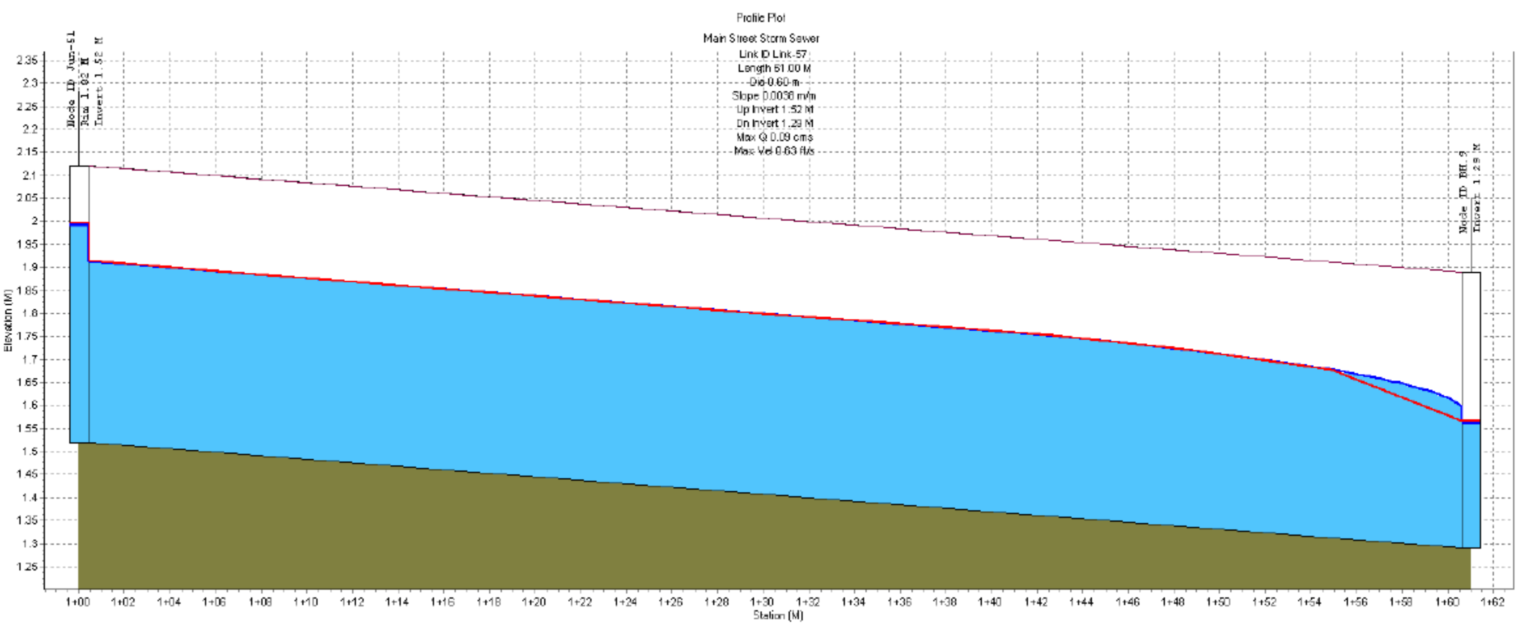
Autodesk Storm and Sanitary Analysis



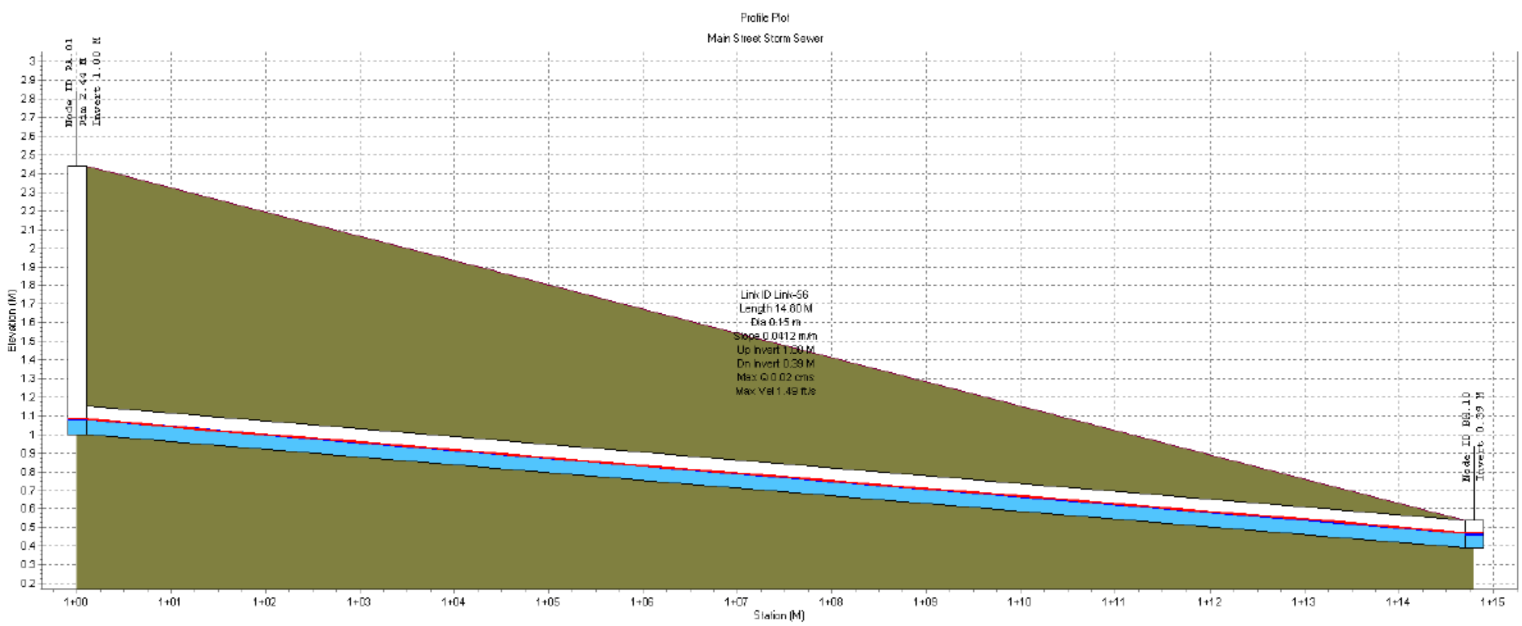
Node ID:	SPA 2	BH 6
Rim (M):	2.44	
Invert (M):	1.50	0.87
Min Pipe Cover (m):	0.64	
Max HGL (ft):	1.74	1.06
Link ID:	Link-50	
Length (M):	14.10	
Dia (m):	0.30	
Slope (m/m):	0.0447	
Up Invert (M):	1.50	
Dn Invert (M):	0.87	
Max Q (cms):	0.13	
Max Vel (ft/s):	2.43	
Max Depth (m):	0.20	



Node ID:	Jun-53	BH 12
Rim (M):	2.00	
Invert (M):	1.60	1.23
Min Pipe Cover (m):	0.00	
Max HGL (ft):	2.09	1.51
Link ID:	Link-59	
Length (M):	90.00	
Dia (m):	0.60	
Slope (m/m):	0.0041	
Up Invert (M):	1.60	
Dn Invert (M):	1.23	
Max Q (cms):	0.09	
Max Vel (ft/s):	0.62	
Max Depth (m):	0.38	



Node ID:	Jun-51	BH.9
Rim (M):	1.82	
Invert (M):	1.52	1.29
Min Pipe Cover (m):	0.00	
Max HGL (ft):	2.00	1.57
Link ID:	Link-57	
Length (M):	61.00	
Dia (m):	0.60	
Slope (m/m):	0.0038	
Up Invert (M):	1.52	
Dn Invert (M):	1.29	
Max Q (cms):	0.09	
Max Vel (ft/s):	0.63	
Max Depth (m):	0.38	



Node ID:	RA.01		BH.10
Rim (M):	2.44		
Invert (M):	1.00		0.39
Min Pipe Cover (m):	1.29		
Max HGL (ft):	1.09		0.47
Link ID:		Link-56	
Length (M):		14.80	
Dia (m):		0.15	
Slope (m/m):		0.0412	
Up Invert (M):		1.00	
Dn Invert (M):		0.39	
Max Q (cms):		0.02	
Max Vel (ft/s):		1.49	
Max Depth (m):		0.08	

APPENDIX C
Rain intensity NOOA Atlas 14

2 Sun Ct. • Peachtree Corners, Georgia 30093 • (404) 266-1400 • Fax (404) 364-0895

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES

Data description

Data type: Precipitation intensity **Units:** English **Time series type:** Partial duration

Select location

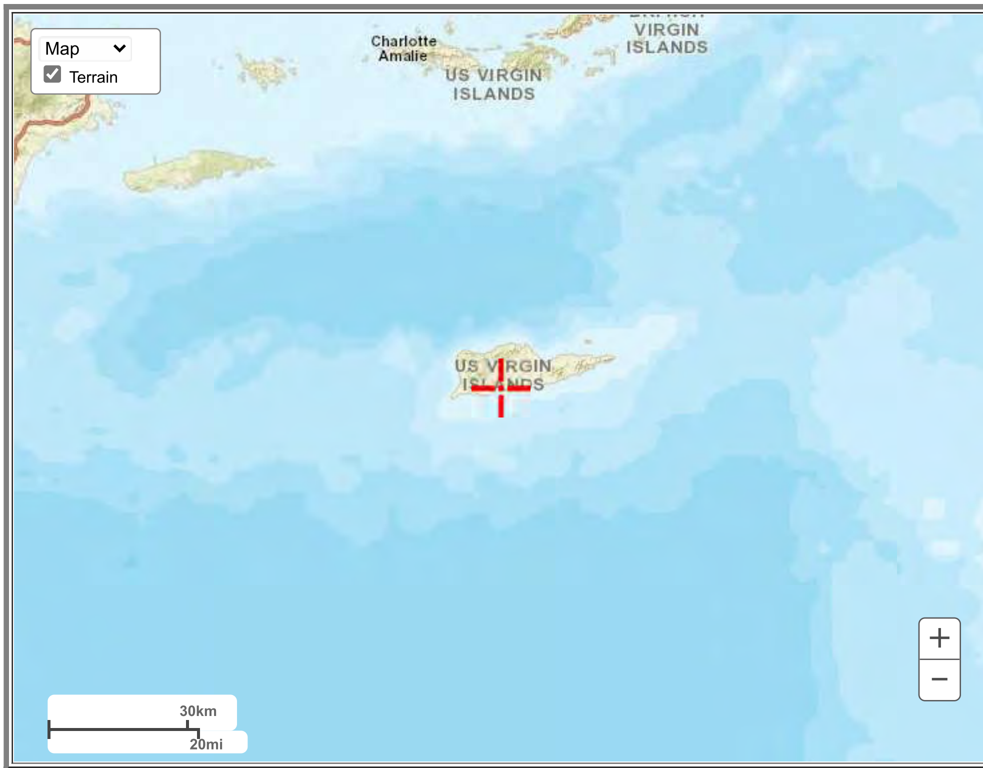
1. Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude: 17.6947 Longitude: -64.799 Submit

b) By station (list of PR stations): Select station

c) By address Search

2. Use map:



a) Select location
Move crosshair or double click

b) Click on station icon
Show stations on map

Map bookmarks:

Overview
Puerto Rico
US Virgin Islands

Location information:
Name: Southcentral, Virgin Islands, VIR*
Latitude: 17.6947°
Longitude: -64.7990°
Elevation: 2 ft **

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 3, Version 4

PF tabular PF graphical Supplementary information Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**4.31** (3.96-4.92)	**5.60** (5.06-6.25)	**6.83** (6.18-7.61)	**7.70** (6.86-8.58)	**8.77** (7.58-10.0)	**9.59** (8.17-11.0)	**10.4** (8.72-12.3)	**11.1** (9.22-13.4)	**12.1** (9.78-15.0)	**12.8** (10.2-16.3)
10-min	**2.95** (2.71-3.37)	**3.83** (3.46-4.27)	**4.66** (4.22-5.20)	**5.27** (4.69-5.87)	**5.99** (5.18-6.85)	**6.55** (5.59-7.54)	**7.07** (5.96-8.38)	**7.58** (6.29-9.14)	**8.27** (6.68-10.3)	**8.77** (6.96-11.1)
15-min	**2.52** (2.31-2.88)	**3.27** (2.96-3.66)	**3.99** (3.61-4.45)	**4.51** (4.02-5.02)	**5.13** (4.44-5.86)	**5.61** (4.78-6.45)	**6.05** (5.10-7.16)	**6.49** (5.39-7.82)	**7.07** (5.72-8.78)	**7.51** (5.96-9.54)
30-min	**2.02** (1.85-2.31)	**2.62** (2.37-2.93)	**3.19** (2.89-3.56)	**3.61** (3.21-4.02)	**4.11** (3.55-4.69)	**4.49** (3.82-5.17)	**4.84** (4.08-5.74)	**5.19** (4.31-6.26)	**5.66** (4.58-7.03)	**6.01** (4.77-7.63)
60-min	**1.50** (1.37-1.71)	**1.94** (1.76-2.17)	**2.37** (2.14-2.64)	**2.68** (2.38-2.98)	**3.05** (2.63-3.48)	**3.33** (2.84-3.83)	**3.59** (3.03-4.26)	**3.85** (3.20-4.64)	**4.20** (3.40-5.21)	**4.46** (3.54-5.66)
2-hr	**0.892** (0.836-1.06)	**1.20** (1.07-1.37)	**1.52** (1.36-1.74)	**1.77** (1.54-2.02)	**2.10** (1.76-2.47)	**2.35** (1.92-2.81)	**2.60** (2.08-3.21)	**2.85** (2.24-3.64)	**3.20** (2.41-4.24)	**3.47** (2.55-4.75)
3-hr	**0.701**	**0.907**	**1.16**	**1.34**	**1.58**	**1.76**	**1.94**	**2.13**	**2.38**	**2.58**

	(0.628-0.798)	(0.812-1.03)	(1.03-1.31)	(1.17-1.52)	(1.33-1.85)	(1.45-2.10)	(1.58-2.38)	(1.70-2.69)	(1.83-3.12)	(1.94-3.47)
6-hr	**0.427** (0.373-0.496)	**0.562** (0.492-0.656)	**0.768** (0.661-0.894)	**0.932** (0.778-1.09)	**1.16** (0.920-1.41)	**1.34** (1.03-1.67)	**1.53** (1.14-1.98)	**1.73** (1.25-2.33)	**2.00** (1.38-2.83)	**2.23** (1.48-3.26)
12-hr	**0.256** (0.217-0.308)	**0.346** (0.294-0.416)	**0.505** (0.422-0.602)	**0.635** (0.512-0.759)	**0.818** (0.625-1.02)	**0.971** (0.718-1.24)	**1.13** (0.808-1.52)	**1.31** (0.896-1.83)	**1.56** (1.00-2.30)	**1.76** (1.09-2.73)
24-hr	**0.144** (0.120-0.175)	**0.196** (0.164-0.238)	**0.296** (0.245-0.358)	**0.380** (0.312-0.456)	**0.505** (0.407-0.608)	**0.610** (0.487-0.732)	**0.725** (0.573-0.872)	**0.852** (0.664-1.03)	**1.04** (0.791-1.25)	**1.19** (0.897-1.44)
2-day	**0.090** (0.075-0.109)	**0.123** (0.102-0.148)	**0.184** (0.152-0.221)	**0.234** (0.191-0.280)	**0.307** (0.246-0.369)	**0.368** (0.292-0.442)	**0.433** (0.340-0.520)	**0.504** (0.390-0.609)	**0.606** (0.460-0.736)	**0.690** (0.515-0.839)
3-day	**0.061** (0.052-0.074)	**0.084** (0.071-0.101)	**0.126** (0.106-0.151)	**0.160** (0.133-0.191)	**0.210** (0.171-0.250)	**0.250** (0.202-0.298)	**0.294** (0.234-0.351)	**0.341** (0.268-0.409)	**0.409** (0.316-0.493)	**0.465** (0.354-0.562)
4-day	**0.047** (0.040-0.057)	**0.065** (0.056-0.078)	**0.097** (0.082-0.116)	**0.124** (0.104-0.147)	**0.161** (0.133-0.190)	**0.192** (0.157-0.226)	**0.225** (0.181-0.266)	**0.260** (0.208-0.309)	**0.311** (0.244-0.372)	**0.353** (0.273-0.423)
7-day	**0.029** (0.025-0.036)	**0.041** (0.034-0.049)	**0.061** (0.051-0.073)	**0.078** (0.065-0.093)	**0.102** (0.084-0.122)	**0.122** (0.099-0.145)	**0.144** (0.115-0.172)	**0.167** (0.132-0.200)	**0.201** (0.156-0.243)	**0.229** (0.176-0.278)
10-day	**0.023** (0.019-0.027)	**0.031** (0.026-0.037)	**0.045** (0.039-0.054)	**0.057** (0.048-0.068)	**0.074** (0.062-0.088)	**0.088** (0.072-0.104)	**0.103** (0.084-0.122)	**0.120** (0.096-0.142)	**0.143** (0.112-0.170)	**0.162** (0.126-0.194)
20-day	**0.014** (0.012-0.017)	**0.019** (0.017-0.022)	**0.027** (0.023-0.031)	**0.033** (0.028-0.038)	**0.041** (0.035-0.047)	**0.047** (0.040-0.055)	**0.054** (0.045-0.063)	**0.061** (0.051-0.072)	**0.071** (0.058-0.086)	**0.081** (0.065-0.098)
30-day	**0.011** (0.010-0.013)	**0.015** (0.013-0.017)	**0.020** (0.018-0.023)	**0.024** (0.021-0.027)	**0.029** (0.025-0.033)	**0.033** (0.028-0.037)	**0.037** (0.032-0.042)	**0.041** (0.035-0.048)	**0.047** (0.040-0.058)	**0.054** (0.045-0.066)
45-day	**0.009** (0.008-0.010)	**0.012** (0.011-0.014)	**0.016** (0.014-0.018)	**0.018** (0.016-0.021)	**0.022** (0.019-0.024)	**0.024** (0.021-0.027)	**0.027** (0.023-0.030)	**0.029** (0.026-0.033)	**0.033** (0.028-0.039)	**0.037** (0.032-0.044)
60-day	**0.008** (0.007-0.009)	**0.011** (0.009-0.012)	**0.013** (0.012-0.015)	**0.016** (0.014-0.018)	**0.019** (0.016-0.021)	**0.021** (0.018-0.023)	**0.023** (0.020-0.026)	**0.025** (0.022-0.028)	**0.028** (0.024-0.032)	**0.030** (0.026-0.034)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

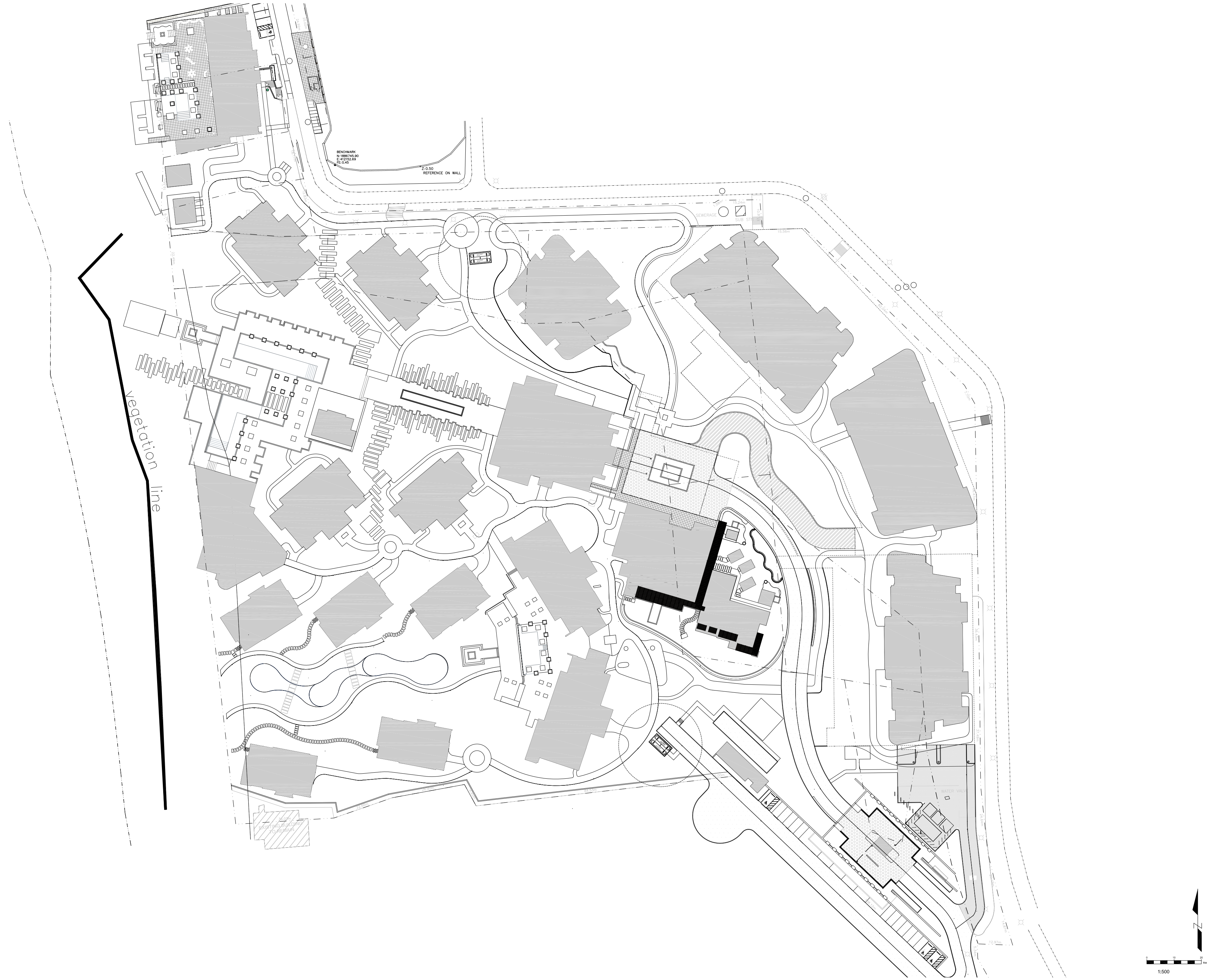
Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates Submit

APPENDIX D

Figures:

Figure 1.1 Proposed Site Plan
Figure 1.2 Antigua Flood Map
Figure 1.3 Aerial Photo
Figure 1.4 Survey Plan
Figure 2.1 Basin Delineation Pre Dev
Figure 2.2 Basin Delineation Post Dev
Figure 3.1 HSG Map Antigua
Figure 4.1 Sub Basin Drainage System
Figure 4.2 Sub Basin Drainage System



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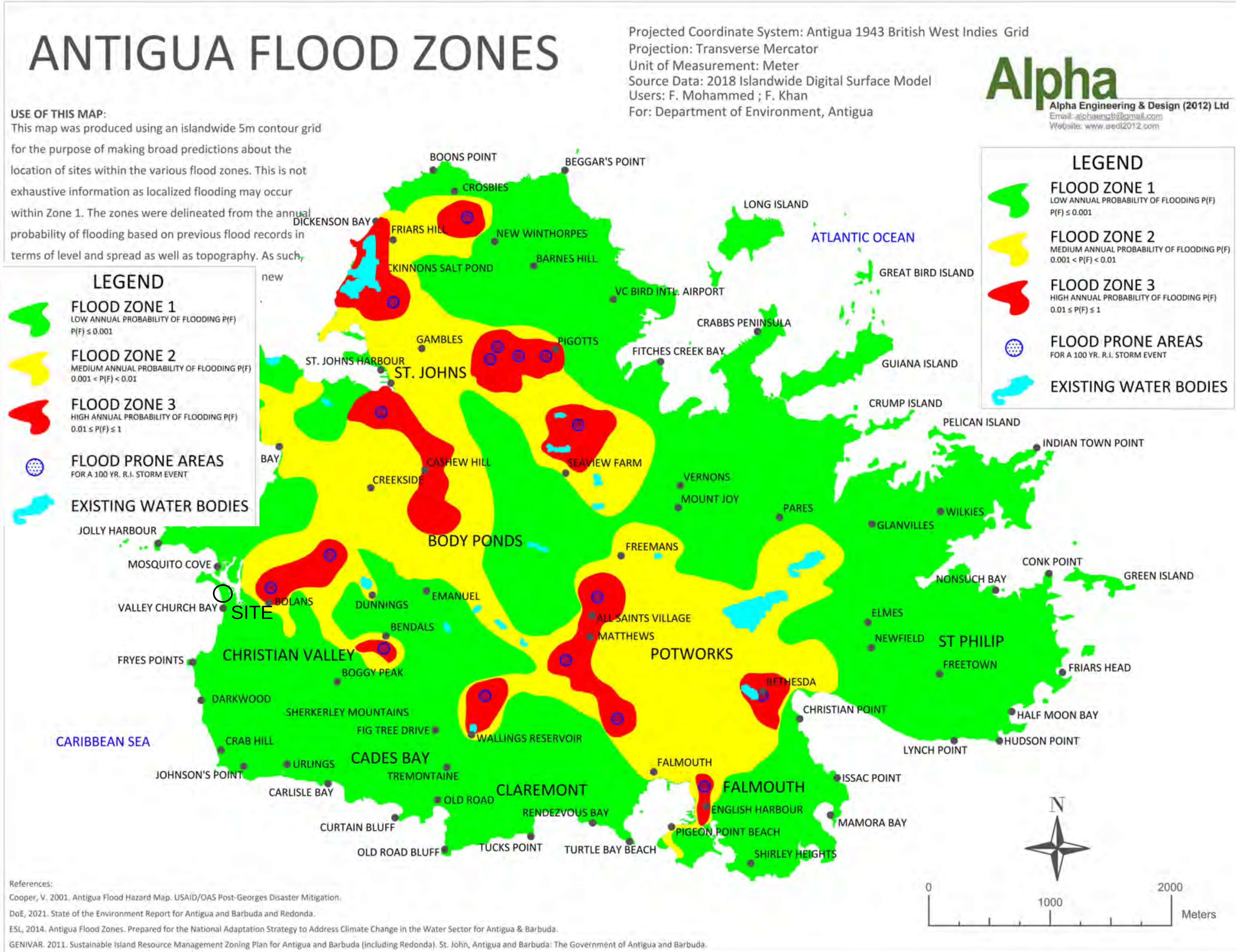
Sketch No.: FIGURE 1.1	Project: NIKKI BEACH RESORT
Title: DEVELOPMENT AREA	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	



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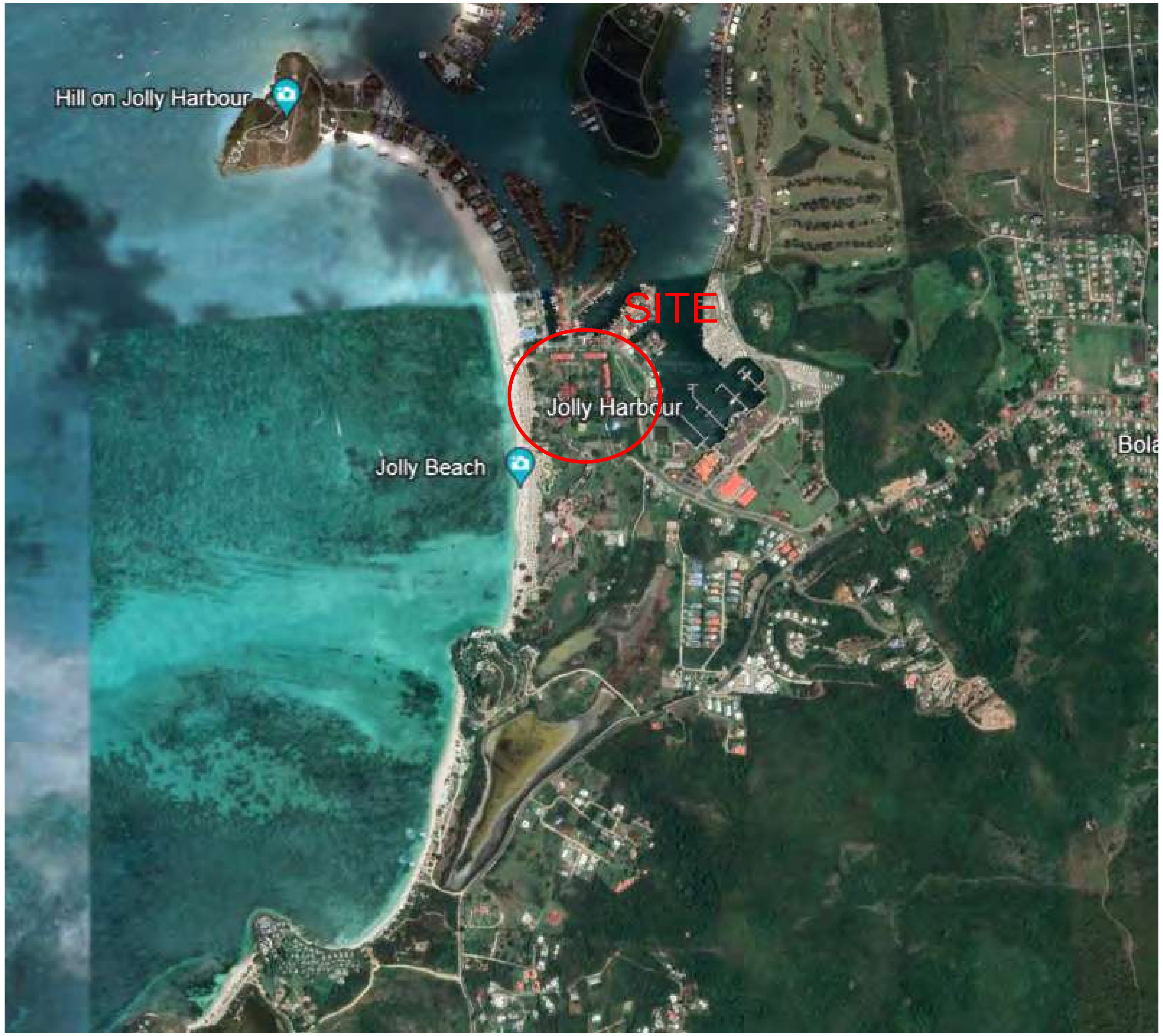
Sketch No.: FIGURE 1.2	Project: NIKKI BEACH RESORT
Title: ANTIGUA FLOOD MAP	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	



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Sketch No.: FIGURE 1.3	Project: NIKKI BEACH RESORT
Title: AERIAL PHOTO	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	

TOPOGRAPHIC SURVEY OF LANDS @ JOLLY BEACH -JOLLY HARBOUR

REGISTRATION SECTION: SOUTH WEST

SHEET: 55-1186A

COMBINATION OF PARCELS 408,410, 540, 541, 543, 544, 836, 837, 846 & 847

TOTAL AREA: 715774 Sq. Ft.
16.43 Ac

Number	Tree Type	Girth	Spread
230	willow	2.3	11
236	mahogany	2.8	15
237	mahogany	2.6	13.6
238	mahogany	2.1	
239	whitewood	1.1	5.4
240	mahogany	2.0	
241	mahogany	2.6	16.4
242	mahogany	2.5	16
243	mahogany	2.8	13.5
244	mahogany	2	11.8

Number	Tree Type	Girth	Spread
245	neem	2.6	17
246	flamboyant	3.1	11.6
247	willow	4.3	10.2
248	mahogany	2.9	18
249	mahogany	3.7	
250	mahogany	3.7	24
251	mahogany	2.6	9.6
252	palm	1.6	3
253	mahogany	4.0	23
254	flamboyant	1.5	4.9

Number	Tree Type	Girth	Spread
255	flamboyant	2.8	16.2
256	flamboyant	2.0	
257	flamboyant	1.2	11
258	flamboyant	2.3	
259	mango	3.9	7.8
260	sea–grape	1.6	12.8
261	flamboyant	2.6	17.3
262	mahogany	2.3	
263	mango	1.65	9.8
264	264	0.4	2.4

Number	Tree Type	Girth	Spread
265	almond	2.5	8.2
266	coconut	1.9	8.5
267	sea–grape	2.0	10.3
268	willow	1.7	6.7
269	flamboyant	3.0	14.8
270	neem	2.8	15.2
271	whitewood	3.20	25.5
272	whitewood	2.3	9.6
273	mahogany	3.3	18.
274	meem	3.2	9.1

Number	Tree Type	Girth	Spread
275	whitewood	2.0	4.2
276	neem	4.8	15.1
277	eucalyptus	3.0	10.2
278	eucalyptus	2.6	6.8
279	neem	3.0	12.0
280	mahogany	2.9	18.4
281	whitewood	1.3	4.1
282	whitewood	1.0	3.0
283	whitewood	2.0	6.5
284	whitewood	3.2	15.5

Number	Tree Type	Girth	Spread
285	neem	1.4	11.3
286	neem	2.7	
287	mahogany	2.5	11.7
288	whitewood	1.5	4.2
289	mahogany	3.8	13.0
290	mango	2.4	7.7
291	mango	3.4	6.7
292	mahogany	2.4	14.5
293	neem	2.0	10.3
294	mahogany	2.2	13.7

Number	Tree Type	Girth	Spread
295	mahogany	2.1	13.2
296	mahogany	2.90	15
2.97	mahogany	1.8	13.0
298	sea–grape	1.1	8
299	sea–grape	3.7	15.3
300	mahogany	2.7	16
301	willow	4.5	20
302	sea–grape	3.6	12.6
303	sea–grape	3.1	7.8
304	mahogany	3.0	17.6

Number	Tree Type	Girth	Spread
305	mahogany	2.0	10
306	willow	1.9	13.0
307	willow	1.3	38.1
308	willow	3.3	
309	willow	2.3	
310	willow	2.1	
311	willow	1.8	
312	willow	1.1	25.7
313	willow	1.2	
314	willow	1.6	

Number	Tree Type	Girth	Spread
315	willow	1.9	25.7
316	willow	0.9	
317	willow	1.4	
318	willow	2.0	
319	neem	1.2	5.6
320	whitewood	1.0	12.3
321	whitewood	1.1	
322	whitewood	1.2	13.0
323	whitewood	2.0	
324	whitewood	2.0	5.3

Number	Tree Type	Girth	Spread
325	whitewood	0.8	8.8
326	whitewood	0.9	
327	whitewood	0.8	2.8
328	whitewood	1.34	57.1
329	whitewood	0.8	
330	whitewood	1.1	
331	whitewood	2.0	
332	whitewood	3.1	
333	whitewood	1.2	
334	whitewood	1.5	

Number	Tree Type	Girth	Spread
335	whitewood	1.4	57.1
336	whitewood	0.9	
337	whitewood	2.4	
338	flamboyant		16
339	flamboyant		
340	flamboyant		
341	flamboyant		
342	neem	2.6	7.7
343	sea–grape		9.9
344	whitewood	2.26	7.60

Number	Tree Type	Girth	Spread
345	neem	1.8	16.6
346	neem	2.0	
347	Tree Type	Girth	Spread
348	sea–grape	3.7	9.0
361	mahogany	3.2	13.4
362	neem	2.8	6.5

MARINA SEA WALL
SHORE SIDE VEGETATION LINE
ROAD EDGE
WALL
PAVED WALKWAY
INTERNAL BOUNDARIES
BRIDGE
SHORELINE
FENCE LINE

....
Ato D. Kentish, L.S.
15th Oct '23

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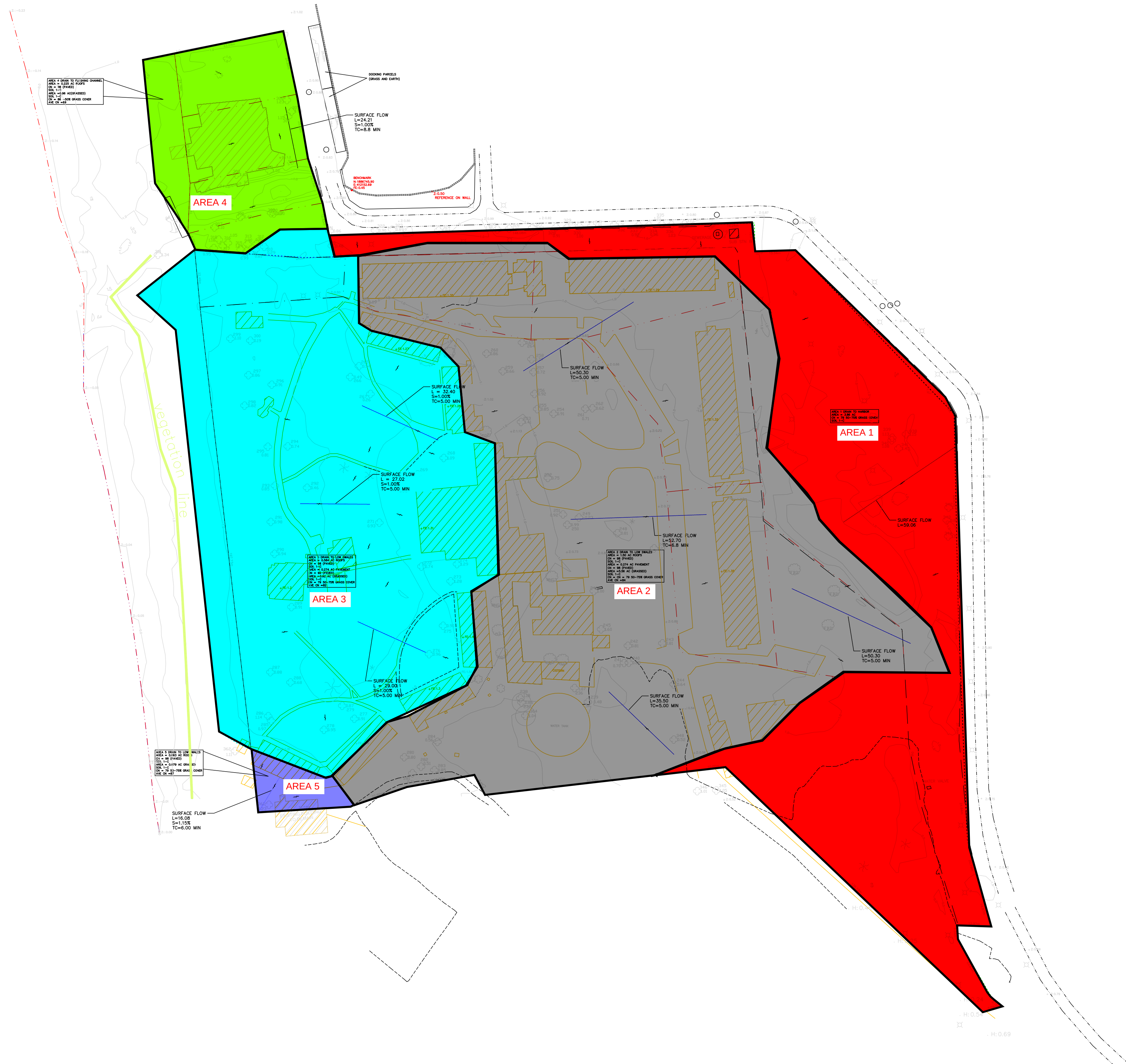
Sketch No.: FIGURE 1.4	Project: NIKKI BEACH RESORT
Title: SURVEY PLAN	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	



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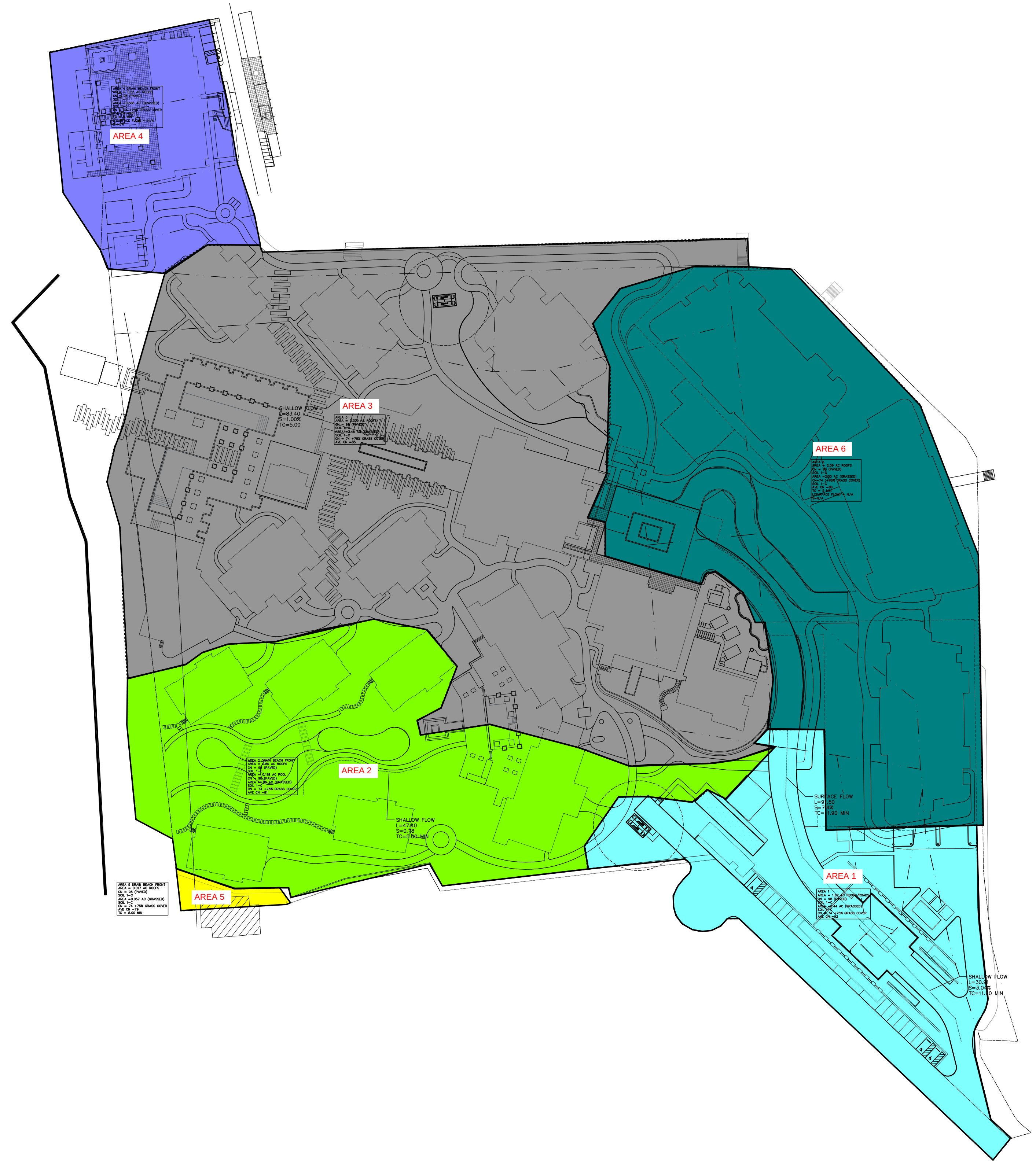
Sketch No.: FIGURE 2.1	Project: NIKKI BEACH RESORT
Title: PRE DEVEOLPMENT BASIN DELINEATION	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	



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Sketch No.: FIGURE 2.1	Project: NIKKI BEACH RESORT
Title: BASIN DELINEATION POST DEV	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	

ANTIGUA HYDROLOGICAL SOIL GROUP CLASSIFICATION

Projected Coordinate System: Antigua 1943 British West Indies Grid
Projection: Transverse Mercator
Unit of Measurement: Meter
Source Data: Digital Surface Model - Environmental Information Management and Advisory System (EIMAS)
Users: F. Mohammed ; F. Khan
For: Department of Environment, Antigua

USE OF THIS MAP:

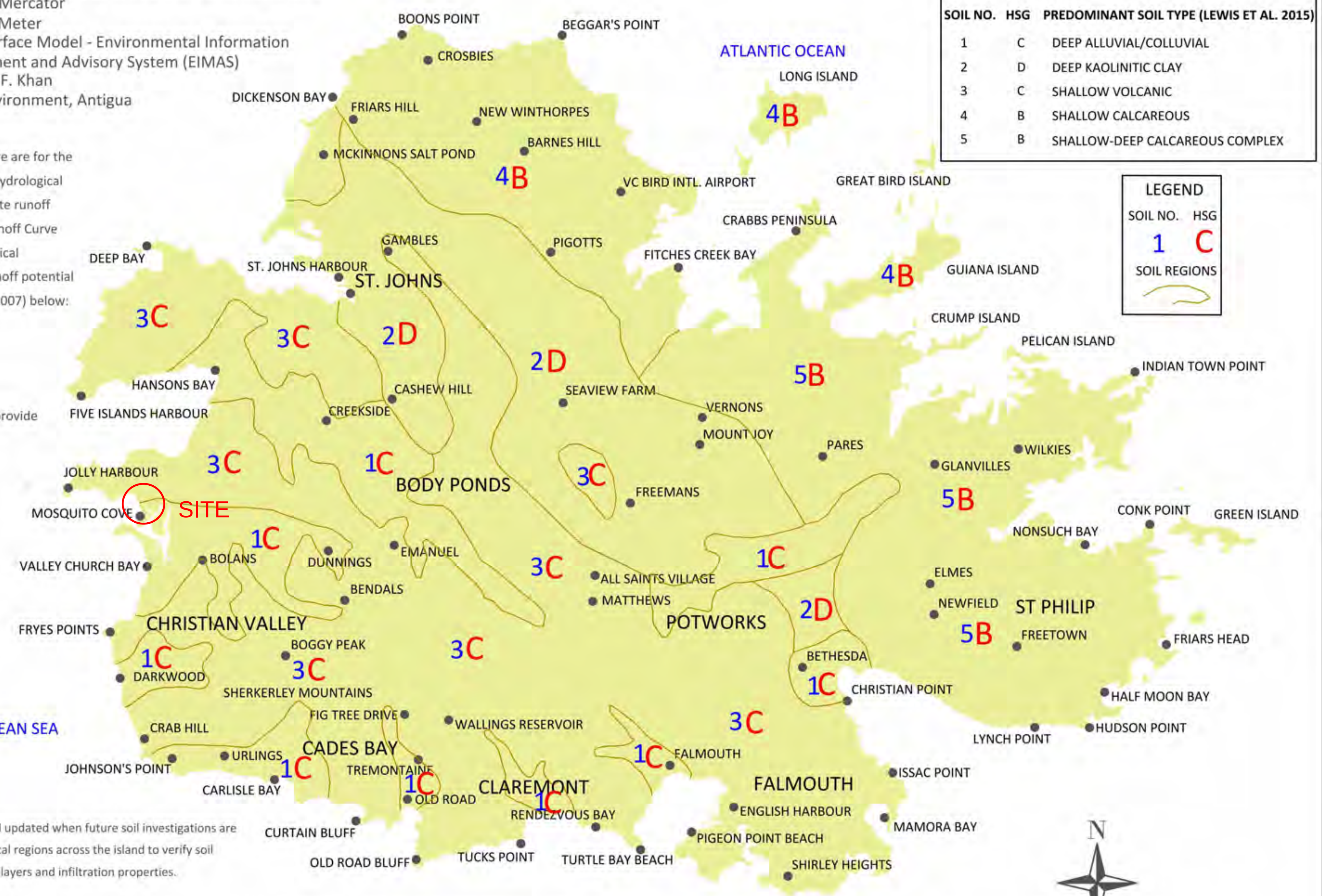
The classifications shown here are for the sole purpose of selecting a hydrological soil group to apply appropriate runoff curve numbers in the SCS Runoff Curve Number Method of Hydrological Assessment based on the runoff potential classifications as per USDA (2007) below:

A - LOW
B - MODERATELY LOW
C - MODERATELY HIGH
D - HIGH

This map is not intended to provide geotechnical classification.

CLASSIFICATION BASED ON USDA (2007)

SOIL NO.	HSG	PREDOMINANT SOIL TYPE (LEWIS ET AL. 2015)
1	C	DEEP ALLUVIAL/COLLUVIAL
2	D	DEEP KAOLINITIC CLAY
3	C	SHALLOW VOLCANIC
4	B	SHALLOW CALCAREOUS
5	B	SHALLOW-DEEP CALCAREOUS COMPLEX



NOTE:

This map should be reviewed and updated when future soil investigations are conducted in the various geological regions across the island to verify soil structure, depth to impermeable layers and infiltration properties.

References:
Cefas. 2018. Satellite Derived Bathymetry and edited Digital Surface Model of Antigua and Barbuda. 2018 Islandwide Digital Surface Model. *TCarta Reference No: PN17011.*
Cooper, B. et al. 2005. Antigua & Barbuda's National Action Plan 2005: *United Nations Convention to Combat Desertification.*
Department of Environment (DoE). 2018. GIS Shapefile "GEO_ATG_Soil_1965_84". *Supplied October 2021.*
Lewis, A. et al. 2015. Antigua & Barbuda's 2015-2020 National Action Plan: Combatting Desertification, Land Degradation & Drought. *United Nations Convention to Combat Desertification.*
USDA. 2007. "*Hydrological Soil Groups - Chapter 7*". Natural Resources Conservation Service (NRCS) National Engineering Handbook (NEH) Part 630 Hydrology.

Map Developed By: Alpha

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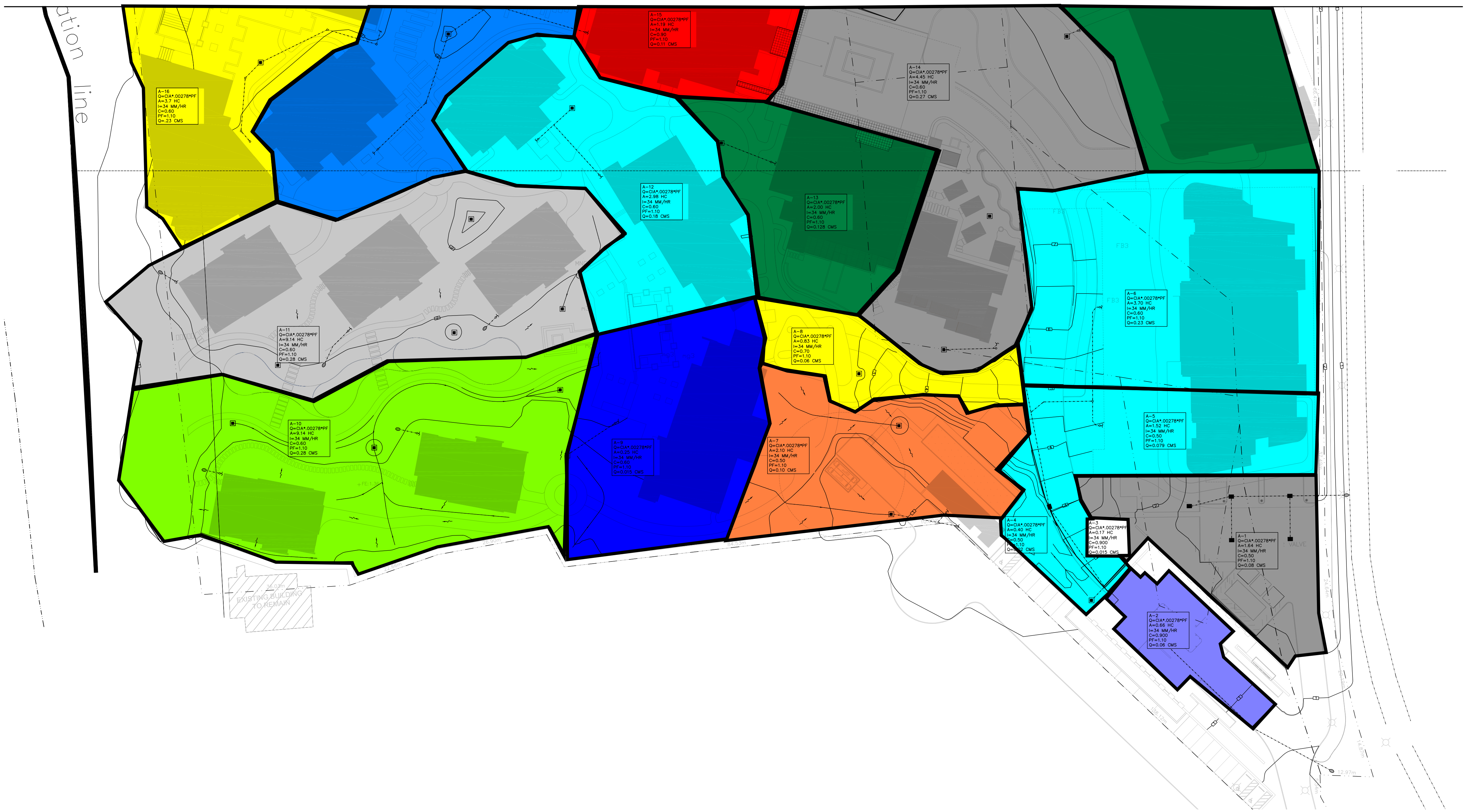
Sketch No.: FIGURE 3.1	Project: NIKKI BEACH RESORT
Title: HSG Map Antigua	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	

STORM SEWER SUB BASIN AREAS



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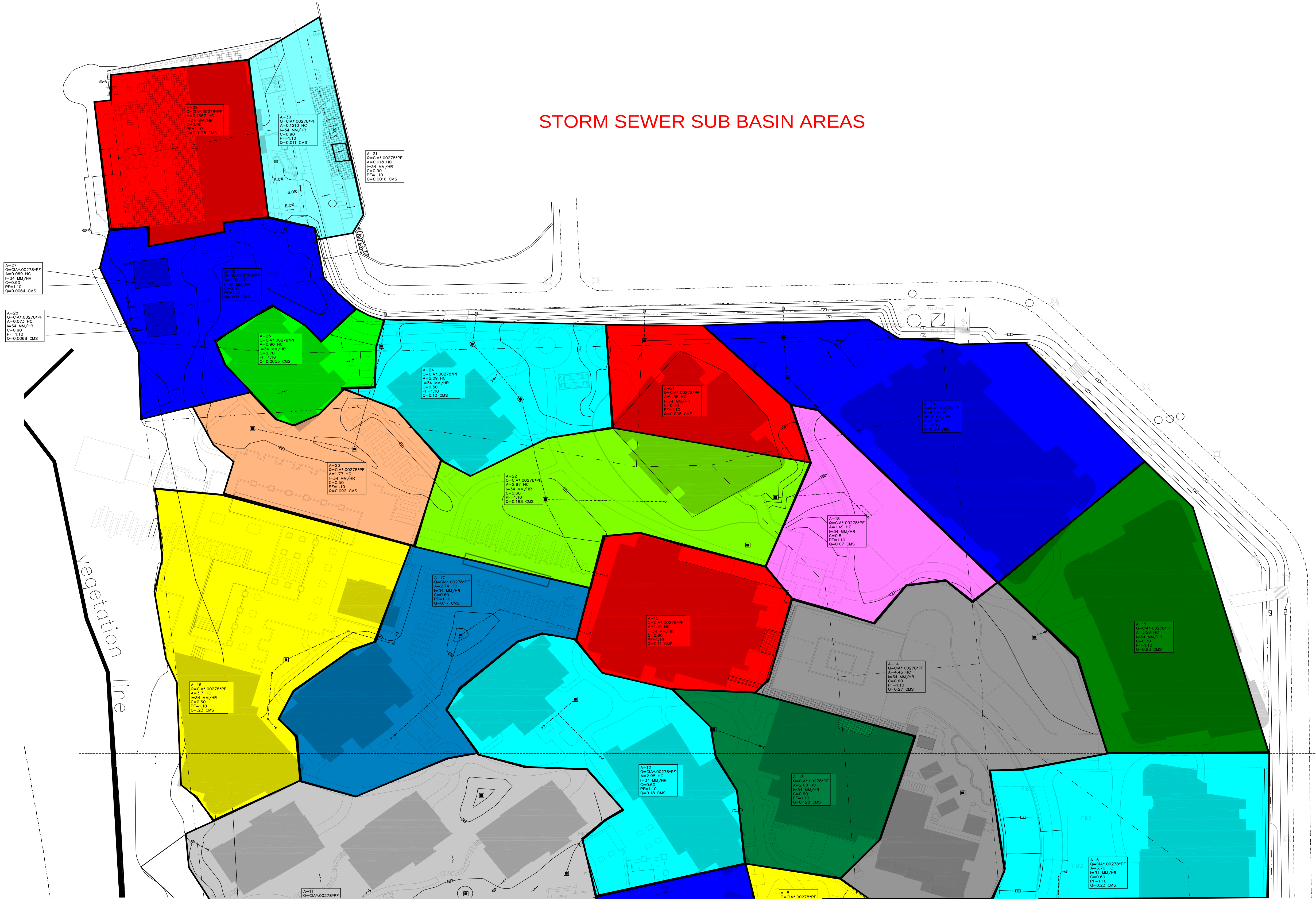
Sketch No.: FIGURE 4.2	Project: NIKKI BEACH RESORT
Title: Sub Basing To Inlets	Location: JOLLLY HARBOUR/MOSQUITO COVE
	TCI Project No.:
	Date: 0.8.13.2024
Scale: N.T.S	



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Sketch No.: FIGURE 4.1
Title: Sub Basing To Inlets
Scale: N.T.S

Project: NIKKI BEACH RESORT
Location: JOLLLY HARBOUR/MOSQUITO COVE
TCI Project No.:
Date: 0.8.13.2024

APPENDIX E

Conceptual Drainage Plans and Details:

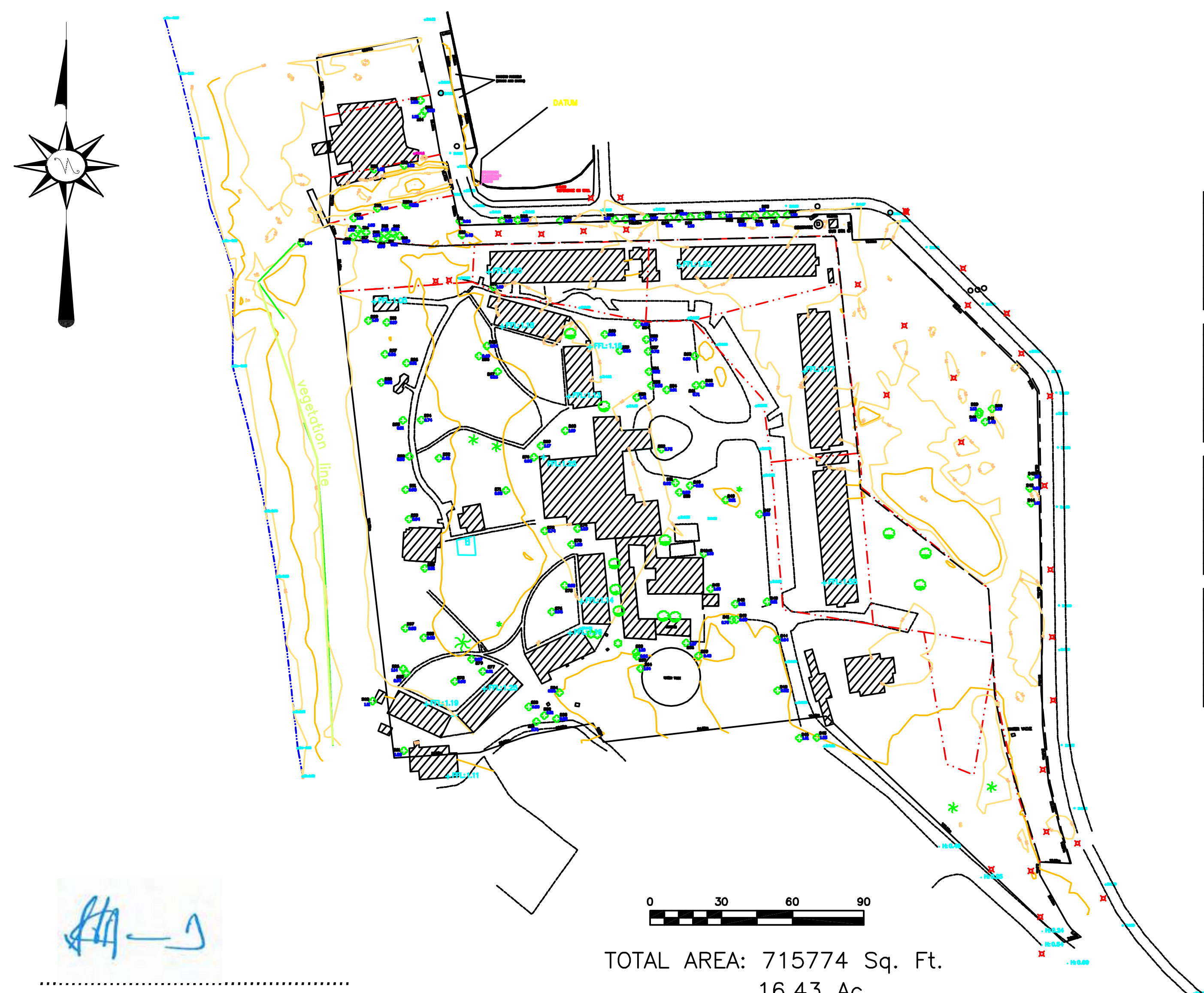
C1.00 EXISTING CONDITIONS PLAN
C2.00 ESPC PLAN
C2.01 ESPC PLAN
C4.02 DRAINAGE PLAN
C4.03 DRAINAGE PLAN
C7.00 DETAILS
C7.03 DETAILS

TOPOGRAPHIC SURVEY OF LANDS @ JOLLY BEACH -JOLLY HARBOUR

REGISTRATION SECTION: SOUTH WEST

SHEET: 55-1186A

COMBINATION OF PARCELS 408,410, 540, 541, 543, 544, 836, 837, 846 & 847



TOTAL AREA: 715774 Sq. Ft.
16.43 Ac

Ato D. Kentish, L.S.
15th Oct '23

Number	Tree Type	Girth	Spread
230	willow	2.3	11
236	mahogany	2.8	15
237	mahogany	2.6	13.6
238	mahogany	2.1	
239	whitewood	1.1	5.4
240	mahogany	2.0	
241	mahogany	2.6	16.4
242	mahogany	2.5	16
243	mahogany	2.8	13.5
244	mahogany	2	11.8

Number	Tree Type	Girth	Spread
245	neem	2.6	17
246	flamboyant	3.1	11.6
247	willow	4.3	10.2
248	mahogany	2.9	18
249	mahogany	3.7	
250	mahogany	3.7	24
251	mahogany	2.6	9.6
252	palm	1.6	3
253	mahogany	4.0	23
254	flamboyant	1.5	4.9

Number	Tree Type	Girth	Spread
255	flamboyant	2.8	16.2
256	flamboyant	2.0	
257	flamboyant	1.2	11
258	flamboyant	2.3	
259	mango	3.9	7.8
260	sea-grape	1.6	12.8
261	flamboyant	2.6	17.3
262	mahogany	2.3	
263	mango	1.65	9.8
264	264	0.4	2.4

Number	Tree Type	Girth	Spread
265	almond	2.5	8.2
266	coconut	1.9	8.5
267	sea-grape	2.0	10.3
268	willow	1.7	6.7
269	flamboyant	3.0	14.8
270	neem	2.8	15.2
271	whitewood	3.20	25.5
272	whitewood	2.3	9.6
273	mahogany	3.3	18.
274	meem	3.2	9.1

Number	Tree Type	Girth	Spread
275	whitewood	2.0	4.2
276	neem	4.8	15.1
277	eucalyptus	3.0	10.2
278	eucalyptus	2.6	6.8
279	neem	3.0	12.0
280	mahogany	2.9	18.4
281	whitewood	1.3	4.1
282	whitewood	1.0	3.0
283	whitewood	2.0	6.5
284	whitewood	3.2	15.5

Number	Tree Type	Girth	Spread
285	neem	1.4	11.3
286	neem	2.7	
287	mahogany	2.5	11.7
288	whitewood	1.5	4.2
289	mahogany	3.8	13.0
290	mango	2.4	7.7
291	mango	3.4	6.7
292	mahogany	2.4	14.5
293	neem	2.0	10.3
294	mahogany	2.2	13.7

Number	Tree Type	Girth	Spread
295	mahogany	2.1	13.2
296	mahogany	2.90	15
2.97	mahogany	1.8	13.0
298	sea-grape	1.1	8
299	sea-grape	3.7	15.3
300	mahogany	2.7	16
301	willow	4.5	20
302	sea-grape	3.6	12.6
303	sea-grape	3.1	7.8
304	mahogany	3.0	17.6

Number	Tree Type	Girth	Spread
305	mahogany	2.0	10
306	willow	1.9	13.0
307	willow	1.3	35.1
308	willow	3.3	
309	willow	2.3	
310	willow	2.1	
311	willow	1.8	
312	willow	1.1	25.7
313	willow	1.2	
314	willow	1.6	

Number	Tree Type	Girth	Spread
315	willow	1.9	25.7
316	willow	0.9	
317	willow	1.4	
318	willow	2.0	
319	neem	1.2	5.6
320	whitewood	1.0	12.3
321	whitewood	1.1	
322	whitewood	1.2	13.0
323	whitewood	2.0	
324	whitewood	2.0	5.3

Number	Tree Type	Girth	Spread
325	whitewood	0.8	8.8
326	whitewood	0.9	
327	whitewood	0.5	2.8
328	whitewood	1.34	57.1
329	whitewood	0.8	
330	whitewood	1.1	
331	whitewood	2.0	
332	whitewood	3.1	
333	whitewood	1.2	
334	whitewood	1.5	

Number	Tree Type	Girth	Spread
335	whitewood	1.4	57.1
336	whitewood	0.9	
337	whitewood	2.4	
338	flamboyant		16
339	flamboyant		
340	flamboyant		
341	flamboyant		
342	neem	2.6	7.7
343	sea-grape		9.9
344	whitewood	2.26	7.60

Number	Tree Type	Girth	Spread
345	neem	1.8	16.6
346	neem	2.0	
347	Tree Type	Girth	Spread
348	sea-grape	3.7	9.0
361	mahogany	3.2	13.4
362	neem	2.8	6.5

MARINA SEA WALL
SHORE SIDE VEGETATION LINE
ROAD EDGE
WALL
PAVED WALKWAY
INTERNAL BOUNDARIES
BRIDGE
SHORELINE
FENCE LINE

0 50 100
Meters
1:1,000

HKS

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KEY PLAN

REVISION
NO. DESCRIPTION DATE

HKS PROJECT NUMBER
25116.000

DATE
08/23/2024

ISSUE
FINAL DESIGN DEVELOPMENT

SHEET TITLE
EXISTING CONDITIONS PLAN

SHEET NO.
C1.00

ESPC NOTES:

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PLACING AND MAINTAINING ALL EROSION AND SEDIMENT CONTROL MEASURES SHOWN ON THESE PLANS AND THAT MAY BE REQUIRED BASED UPON THE PHASING OF THE CONSTRUCTION WORK IN ORDER TO MEET APPLICABLE LOCAL REGULATIONS.
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4. MAINTENANCE OF ALL SOIL EROSION AND SEDIMENTATION CONTROL MEASURES AND PRACTICES, WHETHER TEMPORARY OR PERMANENT, SHALL BE AT ALL TIMES THE RESPONSIBILITY OF THE PROPERTY OWNER.
5. ALL EROSION AND SEDIMENT CONTROL PRACTICES SHALL BE CHECKED FOR STABILITY AND OPERATION FOLLOWING EVERY RUNOFF-PRODUCING RAINFALL, BUT IN NO CASE LESS THAN ONCE EVERY DAY. ANY NEEDED REPAIRS OR REPLACEMENT SHALL BE MADE IMMEDIATELY TO MAINTAIN ALL PRACTICES AS NEEDED. SYNTHETIC SEDIMENT FENCE SHALL BE REPLACED WHEN FABRIC COLLAPSES, TEARS, DECOMPOSES OR BECOMES INEFFECTIVE.
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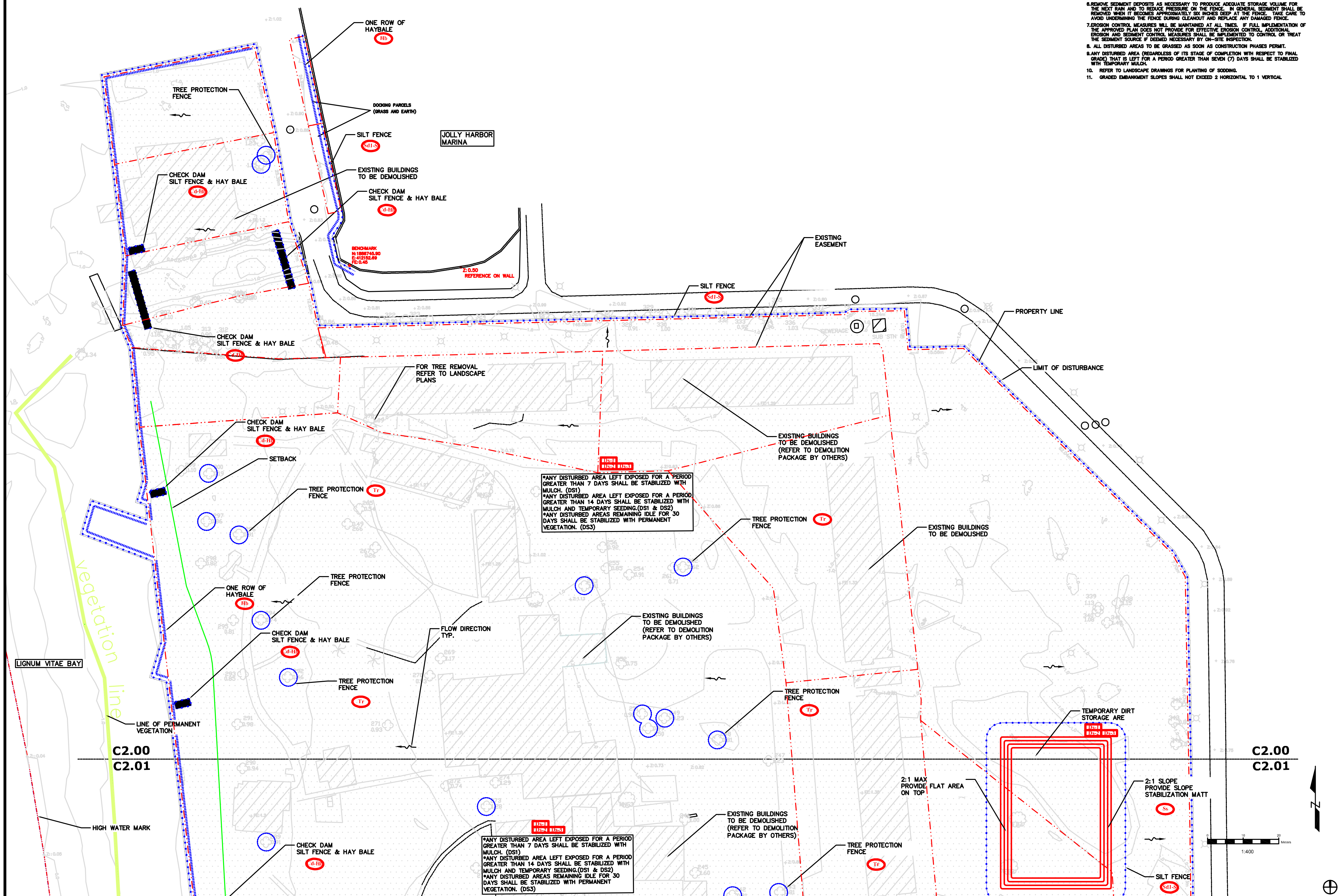
11. GRADED EMBANKMENT SLOPES SHALL NOT EXCEED 2 HORIZONTAL TO 1 VERTICAL



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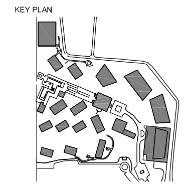

REVISION

NO.	DESCRIPTION	DATE

HKS PROJECT NUMBER
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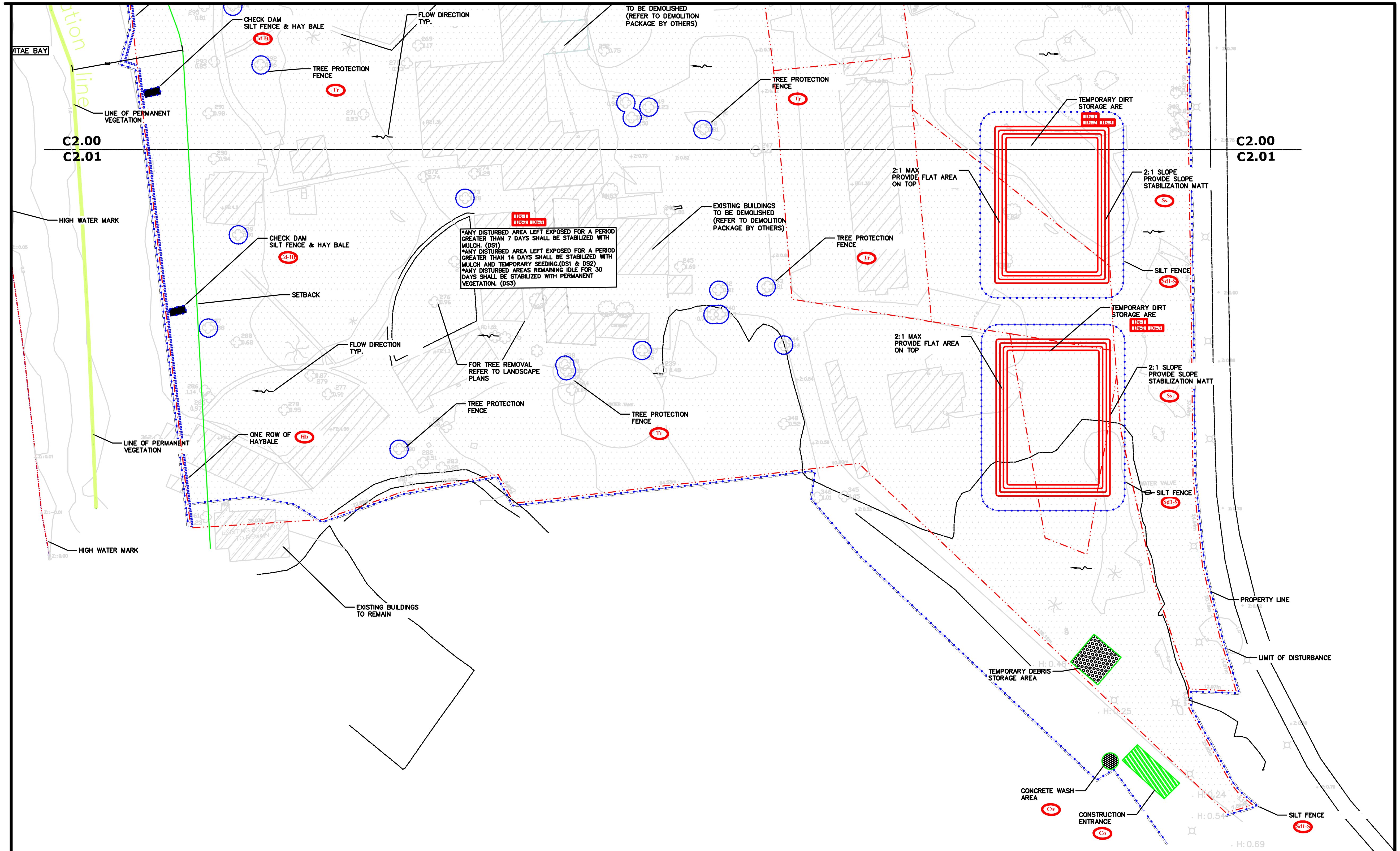
08/23/2024

ISSUE
FINAL DESIGN DEVELOPMENT

SHEET TITLE
EROSION CONTROL PLAN

SHEET NO.
C2.00



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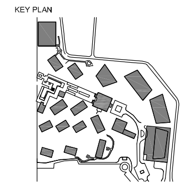
KEY PLAN



REVISION

NO.	DESCRIPTION	DATE

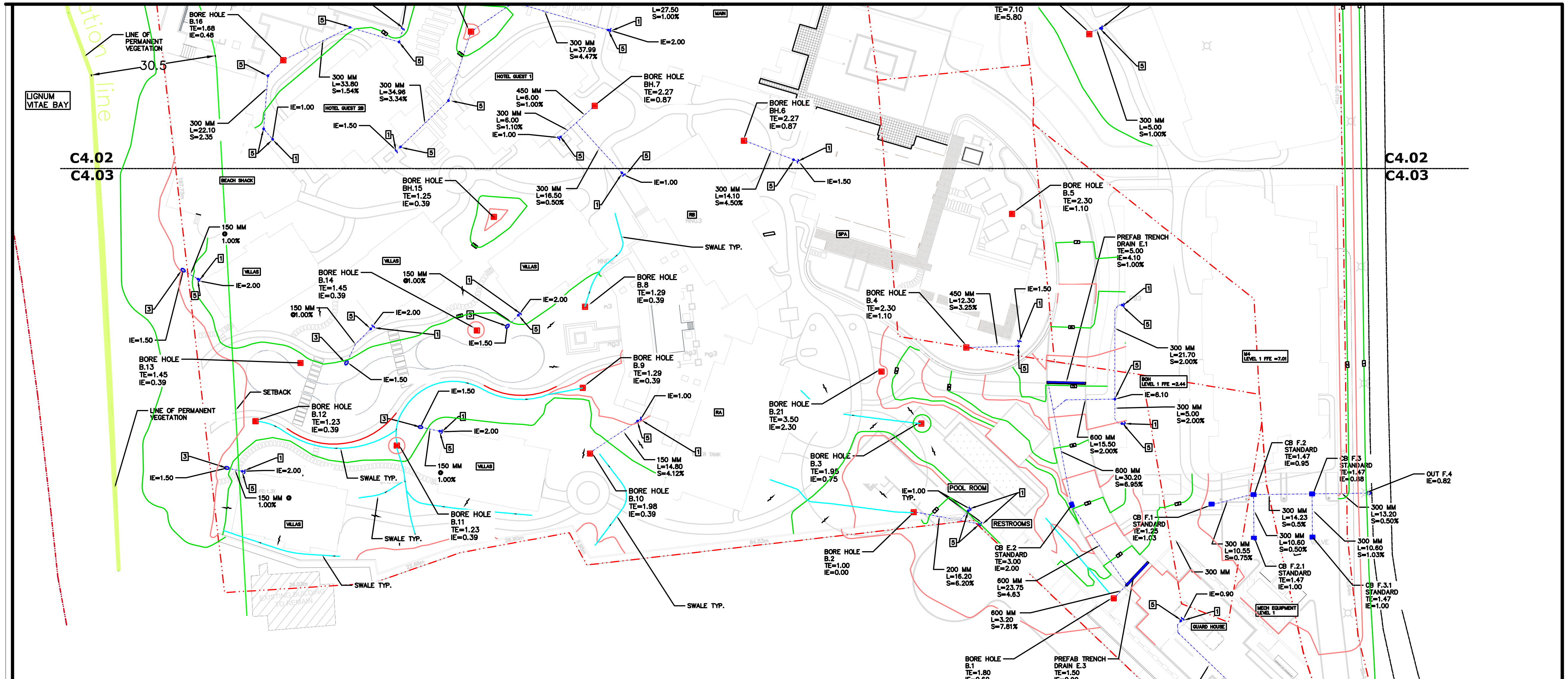
HKS PROJECT NUMBER
25116.000

DATE
08/23/2024

ISSUE
FINAL DESIGN DEVELOPMENT

SHEET TITLE
EROSION CONTROL PLAN

SHEET NO.
C2.01



DRAINAGE KEY NOTES:

1	HDPE ASTM D3350-14 BLDG POC @ 1.00%
2	STORMWATER INFILTRATION CHAMBERS
3	RIP RAP OUTLET PROTECTION
4	HDPE ASTM D3350-14 TEE
5	DRAINAGE CLEAN OUT
6	DRAINAGE MANHOLE
7	150 MM OVERFLOW PIPE HDPE ASTM D3350-14
8	200 MM TANK DRAIN HDPE ASTM D3350-14

GRADING NOTES:

1. NO GRADED SLOPE SHALL EXCEED 2H:1V
2. LIMITS OF CONSTRUCTION ARE APPROXIMATE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ESTABLISHING AND MAINTAINING OPERATIONS. ALL OPERATIONS SHALL BE CONTAINED WITHIN THE EXISTING PROPERTY BOUNDARIES UNLESS SPECIFIC AUTHORIZATION IS OBTAINED TO LOCATE MATERIALS OR TO PROVIDE CONSTRUCTION OUTSIDE THESE LIMITS.
3. OBTAIN ALL APPLICABLE PERMITS PRIOR TO START OF LAND DISTURBING ACTIVITIES.
4. THE CONTRACTOR MUST COORDINATE A STORAGE/LAYDOWN AREA WITH THE OWNER.
5. THE CONTRACTOR SHALL ESTABLISH ADEQUATE SITE DRAINAGE PRIOR TO BEGINNING CONSTRUCTION OPERATIONS AND MAINTAIN POSITIVE DRAINAGE THROUGHOUT THE PROJECT TO PREVENT POOLING OF WATER AND SUBSEQUENT SATURATION OF THE SOIL.
6. CONTOURS AND ELEVATIONS SHOWN ON THESE DRAWINGS REPRESENT FINISHED GRADE. THE CONTRACTOR SHALL ALLOW FOR PAVEMENT THICKNESS, TOPSOIL THICKNESS, SLABS, ETC. WHEN GRADING TO SUB GRADE.
7. CONTRACTOR TO GRADE SITE TO DIRECT RUNOFF AWAY FROM BUILDING FOUNDATIONS.
8. SIDEWALK MAXIMUM CROSS SLOPES IS 2.00%. SIDEWALK MAXIMUM RUN SLOPE IS 5.00% UNLESS OTHERWISE NOTED.
9. CONTRACTOR TO MATCH EXISTING PAVEMENT BOTH IN GRADE AND ALIGNMENT.
10. REFER TO ARCHITECTURAL DRAWINGS FOR BUILDING FLOOR SLAB THICKNESS, AGGREGATE BASE, VAPOR BARRIER AND TERMITE TREATMENT.
11. EROSION AND SEDIMENT CONTROL MEASURES SHALL BE IN PLACE PRIOR TO BEGINNING ANY EARTHWORK OPERATIONS.
12. REFER TO GEOTECHNICAL SUBSURFACE REPORT FOR SOILS INFORMATION AND RECOMMENDATIONS.

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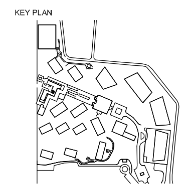

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ISSUE
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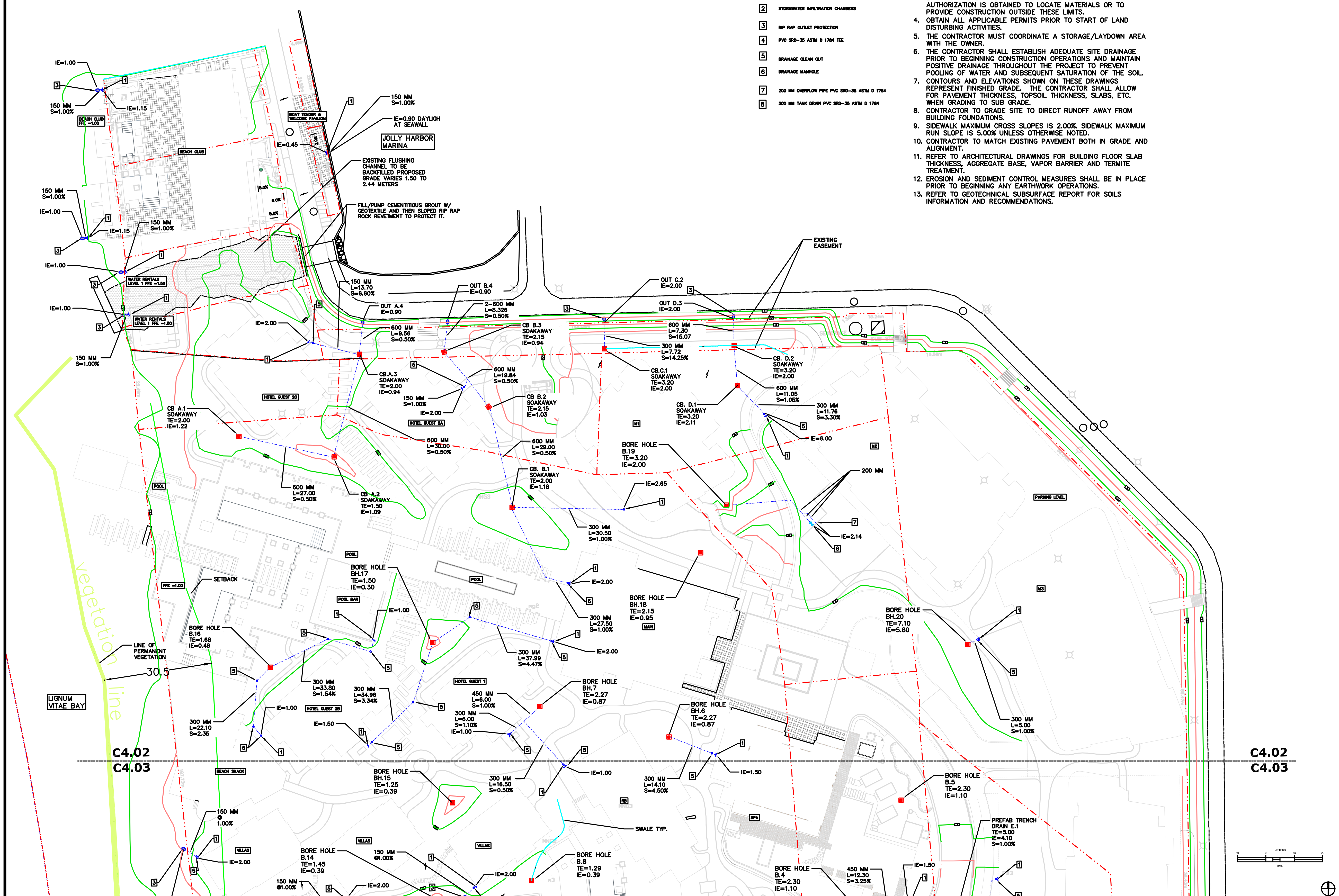
SHEET TITLE
DRAINAGE PLAN

SHEET NO.
C4.03



DRAINAGE KEY NOTES:

1. PVC SRD-35 ASTM D 1784 BLDG POC @ 1.00%.
2. STORMWATER INFILTRATION CHAMBERS
3. RIP RAP OUTLET PROTECTION
4. PVC SRD-35 ASTM D 1784 TEE
5. DRAINAGE CLEAN OUT
6. DRAINAGE MANHOLE
7. 200 MM OVERFLOW PIPE PVC SRD-35 ASTM D 1784
8. 200 MM TANK DRAIN PVC SRD-35 ASTM D 1784

GRADING NOTES:

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2. ALL STORM PIPES SHALL BE PVC SDR-35 ASTM D 1784
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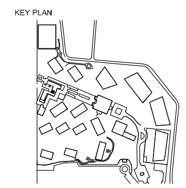
KEY PLAN



REVISION

NO.	DESCRIPTION	DATE

HKS PROJECT NUMBER
25116.000

DATE
08/23/2024

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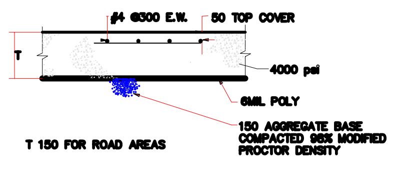
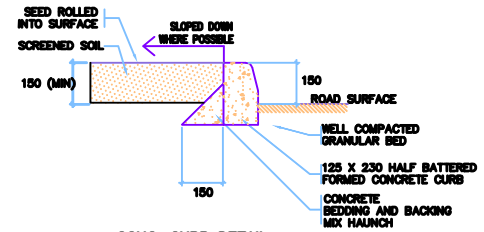
FINAL DESIGN DEVELOPMENT

SHEET TITLE
DRAINAGE PLAN

SHEET NO.
C4.02



LIGHT DUTY PAVEMENT DETAIL
NOT TO SCALE



CONC. CURB DETAIL
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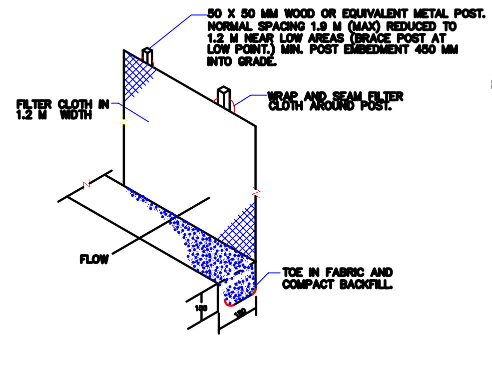

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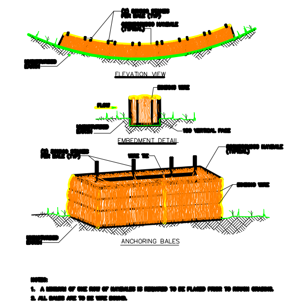

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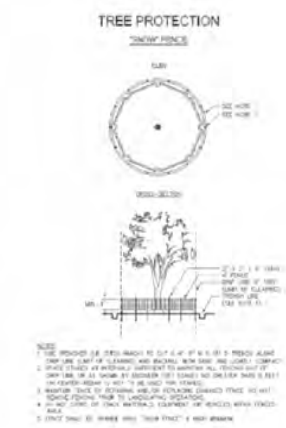

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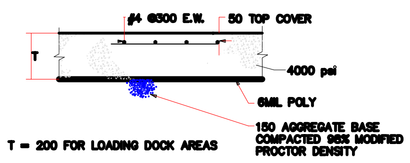

HEAVY DUTY PAVEMENT DETAIL
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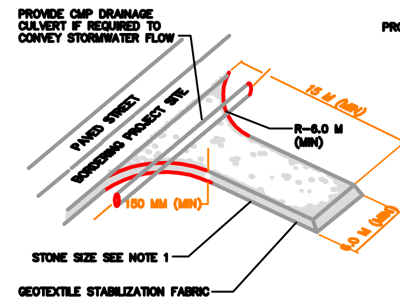
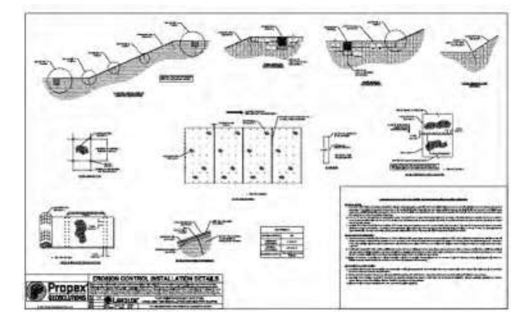


PROVIDE AT ALL CONSTRUCTION ACCESS POINTS INTO THE SITE FROM PUBLIC ROADS AND FROM INTERNAL PAVED ROADS.

NOTES:
1. STONE SIZE AASHTO DESIGNATION M43, SIZE NO. 2. USE CRUSHED STONE.
2. LENGTH – AS EFFECTIVE, BUT NOT LESS THAN 15 M.
3. THICKNESS – NOT LESS THAT EIGHT 200 MM.
4. WIDTH – NOT LESS THAN FULL WIDTH OF ALL POINTS OF INGRESS OR EGRESS.
5. WASHING – WHEN NECESSARY, WHEELS SHALL BE CLEANED TO REMOVE SEDIMENT PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE WHICH DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN. ALL SEDIMENT SHALL BE PREVENTED FROM ENTERING ANY STORM DRAIN, DITCH, OR WATERCOURSE THROUGH USE OF SANDBAGS, GRAVEL, BOARDS, OR OTHER APPROVED METHODS.
6. MAINTENANCE – THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT-OF-WAYS. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO PUBLIC RIGHT-OF-WAYS MUST BE REMOVED IMMEDIATELY BY THE CONTRACTOR.

SLOPE STABILIZATION TO BE USED IN 2:1 SLOPES



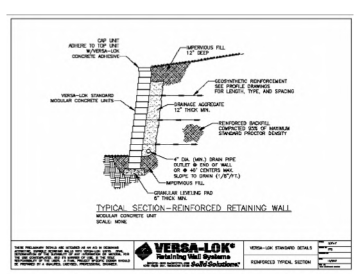
SLOPE STABILIZATION
NOT TO SCALE

DS–1 MULCHING ONLY

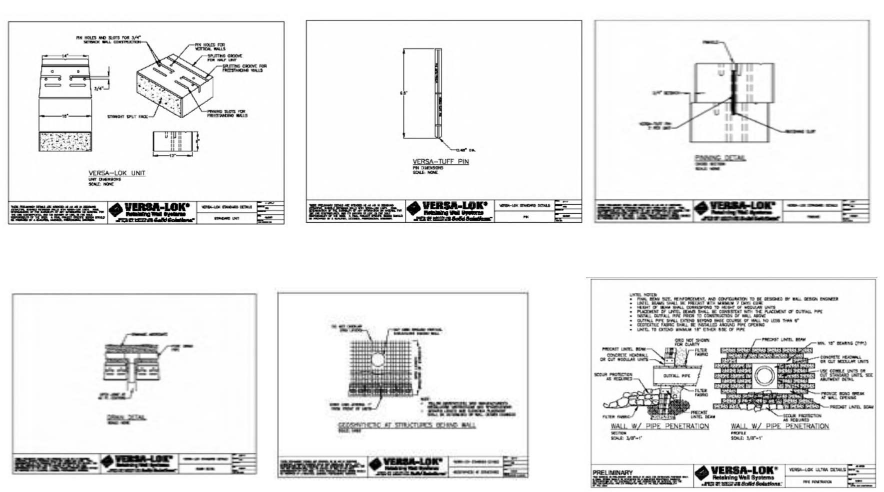
MATERIAL	DEPTH
DRY STRAW OR HAY	2" TO 4"
WOOD WASTE (SAW DUST, BARK, CHIPS)	2" TO 3"
BLACK POLYETHYLENE	COMPLETELY COVER AREA HOLD IN PLACE WITH SOIL @ENDS

REQUIREMENT FOR REGULATORY COMPLIANCE

DS–1 MULCH STABILIZATION
NOT TO SCALE



ALL WALLS OVER 30" HIGH SHALL HAVE A 42" HIGH RAIL OR FENCE ALONG TOP OF WALL AS PER LOCAL LIFE SAFETY CODES, SEE ARCH PLANS FOR DETAILS
PRIOR TO CONSTRUCTION OF PRE ENGINEERED WALL, THE CONTRACTOR SHALL SUBMIT WALL CONSTRUCTION DETAILS STAMP BY A REGISTERED STRUCTURAL ENGINEER FOR APPROVAL.
NO VOID BLOCK EXPOSED SHALL BE ACCEPTED BY FIELD INSPECTION
PRE ENGINEERED RETAINING WALLS SUBJECT TO OWNER'S AND ENGINEER'S APPROVAL. DRAWINGS SHALL INCLUDE WALL PROFILES WITH SITE KEY PLANS.



MSE WALLS DETAIL
NOT TO SCALE

Table 1. Recommended Species for Temporary Seeding

Species		Seeding Rate lbs/acres	Seeding Rate lbs/1000 sq.ft.	Planting Depth (in)
Grasses				
Ryegrass*	*Lolium perenne*	40	1	½
Brown Top Millet*	*Urochloa ramosa*	40	1	¼
Legumes				
Habichuela de terciopelo Velvet bean	*Mucuna pruriens*	20	0.5	¼
Neonotonia wightii		5 [a]	0.12	½

* Commercially available grasses which have been proven to perform well under prevailing conditions in Puerto Rico.
(a) deep in water 24 hrs before planting

DS–2 TEMPORARY VEGETATIVE STABILIZATION
NOT TO SCALE

Table 1. Recommended Species for Permanent Seeding

Seeding Mixtures	Seeding Rate lbs/acres	Seeding Rate lbs/1000 sq.ft.
Bermudagrass*	60	1.5
Ryegrass	40	1
Bermudagrass	60	1.5
Brown Top Millet	60	1.5

Seeding Mixtures	Seeding Rate lbs/acres	Seeding Rate lbs/1000 sq.ft.
Ciempies*	20	0.5
Ryegrass	40	1
Ciempies	20	0.5
Brown Top Millet	60	1.5

Seeding Mixtures	Seeding Rate lbs/acres	Seeding Rate lbs/1000 sq.ft.
Bahiagrass*	40	1
Ryegrass	40	1
Bahiagrass	40	1
Brown Top Millet	60	1.5

Seeding Mixtures	Seeding Rate lbs/acres	Seeding Rate lbs/1000 sq.ft.
Carpetgrass*	40	1
Ryegrass	40	1
Carpetgrass	40	1
Brown Top Millet	60	1.5

Seeding Mixtures	Seeding Rate lbs/acres	Seeding Rate lbs/1000 sq.ft.
Zoyzia*	40	1
Ryegrass	40	1
Zoyzia	40	1
Brown Top Millet	60	1.5

Seeding Mixtures	Seeding Rate lbs/acres	Seeding Rate lbs/1000 sq.ft.
Dallis*	20	0.5
Ryegrass	40	1
Dallis	20	0.5
Brown Top Millet	60	1.5

* Springgs planting rate 1,500 lb/acre

Maximum seeding depth should be 1/4 inch on clay soils and 1/2 inch on sandy soils.

Brown Top Millet and Ryegrass are annual grasses (commercially available) that will create favorable conditions for establishment of the perennial grasses.

Name: English	Spanish	Scientific
Bahia grass	Yerba Bahia	*Paspalum notatum*
Bermuda grass	Yerba Bermuda	*Cynodon dactylon*
Browntop millet		*Urochloa ramosa*
Carpet grass	Grama colorada	*Axonopus compressus*
Centipede grass	Ciempies	*Eremochloa ophiuroides*
Dallis grass	Yerba Dalis	*Paspalum dilatatum*
Ryegrass		*Lolium perenne*
Zoyzia	Zoisia	*Zoysia spp.*

DS–3 PERMANENT VEGETATIVE STABILIZATION

HKS

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HOTELS AND RESORTS ANTIGUA

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ST JOHN'S ANTIGUA

OWNER'S REPRESENTATIVE
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ARCHITECT OF RECORD
DARYL BENJAMIN ARCHITECTS
CNR. NEVIS & CROSS STREET
ST. JOHNS, ANTIGUA

INTERIM REVIEW ONLY
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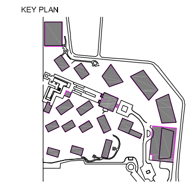
Architect: XXXXXX
Arch. Reg. No.: XXXX
Date: XX/XX/XXXX

KEY PLAN



REVISION
NO. DESCRIPTION DATE

HKS PROJECT NUMBER
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DATE
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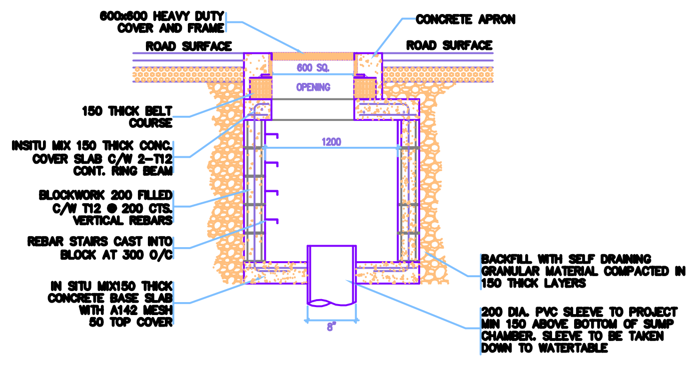
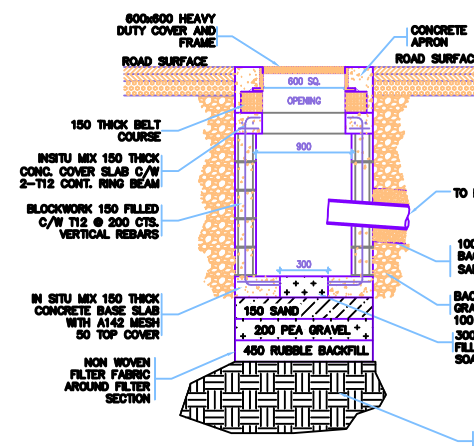
ISSUE
FINAL DESIGN DEVELOPMENT

SHEET TITLE
SITE DETAILS

SHEET NO.
C7.00



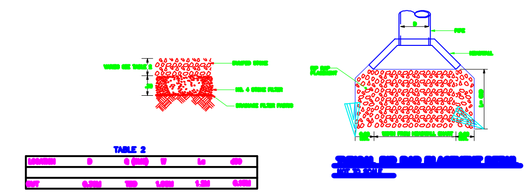
TYPICAL BOREHOLE SECTION
NOT TO SCALE



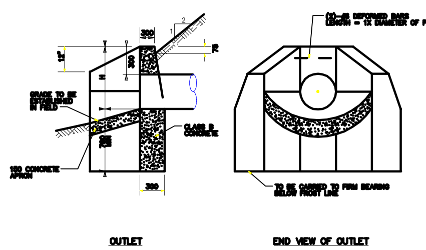
SOIL PROTECTION & PREPARATION FOR STORM MANAGEMENT SYSTEMS INSTALLATION:

1. DURING EXCAVATION, HEAVY MACHINERY SHALL NOT DRIVE OVER EXPOSED UNDERLYING SOILS.
2. EXCAVATE IN DRY CONDITIONS AS MUCH AS POSSIBLE.
3. USE TRACK OR LOW GROUND PRESSURE VEHICLES.
4. EXCAVATE FINAL 300 WITH TEETH OF BUCKET(DO NOT SMEAR)
5. SUB SOILS SHALL BE SCARIFIED (NOT COMPACTED PRIOR TO PLACEMENT OF CLEAN, WASHED DRAINAGE STONE.

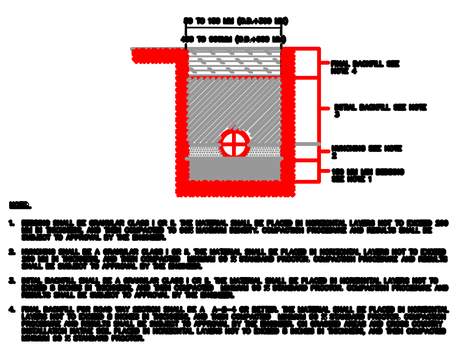
TYPICAL CATCH BASIN SOAKAWAY SECTION
NOT TO SCALE



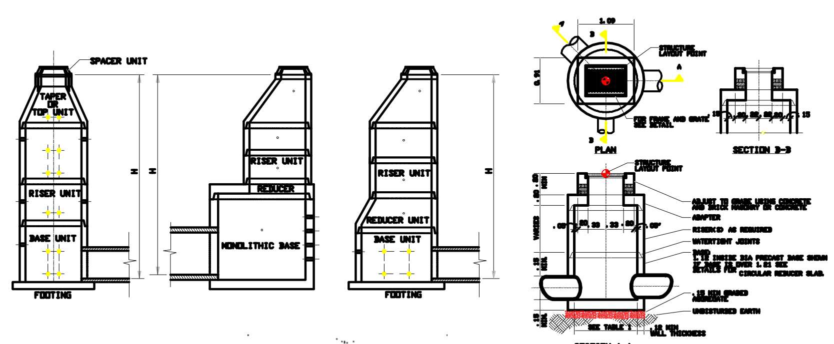
TYPICAL RIP RAP DETAIL
NOT TO SCALE



TYPICAL HEADWALL DETAIL
NOT TO SCALE



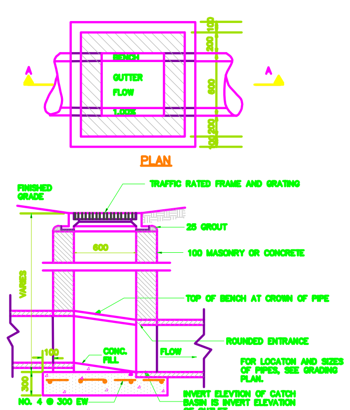
PLASTIC PIPE TRENCH (STORM) DETAIL TYP.
NOT TO SCALE



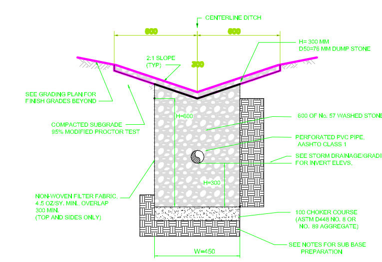
NOTE:
QUANTITIES SHOWN ARE FOR THE CONTRACTOR'S INFORMATION ONLY. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE ALL QUANTITIES.

REFER TO TABLE 1 FOR STRUCTURE SIZE BASED ON ANGLE AND PIPE DIAMETE

TYPICAL DRAINAGE STRUCTURE DETAIL
NOT TO SCALE



STANDARD CATCH BASIN STRUCTURE DETAIL
NOT TO SCALE



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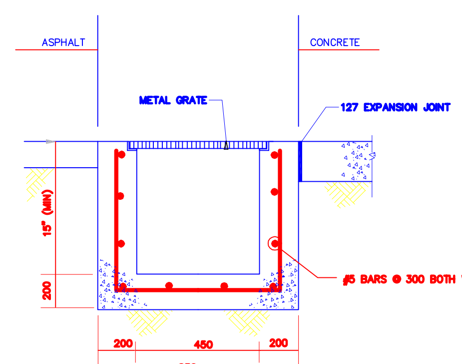
2. EXCAVATE IN DRY CONDITIONS AS MUCH AS POSSIBLE.
3. EXCAVATE FINAL 300 WITH TEETH OF BUCKET(DO NOT SMEAR)
4. SUB SOILS SHALL BE SCARIFIED (NOT COMPACTED PRIOR TO PLACEMENT OF CLEAN, WASHED DRAINAGE STONE.

RIP RAP LINED SWALE DETAIL
NOT TO SCALE



NOTE:
THIS BOX CAN BE USED FOR SHALLOW DROP INLETS WHEN PIPE DIAMETER IS 12" OR LIES AT MIN. DEPTH OF 24"

TRENCH GRATE DETAIL
NOT TO SCALE

HKS

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Date: XX/XX/XXXX

KEY PLAN

REVISION

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DATE
08/23/2024

ISSUE
FINAL DESIGN DEVELOPMENT

SHEET TITLE
DRAINAGE DETAILS

SHEET NO.
C7.03

Appendix 5 – Coastal Engineering Assessment and Hazard Analysis

Coastal Engineering Assessment and Hazard Analysis

Nikki Beach Resort

Jolly Beach, Antigua

Prepared For:

Muqali, Ltd

St. Johns, Antigua and Barbuda

Report Prepared By:

ATM
A Geosyntec Company

Rev 17 June 2024

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APPENDICES

EXECUTIVE SUMMARY

Applied Technology & Management (ATM), a Geosyntec Company, was contracted by Muqali, Ltd (Client) to provide coastal consultancy services associated with the redevelopment of the beachfront property at the former Jolly Beach Hotel on Lignum Vitae Bay, just south of Jolly Harbor on the western shoreline of Antigua. The site is being redeveloped as a Nikki Beach Resort. The following summarizes ATM's assessment of long-term shoreline change for future beach management and recommendations regarding risk mitigation of potential coastal hazards to inform on proper building construction setbacks and elevations for the project.

Long-Term Shoreline Change

Long-term shoreline change was assessed for the project site beach and immediately adjacent areas to inform the Client on beach stability, long-term sediment transport patterns, and potential future beach management needs.

- Review of satellite photos and long-term shoreline change from various sources indicates the site shoreline is relatively stable and a Beach Monitoring Plan is proposed to assess overall health and determine when future maintenance or beach nourishment may be needed.
- No new shoreline stabilization structures (e.g., groynes, breakwaters) are recommended at this time.
- It is recommended that the existing rock groynes near the Jolly Harbor flushing channel and at the south end of the property shoreline be left in place, as they likely assist with maintaining beach stability. These can potentially be rehabilitated in the future to improve functionality if necessary.

A Beach Management Plan with recommended survey profile locations is provided in Appendix A.

Coastal Flood Hazard Analysis

A coastal flood hazard analysis, specifically focused on the effects of passing tropical storms and hurricanes was conducted to develop Design Flood Elevations (DFEs), setbacks, and other construction recommendations to support the project design team. The analysis was conducted with methods generally following FEMA guidelines for flood hazard mapping in the United States (US).

DFEs can serve as a minimum target elevation for setting finished floor elevations (FFEs) and/or lowest horizontal structural member elevations (LHSMEs) to reduce potential flood loading on buildings. A proposed site grading and development plan was provided by the Client and utilized for this effort. *For reference, the project team initially proposed building finished floor elevations (FFEs) for residential/habitable structures at primarily elevation +2.44 m local survey datum (LSD) for the beachfront buildings*. The results of the flood hazard analysis are summarized below.

- The 100-year storm erosion model simulations confirm the recommended minimum setbacks of ~ 30 m (100 ft) from the existing approximate line of permanent vegetation (LPV) at the landward edge of the beach (delineation provided by Client) for the proposed development.

  - Erosion was observed landward of this setback under proposed conditions scenarios in areas where no retaining walls are proposed; however, the erosion is relatively minor and with the oceanfront row of buildings founded on piles, any impacts should be largely to landscape and/or hardscape per Client-provided site plan.
  - Planting stabilizing vegetation, hardscape, and/or enhancing the dune system will help to mitigate potential for erosion damage along the site's beach/upland transition.

- It is recommended that any habitable and/or permanent (non-expendable) structures *at or seaward of the minimum setback limits* are founded on piles or other foundation which can accommodate the anticipated potential storm scour/erosion and wave/overwash forces.
- DFEs are typically recommended to include a factor of safety (or freeboard) on top of anticipated 100-year flood elevations and/or account for projected future sea level rise (SLR). Coordination with the Client after initial analysis, based on Client accepted balance of acceptable risk versus project economics and other factors, indicated a directive to not explicitly include SLR or additional freeboard in the flood hazard analysis. Therefore, only present day 100-year storm event scenarios (i.e., without SLR) are presented.
- Based on the 100-year event modeling results without SLR, a minimum DFE of +2.4 m LSD is recommended for the planned buildings/amenities, noting that this value does not include a freeboard/factor-of-safety. The vertical dimension of the building and structure floors and horizontal support members below the DFE shall be minimize to the extent possible to reduce lateral wave impact loads.
- No vertical retaining walls are planned west of the oceanfront buildings in the current site plan. However, for any such location where a vertical retaining wall may be required, DFEs shall be adjusted to be at least 1 m above the wall crest elevation for a distance of 9.1 m landward of the wall. This is due to wave effects which result in significant overtopping and runup (i.e., FEMA wave splash zone). *As an example, where an oceanfront retaining wall has a crest elevation of 2.4 m LSD, a DFE of 3.4 m is recommended extending 9.1 m landward of the wall.*
- The project design team has reported that the local soils conditions will require all habitable buildings to be founded on piles. For the area more than 20 m landward of the 30 m LPV setback, if any buildings are not structurally required to be founded on piles, stem walls are recommended at a minimum (as opposed to simple slab on grade) to protect the foundation from scour/erosion from sheet flow (e.g., overtopped flowing water, return flow as flood waters recede) adjacent to buildings.
- Upland control of stormwater runoff will be important in the final site design to divert water away from structure foundations and minimize ponding in unwanted areas.

The above recommendations are based on the 100-year return period storm condition (1% chance of occurring, on average, in any given year). The 100-year design storm event is used by FEMA in the US for establishing flood insurance premiums and building requirements in coastal flood zones. The Client/Developer/Owner may choose to adopt more (or less) conservative DFEs, setbacks, and/or construction approaches based on their goals and acceptance of risk concurrent with Government development requirements, available insurance, and aesthetics.

1.0 INTRODUCTION AND BACKGROUND

Applied Technology & Management (ATM), a Geosyntec Company, was contracted by Muqali, Ltd (Client) to provide coastal consultancy services associated with the redevelopment of the beachfront property at the former Jolly Beach Hotel on Lignum Vitae Bay, just south of Jolly Harbor on the western shoreline of Antigua (Figure 2-1). ATM has prepared this Coastal Engineering Assessment and Hazard Analysis report to support coastal upland development planning and design.

This report summarizes ATM's site-specific methodology and evaluations regarding risk of potential coastal hazards (coastal erosion, surge, flooding, and wave impacts) to inform proper building construction setbacks and elevations for the project.

The analysis included a site assessment and review of available information related to extreme coastal storm event occurrences (hurricanes and tropical storms). Long-term shoreline change was also assessed for the project site beach and nearby reaches to inform the Client on beach stability, long-term sediment transport patterns, and potential future beach management needs.

Recommendations for construction setbacks and building elevations of major and/or habitable structures were developed for the proposed project based on the available data, wave transformation and coastal risk modeling, as well as ATM's engineering judgment and experience in the region.

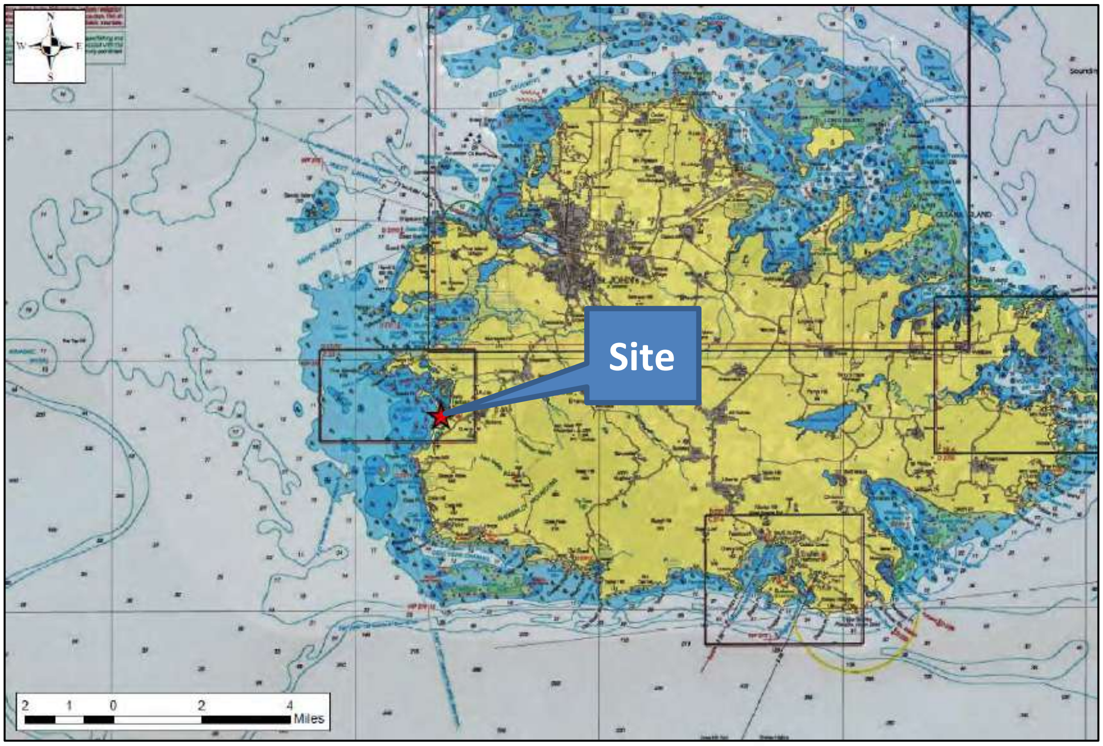
2.0 METOCEAN & COASTAL CONDITIONS

2.1 Project Setting and Exposure

The project site is located on the western shoreline of Antigua at Lignum Vitae Bay, immediately south of Jolly Harbor (Figure 2-1).

The primary environmental forces with the potential to affect the project site include wind, waves, and elevated water levels including sea level rise. The project location on the leeward / western side of Antigua is generally well protected from the prevailing easterly trade wind and waves which dominate the region. The proposed development is situated along an open coast sandy beach, however, the wide shallow shelf and reef systems which surround Antigua shelter the site from direct open ocean swell.

Additionally, the adjacent rocky headlands and offshore islets provide some level of protection and serve to "pin" the beach and, in conjunction with local bathymetry (depths), result in the relatively curved pocket beach geometry of Lignum Vitae Bay. It is noted that the project site is generally near the center of the Lignum Vitae Bay littoral cell, between the adjacent headlands.



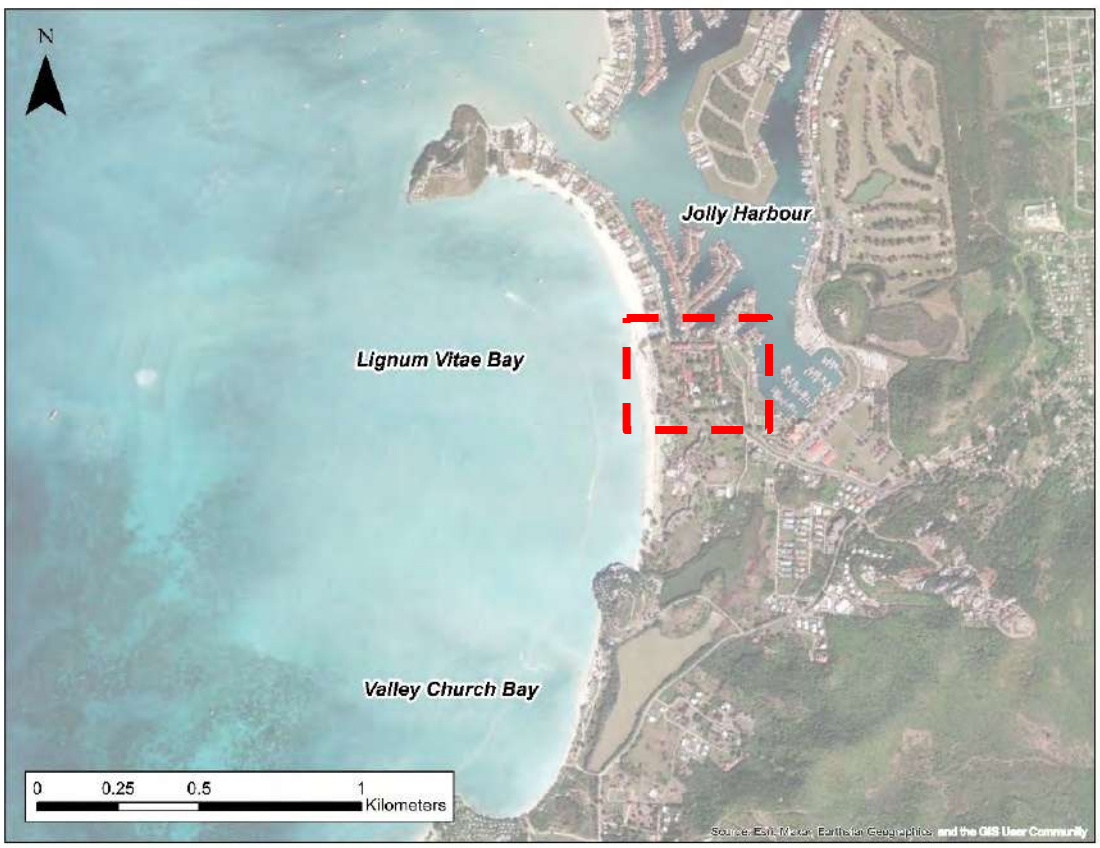


Figure 2-1. Upper Panel – Antigua Nautical Chart #C27 (Depths in Meters) and Lower Panel – Zoomed Nearshore View Showing Approximate Project Site Location (Red Dashed Box).

2.2 Project Tidal Datums

Table 2-1 presents tidal datums from the nearest NOAA (US National Oceanic and Atmospheric Administration) tide station (#9761115, Barbuda), located ~35 miles north of the project site. The NOAA datums exhibit good agreement with those of the St Johns Port datum (provided by Oceanside Solutions, Inc., 2024) located ~5 miles north of the site. Typical of this region of the Caribbean, the normal tide range at the site is small (less than 0.3 m between MLLW and MHHW).

Table 2-1. Project Tidal Datums

Water Level Datum	ft, MSL	m, MSL	ft, LSD	m, LSD
LSD* – Local Survey Datum	1.3	0.4	0.0	0.0
HAT – Highest Astronomical Tide	0.6	0.2	-0.7	-0.2
MHHW – Mean Higher High Water	0.3	0.1	-1.0	-0.3
MHW – Mean High Water	0.3	0.1	-1.0	-0.3
MSL – Mean Sea Level	0.0	0.0	-1.3	-0.4
MLW – Mean Low Water	-0.3	-0.1	-1.6	-0.5
MLLW – Mean Lower Low Water	-0.4	-0.1	-1.7	-0.5
LAT – Lowest Astronomical Tide	-1.0	-0.3	-2.3	-0.7

*Based on information provided by Oceanside Solutions – (~5-day tide study and timestamped site tide gauge measurement correlated with St Johns Port)

Some minor deviations from this NOAA station's (and St John's Port's) tidal datum would be expected at the Lignum Vitae Bay site, however, based on an ~ 5-day tide gauge deployment by Oceanside Solutions as well as previous nearby tidal studies by ATM, these tidal datums and ranges are considered generally representative of local site conditions for the purposes of this study. Based on information provided by Oceanside Solutions, the local survey datum (LSD) is approximately 0.4 m (1.3 ft) higher than Mean Sea Level.

2.3 Site Topography and Bathymetry

Upland topographic and nearshore bathymetric survey data for the site was provided by the Client. Figure 2-2 presents the bathymetric and topographic contours of the project location representative of existing site conditions. Existing upland elevations are variable throughout the project site, generally within the range of +1 to 2 m LSD. *Unless otherwise noted, all depths and/or elevations mentioned in this report are referenced to the local survey datum (LSD) to match the Client-provided surveys and grading/development plans*.

Offshore bathymetry was obtained from local nautical charts as well as Esri ArcGIS bathymetric layer services datasets, which primarily consists of the GEBCO (General Bathymetric Chart of the Oceans) 2019 grid dataset.

Depths in the immediate nearshore are shallow, less than 3.5 m (~12 ft), and mildly slope on the wide surrounding bank, which exhibits intermediate depths typically between 10 to 20 m (30 to 100 ft) for approximately 11 km (~7 miles) offshore from the site shoreline before drastically dropping off to deep water with depths greater than 300 m (1,000 ft).

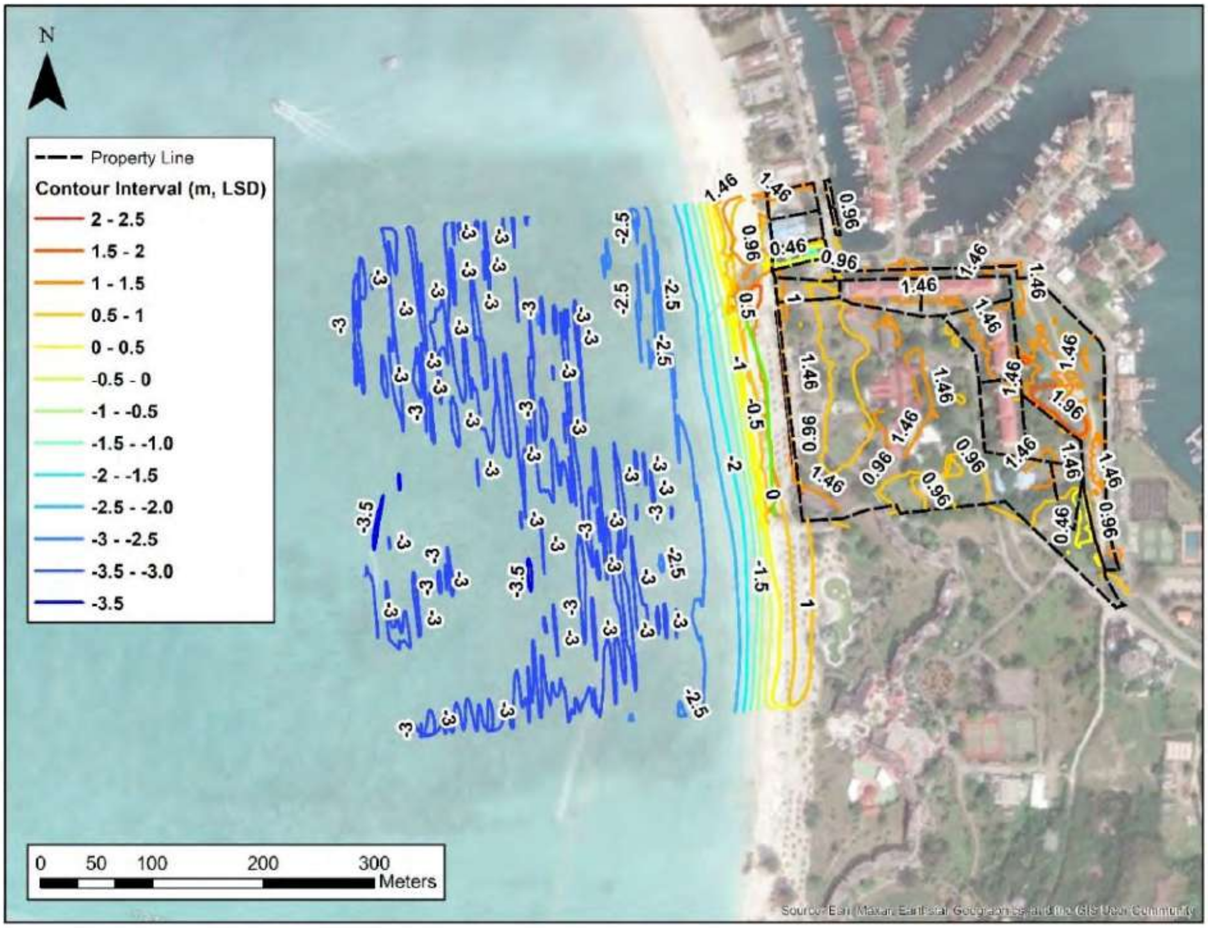


Figure 2-2. Existing Study Site Bathymetric and Topographic Contours. Property Line Shown as Black Dashed Line. Elevations are in meters referenced to the local survey datum.

2.4 Long-term Shoreline Change Analysis

Shoreline changes in Antigua have been monitored by the Fisheries Division since 1995 at various beaches, including Lignum Vitae Bay. The long-term trend is documented by James (2008) who analyzed beach profile changes on Antigua for the period 1995-2008. Figure 2-3 shows mean annual beach area (sectional volume) changes at Lignum Vitae Beach, noting that Sites B and D are representative of the project site beach. Observed trends are general accretion or stability, with periodic erosion due to seasonal conditions or tropical system impacts. Following impacts of Hurricane Georges on Antigua, Cambers (1998) assessed potential for erosion hazard on Antigua beaches and characterized Lignum Vitae Bay beach as “Low Hazard” due to general stability or accretional trends.

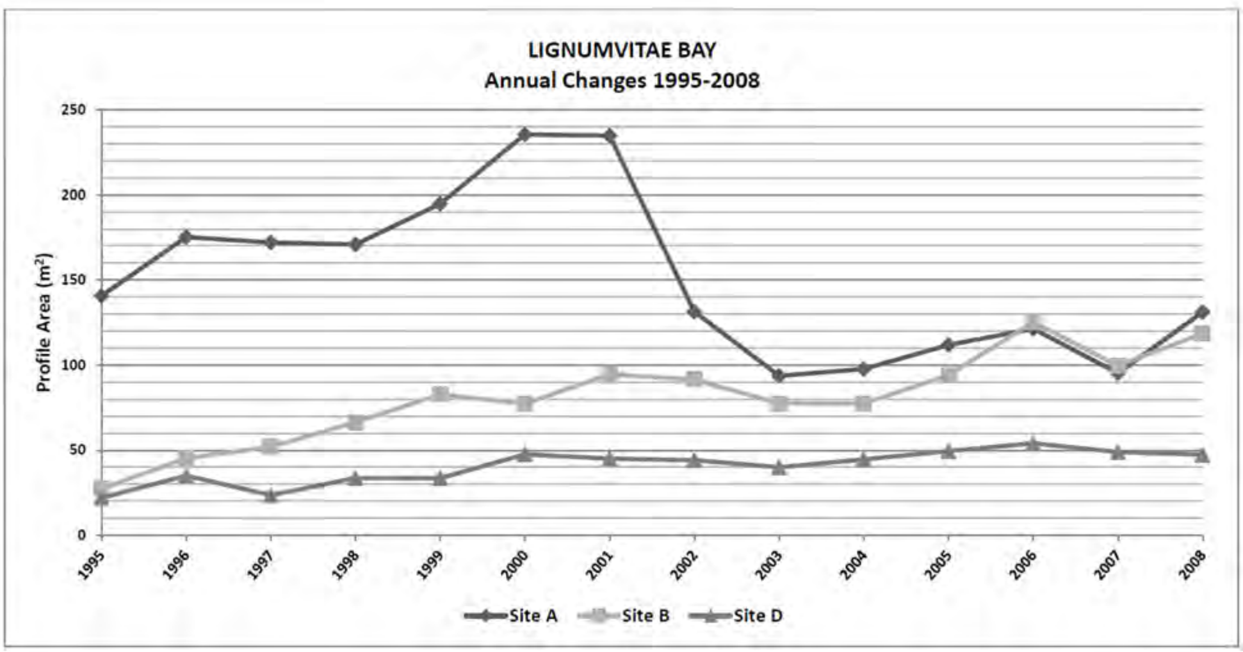


Figure 2-3. Beach Profile Area Changes, Lignum Vitae Bay (source: James, 2009)

ATM digitized approximate shorelines for years between 2003-2022 from publicly available aerial imagery to examine long-term shoreline change (Figure 2-4). The rocky headlands to the north and south, which encompass Lignum Vitae Bay, form a distinct littoral cell where sediment transport is primarily isolated to within this pocket beach system (meaning sand is largely localized to and shifts alongshore within this area due to changes in wave climate). Analysis reveals the site shoreline has exhibited general accretion (~70 ft) since 2003.

More recently (over the past few years), the shoreline has been largely stable with no obvious long-term erosional or accretional pattern. Being located in the center of a pocket beach, no significant longshore sand movement dominates in any particular direction. Longshore transport direction can be expected to vary seasonally throughout the year with changing wind and wave directions. However, no significant long-term erosion is observed, and the beach has remained relatively stable over the past two decades. Short-term erosional events are anticipated to occur primarily in the cross-shore direction associated with large storm events which can erode the upper beach and dune. This sand is carried offshore but generally remains within the system and can be expected to gradually return to the nearshore and beach over time in the calmer months following a large swell and/or storm event. Significant erosional events may warrant beach maintenance (e.g., sand nourishment) to restore the recreational beach and protective dune faster than the beach would recover naturally.

Beach monitoring through regular beach profile surveying along with post-storm assessments and surveys are a useful beach management strategy recommended for determining any future beach maintenance needs and gauging long-term trends. Since the Government's beach profile monitoring is relatively coarsely spaced, and not tied to known vertical and horizontal datums, a recommended Beach Monitoring Plan is provided in Appendix A for the Nikki Beach development.

Given the relative stability of the project beach, no new beach stabilization structures (such as groynes or breakwaters) are suggested at this time. However, it is recommended that the existing largely buried rock groyne structures at the Jolly Harbor flushing channel entrance and the small groyne at the south end of the property remain in place and not be removed during site construction and/or future development (Figure 2-4). These rock structures were constructed in the 1990s (exact dates unknown) but are likely helping to trap sand and maintain beach stability. Aerial imagery reveals the site shoreline has accreted overall since 2003, when these groynes were more exposed and the shoreline was farther landward. Currently these structures are largely buried, which is an indication of a stable to accretional beach.

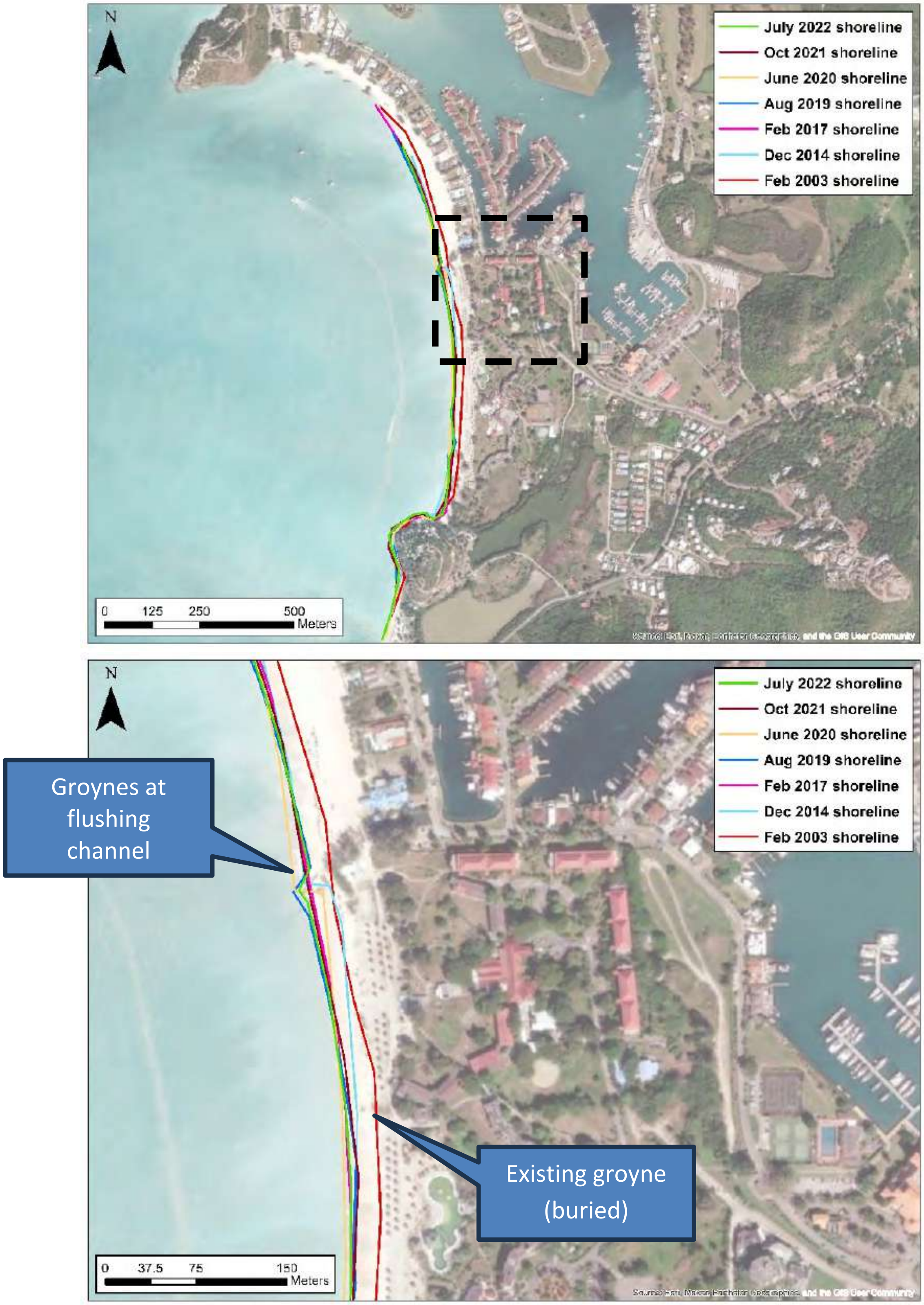


Figure 2-4. Shoreline Change Analysis at Study Site. Panels Show Shoreline Position by Month and Year with Shoreline Stabilization Features Identified

2.5 Winds

Figure 2-5 presents a wind rose summarizing windspeed and direction from 2011 to 2023 at V.C. Bird Airport, located ~ 7 miles northeast of the site. As Figure 2-4 shows, the average wind speed is 10.3 miles per hour (mph) and predominantly from the east-southeast to east-northeast. The easterly trade winds dominate the majority of the time, however, winds from more westerly directions do occur. These winds are much less frequent but are typically observed in the fall months. The project site is generally well sheltered from the prevailing easterly trade winds and waves, however, less frequent / more extreme events (e.g., tropical storms, hurricanes) can bring damaging windspeeds and large waves from various directions.

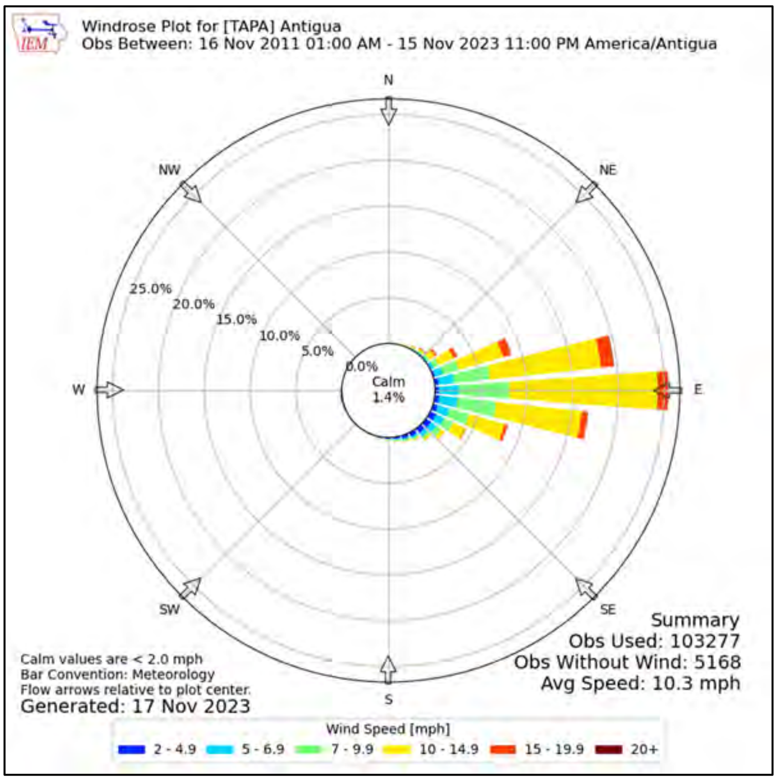


Figure 2-5. Antigua – V.C. Bird International Airport Windrose (source: Iowa State Mesonet)

2.6 Currents

There is no source of comprehensive current observations or predictions for Antigua waters. Ocean currents in the region are primarily tidally and geographically driven. The easterly trade winds are caused by the earth's rotation and a similar current pattern is also evident, known as the North Equatorial Current. This current pattern then turns into the Antilles Current as soon as it reaches the Leeward Islands (see Figure 2-6). On a regional scale, this current is typically ~ 0.5 knots (0.25 m/s).

The regional navigation charts show the Antilles Current running generally toward the NW, on both sides of Antigua in deep waters. However, more variable and stronger currents may be observed closer to shore, along headlands and between the mainland and small offshore islands and nearshore reefs, where local wind and bathymetric effects will control currents.

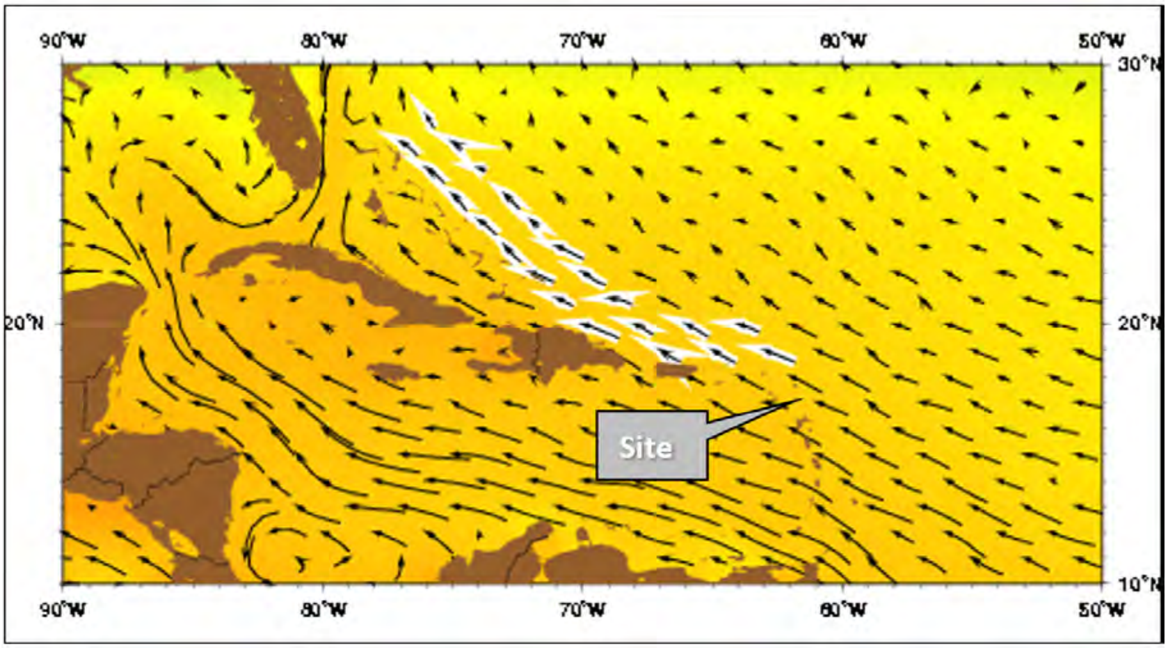


Figure 2-6. Regional mean currents (image source: University of Miami, 2007)

2.7 Tropical Storms and Hurricanes

Hurricane season for the Atlantic Basin is during the months of June through November and Antigua's location makes it susceptible to tropical systems. For the period of 1950 through 2023 (approximately 73 years), tropical storm/hurricane centers have passed within 50 miles of the island 24 times. This translates to Antigua being affected by a tropical storm or hurricane every 3 years on average. Tropical systems are the primary cause of extreme water levels (storm surge), wind, and wave conditions which can cause significant episodic beach erosion, and serve as design conditions for habitable structures and critical infrastructure along the coast.

Figure 2-7 presents hurricane tracks (tropical storms and depressions excluded) within 50 miles (80 km) of Antigua since 1950. Details on these storms are shown in Table 2-2. Over the 73-year time period, 12 hurricane centers have passed within 50 miles and half of these were "major hurricanes" (Category 3 or higher) when passing within 50 miles of Antigua. On average, this translates to a hurricane approximately every 6 years and a major hurricane about once every 12 years.

The most recent major hurricane that came within 50 miles of the site was Hurricane Irma in 2017 which made landfall on Barbuda as a powerful Category 5 storm and is the highest recorded intensity storm to make landfall in the Leeward Islands to date.

Generally speaking, Atlantic Basin hurricanes and tropical storms approach from the east and move westward, which situates the project site in a relatively more protected location on the leeward side of the island from these events. However, historical tracks show hurricanes can approach from other directions capable of significantly impacting the site. The potential for a landfall on the west coast of Antigua cannot be ruled out either given past activity. Hurricane Lenny in 1999 was only a tropical storm when it passed Antigua, but its effects from moving atypically eastward as it approached Antigua caused significant surge and wave impacts to the island's west coast.

Additionally, even with an east coast landfall, large slowly moving storms can cause the site shoreline to be subjected to surge and extreme waves as they move westward. Hurricanes in general are showing a trend of slower translational (i.e., forward) movement and this pattern is expected to continue. A recent study by NOAA revealed that that from 1949 to 2016, tropical cyclones across the globe slowed their movement by 10 percent on average (Kossin, 2018). Slow moving storms can increase the potential for coastal impacts as shorelines are subjected to extreme conditions for prolonged durations as they pass.

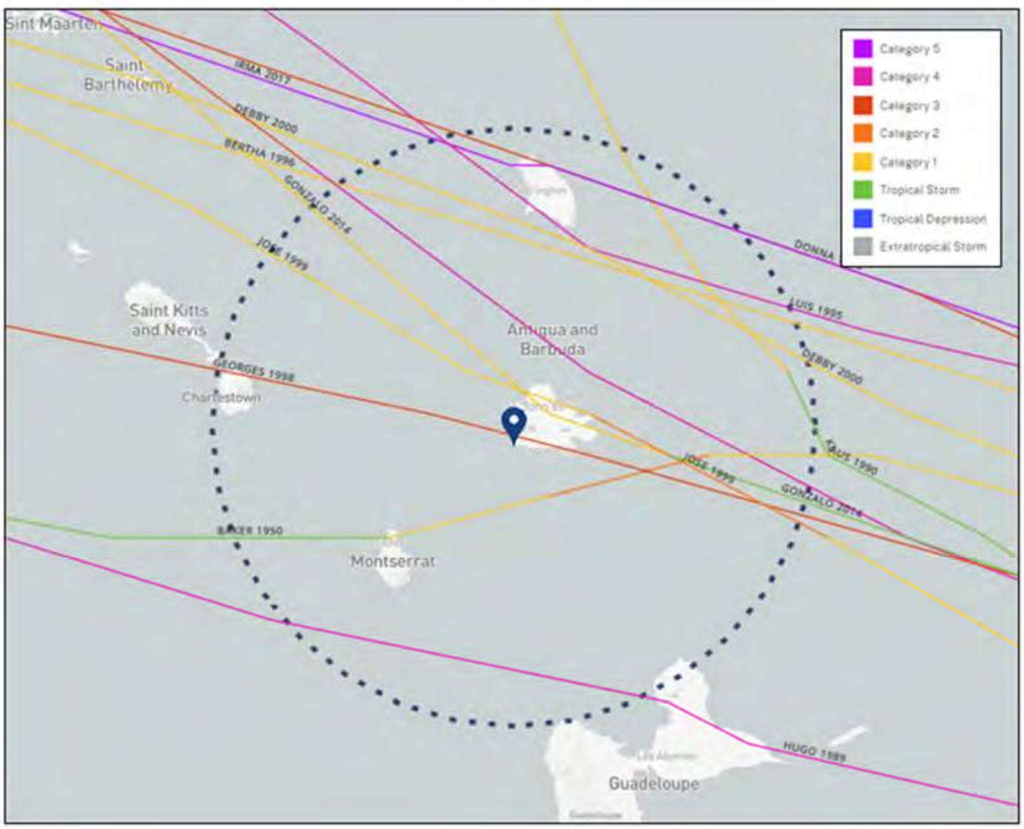


Figure 2-7. NOAA Hurricane Tracks within 50 miles of Antigua (1950-2023)

Table 2-2. Hurricanes Passing Within 50 miles of Antigua Since 1950

Date	Storm Name	Category
2017	Irma	Major Hurricane (5)
2014	Gonzalo	Major Hurricane (4)
2000	Debby	Hurricane (1)
1999 (Oct)	Jose	Hurricane (2)
1998	Georges	Major Hurricane (4)
1996	Bertha	Major Hurricane (3)
1995 (Aug-Sept)	Luis	Major Hurricane (4)
1990	Klaus	Hurricane (1)
1989	Hugo	Major Hurricane (5)
1960	Donna	Major Hurricane (4)
1950 (Aug-Sept)	Dog	Major Hurricane (4)
1950 (Aug-Sept)	Baker	Hurricane (2)

In addition to tropical systems, winter storms (particularly North Atlantic cold fronts due to the site's exposure) have the potential to impact the site with winds, waves, and elevated water levels and occur on a more frequent basis. They also can cause episodic beach erosion.

2.8 Storm Surge

Storm surge values were evaluated from several regional sources (OAS, 2001; GAR, 2015), past ATM regional experience, as well as Antigua specific studies (by others).

Based on ATM's review of available surge information, a value of 1.34 m above LSD (or ~1.7 m above MSL) was selected as a reasonable estimate of total storm tide (surge and astronomical tide) for a 100-year return period storm event at the study site. As a point of reference, the measured maximum water level on Barbuda (NOAA Station 976115) during passage of Hurricane Irma in 2017 was 8.2 ft (2.5 m) MSL. No known correlations to return period for Irma are available but is anticipated to be well over 100 years given it was a direct hit by one of the strongest Category 5 events to be documented in the Caribbean.

For siting of habitable structures and critical upland infrastructure, the guidance offered by the US Federal Emergency Management Agency (FEMA) is recommended. FEMA prescribes a 100-year return period (1% chance of occurring during any given year, on average) as the combined conditions of water level (storm surge and tide) plus wave effects.

It is noted that storm surge around open exposed coasts of the Caribbean islands are relatively small compared to long coasts with shallow offshore depths (e.g., the US Gulf Coast). The water has little area on which to "pile up" and the wave effects – wave setup, breaking waves, and wave runup, which occur on top of the static water level – oftentimes dominate what observers may call "storm surge".

2.9 Sea Level Rise

Various sources are available for the projection of future sea level rise (SLR). The nearest NOAA sea level trend gauge to the site is located at Charlotte Amalie, USVI (Station #9751639), and averages a SLR rate of 2.13 mm/year between 1975 and 2022 (see Figure 2-8) equating to a rise in MSL of ~0.1 m (4 inches) since 1975. This location can be considered generally representative of the eastern Caribbean and the Antigua study site in terms of relative sea level change and SLR projection curves anticipate this rate of rise to increase (see Figure 2-9).

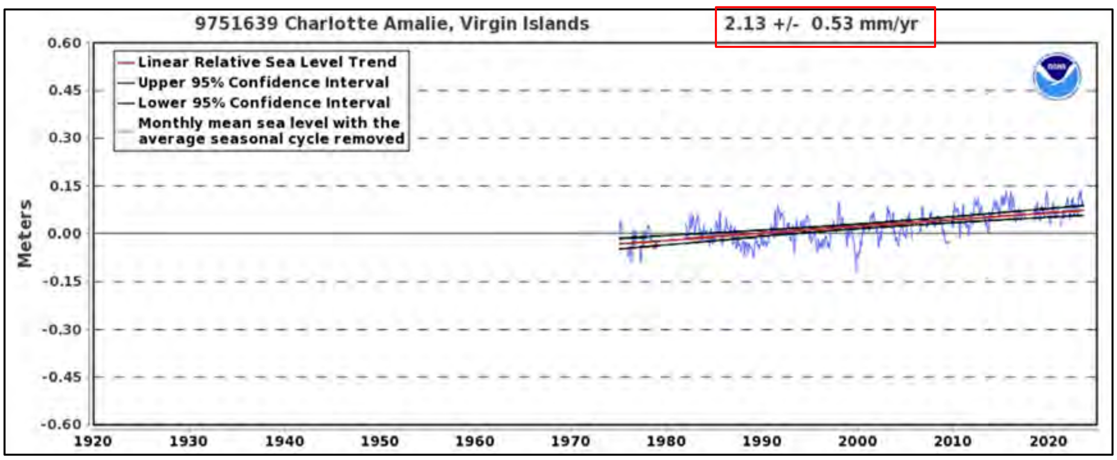


Figure 2-8. Observed Sea Level Rise at Charlotte Amalie USVI between 1975 and 2022** (**NOAA Tides & Currents)

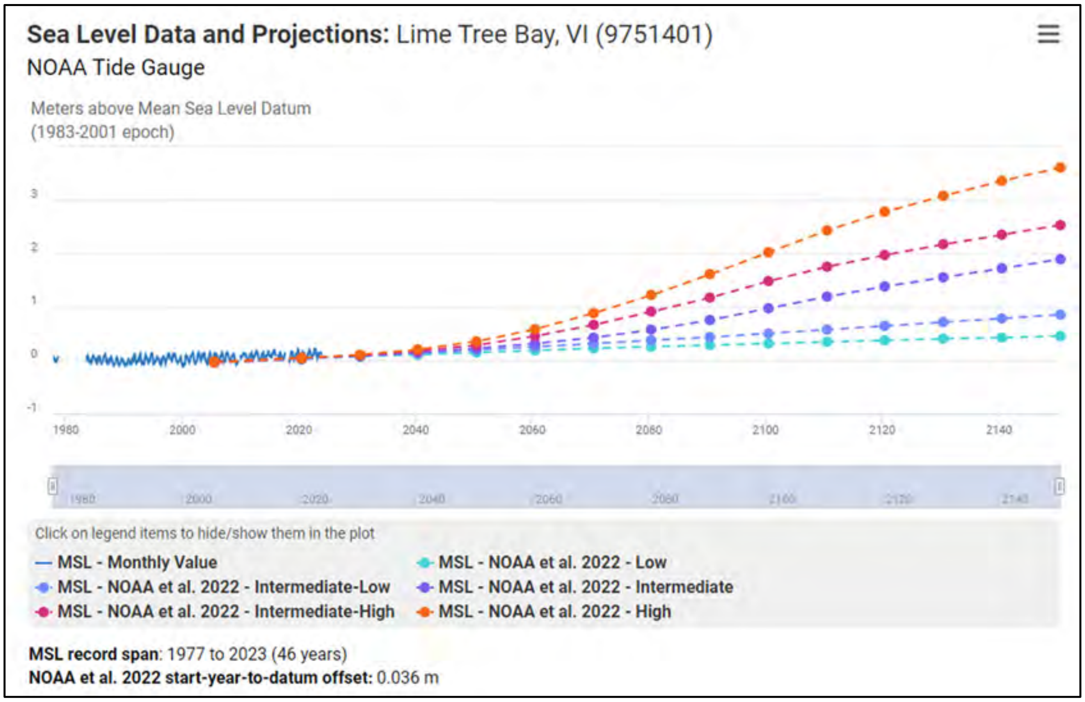


Figure 2-9. Projected Future Sea Level Rise to 2100 at Lime Tree Bay, USVI (source:* https://climate.sec.usace.army.mil/slat/*)

Based on the most recent literature and NOAA SLR prediction curves (NOAA et al. 2022), a projected SLR allowance of 0.3 - 0.4 m (1.0 - 1.3 ft) would typically be added to the 100-year surge level of 1.34 m (~4.4 ft) LSD in addition to the existing / ”present day” value (i.e., without SLR) assessment. This SLR scenario is representative of an intermediate rate of SLR over the next 30-50 years, which is a typical minimum horizon for coastal structures and buildings prior to requiring significant maintenance or replacement.

NOAA SLR values are compared with the range of potential sea level rise scenarios included in the Antigua and Barbuda Draft Coastal Development Guidelines (JECO Caribbean, 2015), which suggests a range of 0.13-1.45 m for a 100-year horizon. Averaging the JECO range over a 50-year period results in a similar 0.4 m value.

If the project Client/Owner/Developer chooses to be more conservative, higher values could be used. Conversely, although ATM typically recommends that an allowance for SLR be considered in development planning and design, the current FEMA methodology does not include explicit SLR projection allowances. As such, it is ultimately the Client/Owner/Developer’s decision whether to include SLR or freeboards based on their accepted level of risk versus project economics, aesthetic preferences, available insurance, and any applicable local Government requirements.

2.10 Seismic and Tsunami Activity

Antigua lies on the east edge of the Lesser Antilles volcanic arc, which extends from Grenada in the south to the U.S. Virgin Islands in the north. The Caribbean Sea region is exposed to tsunamis due to submarine earthquakes, landslides (subaerial and subaqueous), and submarine volcanic explosions. The primary submarine explosion threat is due to the active Kick'em Jenny submarine volcano, located just north of the island of Grenada, at the southeast corner of the Caribbean Sea. Figure 2-10 presents submerged and emergent volcanoes of the Eastern Caribbean Arc, including Kick'em Jenny.

Tsunami threat exists for Antigua, however, no current data is available to predict or document quantitative risks associated with tsunami. The Global Facility for Disaster Reduction and Recovery GFDRR (World Bank, 2010) reports the following:

Antigua and Barbuda are regularly exposed to seismic risk and are located in seismic zone 4 (on a 0-4 scale), a high-risk earthquake zone. The islands are located along the eastern margin of the Caribbean plate and as recently as 1974, were hit with a 7.5-magnitude earthquake which caused structural damages estimated in the millions. No active volcanic centers are located in the island group.

While tsunami is not considered a major recurrent risk for the region, the low-lying nature of the islands would make them particularly vulnerable to storm surge and tsunami. Tsunami risk is generally associated with the potential effects of an eruption of Kick-'em-Jenny located 500 km south of Antigua. Reports on the 1939 eruption indicate that a 2-meter tsunami was generated.

The BVI Department of Disaster Management's QRAP report (Young, 2006) states the following:

… structures near to the coast and less than 5 m above sea level are exposed to some (low) level of tsunami hazard. It is unlikely, though, that return-period based tsunami losses to critical infrastructure would be significant when compared to modeled earthquake and hurricane losses.

The above statement would also be true of proposed development at Lignum Vitae Bay. Thus, while tsunami threat does exist, the relative risk is much lower than that of wind and wave impacts associated with a passing tropical system. Wise coastal construction practices include siting building and critical infrastructure as far landward as possible and above minimum elevations described herein to minimize potential impacts. In addition, foundations of critical and habitable structures should be designed to withstand the local seismic loadings with applicable foundations penetrating the local soils as required by detailed structural and geotechnical design.

Figure 2-10. Volcanoes of the Lesser Antilles/Eastern Caribbean Arc

2.11 Offshore Wave Conditions

The primary source of deep-water wave data offshore of Antigua is from NOAA's WaveWatchIII model (WW3) hindcast. The WW3 model has been thoroughly tested world-wide and the operational wave forecasting systems at NOAA are based on the WW3 model. The project site is located within the WW3 model's 10-Minute Atlantic Grid, which provides wave hindcast data over an approximately 20-year period of record (July 1999 - May. 2019) and represents the most recent WW3 model output for the study site. Figure 2-11 presents the approximate locations of the WW3 data extraction relative to the study location on the west coast of Antigua.

Figure 2-11. WW3 Offshore Wave Extraction Locations for Study Site Overlaid on Esri Aerial Imagery and Topobathy

Figure 2-12 shows the corresponding WW3 wave roses illustrating the range of wave height conditions offshore of the southern, northern, and western shorelines of Antigua. Note that the wave directions shown in the roses use the convention indicating the direction from which the waves are coming. Wave heights are reported as significant wave height (H_s) which is a statistical basis for project design and represent the mean of the highest one-third wave heights within a given sea state. Larger waves than this height will occur, though they will be rarer and not representative of general conditions.

Offshore wave data is regional in nature and does not take into account local bathymetry and nearshore effects. Therefore, WW3 data is necessarily extracted in deep water and propagated into the nearshore at the project location with site specific models. The CMS-Wave model was used to transform the offshore wave data to the project shoreline, and this analysis is discussed in detail in the subsequent section.

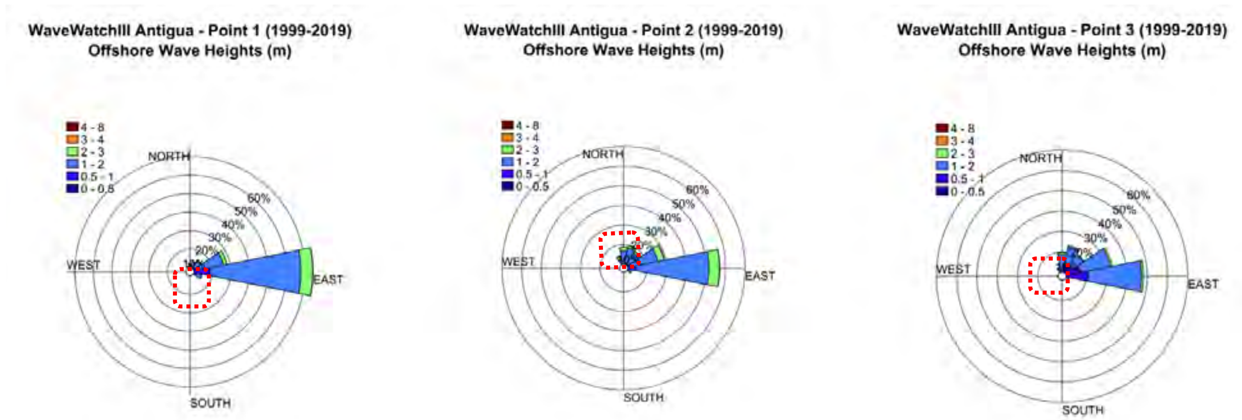


Figure 2-12. Offshore Wave Roses Showing Occurrences of Significant Wave Heights (H_s, meters) and by Direction for three WW3 locations

As Figure 2-12 shows, the offshore waves at the three WW3 locations are predominantly from the east with significant wave heights typically ranging from 1 to 3 m, which is expected given the regional easterly trade winds. Point 3 is more sheltered (by Antigua itself) and relatively smaller east incident waves are observed here. Similarly, easterly waves at Point 2 are generally smaller and occur less often than Point 1; however, larger swell from the more northerly and northwesterly directions are observed at Point 2 and occur relatively frequently (~13% of the time, see Table 2-3).

The project location, as situated on the leeward (western) side of Antigua is largely protected from easterly waves, however, large waves from the more southerly, northerly, and westerly directions do occur during more extreme (less frequent) events. Although waves from these directions occur far less often, they have the potential to greatly impact the site given its exposure to offshore waves.

Based on Jolly Beach's location, the statistical return period analysis for each WW3 point was selected considering the exposure of the site and incident wave directions critical to the project shoreline. Figure 2-10 highlights the critical directions analyzed at each point (red dashed square) based on the exposure of the site shoreline to the WW3 locations. Generally speaking, the extreme analysis directions for each location are defined as follows: Point 1 = "South" (southerly to southwesterly incident); Point 2 = "North" (northwesterly to northerly incident); and Point 3 = "West" (southwesterly to northwesterly incident). A summary of wave height statistics for the WW3 dataset for Point 2 (north of Antigua) is presented in Table 2-4 and highlights (in blue) the incident wave directions which are critical for the site given its offshore exposure to this location.

Table 2-3. Offshore Wave Height Percent Occurrences (Point 2)

Incident Wave	*WW3 Offshore Significant Wave Heights, m*						*Totals*
	0-0.5	0.5-1	1-1.5	1.5-2	2-4	4-8	
N	0.00%	0.40%	6.37%	1.76%	0.12%	0.00%	***8.66%***
NNE	0.00%	0.82%	7.46%	1.41%	0.07%	0.00%	*9.77%*
NE	0.00%	0.91%	6.36%	0.97%	0.07%	0.00%	*8.31%*
ENE	0.00%	1.74%	14.01%	3.32%	0.18%	0.01%	*19.26%*
E	0.00%	4.11%	37.45%	5.33%	0.16%	0.02%	*47.07%*
ESE	0.00%	0.35%	1.73%	0.10%	0.02%	0.02%	*2.22%*
SE	0.00%	0.00%	0.02%	0.01%	0.01%	0.01%	*0.04%*
SSE	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	*0.02%*
S	0.00%	0.00%	0.04%	0.01%	0.00%	0.00%	*0.05%*
SSW	0.00%	0.00%	0.02%	0.01%	0.00%	0.00%	*0.03%*
SW	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	*0.03%*
WSW	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	*0.03%*
W	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	*0.00%*
WNW	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	***0.01%***
NW	0.00%	0.02%	0.05%	0.01%	0.00%	0.00%	***0.08%***
NNW	0.00%	0.13%	2.76%	1.41%	0.10%	0.01%	***4.41%***
Totals	*0.01%*	*8.51%*	*76.31%*	*14.36%*	*0.73%*	*0.08%*	*100.00%*

The CMS-Wave model grid and input wave conditions were developed and considered in a similar manner to account for the critical exposures in terms of propagating the extreme offshore waves to the nearshore.

ATM completed a statistical return period analysis of the WW3 offshore wave data to develop a range of extreme wave conditions for each WW3 point, based on the exposure directions critical to the project shorelines described above. Table 2-4 presents the resulting offshore significant wave heights (H_s) for extreme return periods. The analysis consisted of both Annual Maxima and a peaks-over-threshold (POT) analysis utilizing in-house Matlab programs and the USACE (United States Army Corps of Engineers) CEDAS software package. In addition to significant wave heights, associated peak wave periods (T_p) were also developed based on the WW3 records and statistical analysis.

Table 2-4. Directional Extreme Offshore Wave Conditions

Return Period (Years)	Point 1 “South” Hs (m)	Point 2 “North” Hs (m)	Point 3 “West” Hs (m)	Tp (sec)
10	3.5	4.8	4.5	8
25	4.9	5.7	5.7	9
50	6.1	6.4	6.5	10
100	7.3	7.1	7.3	12

FEMA guidelines consider a 100-year storm event for flood hazard and coastal risk mapping. Therefore, the 100-year return period wave conditions in Table 2-5, (taken conservatively as 7.3 m, T_p =12 sec), were used as inputs for the CMS-Wave model from the various incident critical directions to simulate the transformation of these waves into the nearshore.

3.0 CMS-WAVE MODELING

The CMS-Wave model was used over the entire project region, out to deep water utilizing a 50 m cell resolution CMS-Wave grid generated in Aquaveo's Surface-water Modeling Solution (SMS) software. CMS-Wave, previously called WABED (Wave-Action Balance Equation Diffraction), is a component of the Coastal Modeling System (CMS) and was developed by the Coastal Inlets Research Program (CIRP) of the U.S. Army Corps of Engineers Research and Development Center, Coastal and Hydraulics Laboratory, in collaboration with two universities in Japan.

Model bathymetry was derived from Esri/GEBCO data and local nautical charts (described previously). All bathymetric data were converted to meters, referenced to Mean Sea Level (MSL), and a comprehensive merged dataset was then interpolated onto the model grid. The CMS-Wave model grid domain and bathymetry are shown on Figure 3-1.

CMS-Wave is a spectral wave transformation numerical model designed for accurate and reliable representation of wave processes affecting operation and maintenance of coastal structures in navigation projects as well as in risk and reliability assessment of shipping in inlets and harbors. CMS-Wave is capable of simulating wave processes such as diffraction, refraction, reflection, wave breaking, and dissipation mechanisms, and the wave-current interaction.

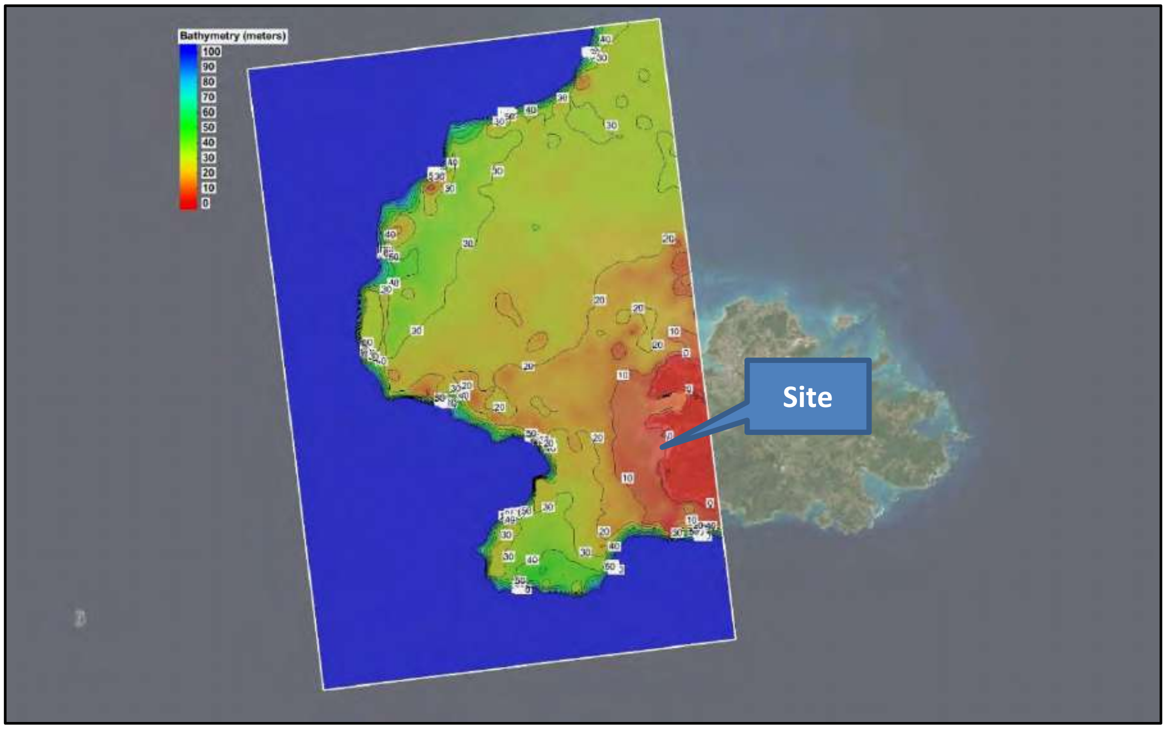


Figure 3-1. CMS-Wave Model Grid Domain and Bathymetry (in meters, MSL)

Following setup runs and preliminary testing of input coefficients and model settings, a CMS-Wave model 100-year conditions input matrix was developed based on the offshore wave analysis and exposure (discussed in the previous section). 100-year wave conditions were conservatively defined as: H_s = 7.3 m, T_p = 12 seconds and were input for various critical directions (ranging from south-southwest to north-northwest incident conditions) at the CMS-Wave model boundary.

Graphical outputs of wave vectors and wave heights (in meters) of select model simulations are presented on the following pages for discussion, and outputs of all model simulations are provided in Appendix B. Figure 3-2 presents the model outputs for the 100-year return period storm event incident from the northwest.

The offshore shelf, nearshore reef, and surrounding headlands provide some protection during extreme events, causing waves to shoal and as they transition from deep water to the shallow reef. As would be expected given Lignum Vitae Bay's cuspate shoreline and surrounding protective headlands, waves incident from between WSW and WNW - in general - are the controlling /worst-case scenarios. Under these conditions waves are oriented more perpendicular with the project shoreline, and tend to refract less and maintain their energy farther into the nearshore. Figure 3-3 presents a zoomed view of the governing case and shows offshore wave heights are significantly reduced as they shoal into the shallower nearshore waters and reefs.

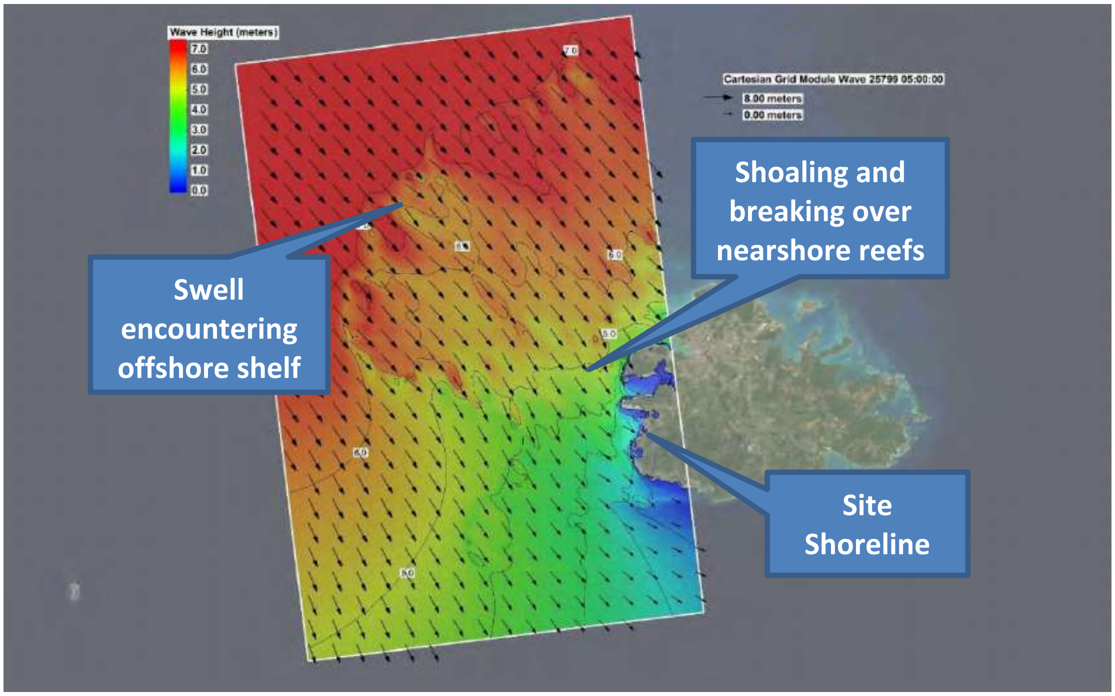


Figure 3-2. Case 1 – NW 100-Year [H_s = 7.3 m, T_p = 12 sec]

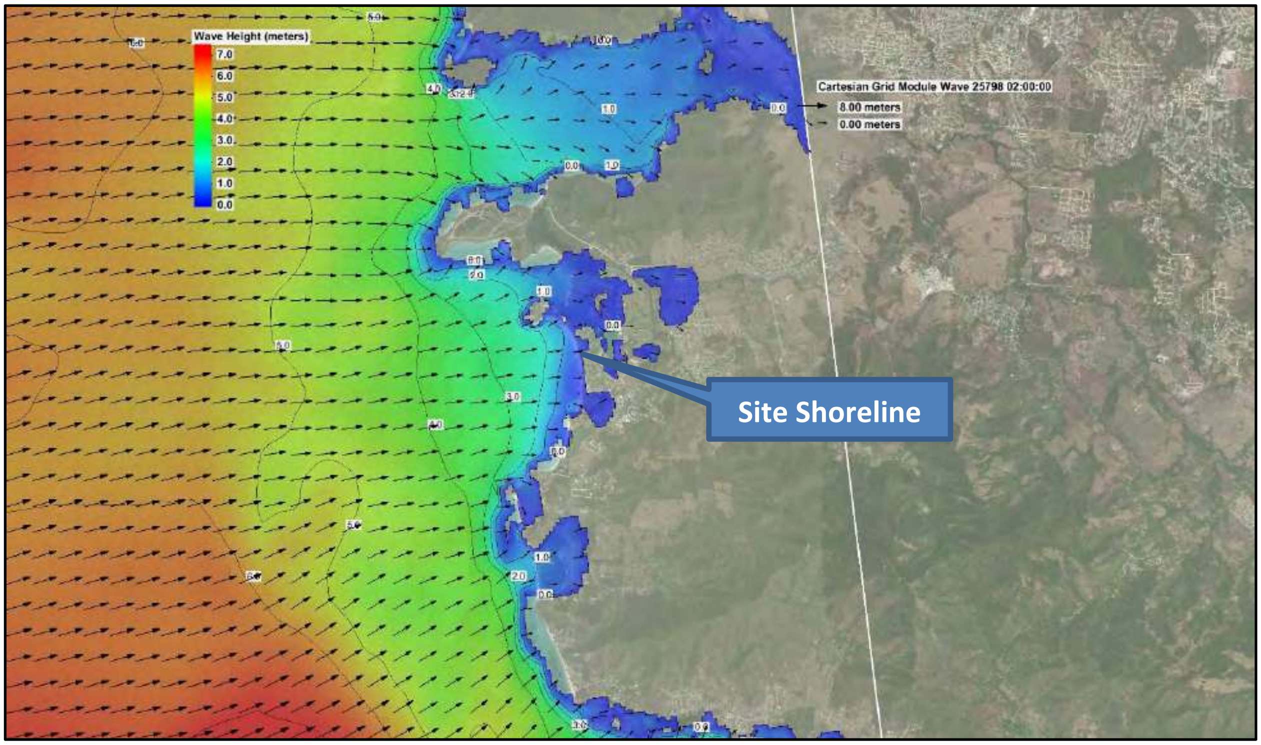


Figure 3-3. Zoomed Case 3 – West 100-Year [H_s = 7.3 m, T_p = 12 sec]

Following standard FEMA and SBEACH model guidance and methodology, wave conditions in the nearshore just outside/beyond the breaker zone are input for site-specific transect analysis. Based on the CMS-Wave modeling, governing 100-year nearshore wave conditions in this location at the center of the bay and approximately 1.6 km (~1 mile) offshore are $H_s = 4$ m, $T_p = 12$ s, generally from the west direction, but have the potential to approach from varying directions (these can be assumed to act shore perpendicular along the site coastline). ATM utilized these results as inputs into the CEDAS SBEACH model which will be discussed in more detail in the following sections.

4.0 COASTAL HAZARD ASSESSMENT

A coastal flood hazard analysis, specifically focused on the effects of passing tropical storms and hurricanes, was conducted to develop building finished floor elevations, setbacks, and other construction recommendations.

The methodology for this analysis included:

- Selection of extreme 100-year return period event water levels via review of available storm surge data/information, but not explicitly including projected sea level risk per directive of the Client (discussed further in Section 4.2);

- Development of extreme event wave conditions in the site vicinity based on an analytical coastal exposure analysis and numerical wave propagation modeling for the study site (described previously);

- Prediction of extreme 100-year return period event coastal risks, including surge, wave effects, erosion, and maximum wave height envelope and Base Flood Elevations (BFEs) using one-line wave models and coastal transect analysis at the site (described below); and

- Calculation of Design Flood Elevations (DFEs), development/construction setback recommendations, and other potential coastal flood hazards at the project site, similar to US Federal Emergency Management Agency (FEMA) guidelines (described below).

4.1 Potential Wave Effects at Shoreline and Base Flood Elevations

To determine the total flood coastal hazard during a storm event, wave effects are superimposed on top of the extreme storm water level.

Following FEMA guidelines, it was assumed that 70 percent of the wave height is projected above the still water level (comprised of surge plus wave setup). Still water level is often also referred to as still water elevation and denoted as SWL or SWEL. The maximum elevation of still water level plus wave height is known as the Maximum Wave Crest Elevation. This is the critical elevation to which wave crest heights can reach and serve as one basis for FEMA's Base Flood Elevations (BFE) for flood risk mapping in the United States and its territories (refer to Figure 4-1, below).

In addition to wave crest elevations, planning and design of project elements proximal to the shoreline must consider that during extreme events, as waves break along the site shoreline, there is potential for wave runup, overtopping, scour and erosion. Wave runup is the maximum vertical extent of wave uprush on a beach or other coastal topography or structure above the still water level. Figure 4-2 shows wave runup schematics for naturally sloped beaches and steeper coastal terrain. In some situations, the total potential wave runup elevation can exceed the maximum wave crest elevation and therefore the wave runup elevation would produces the governing BFE.

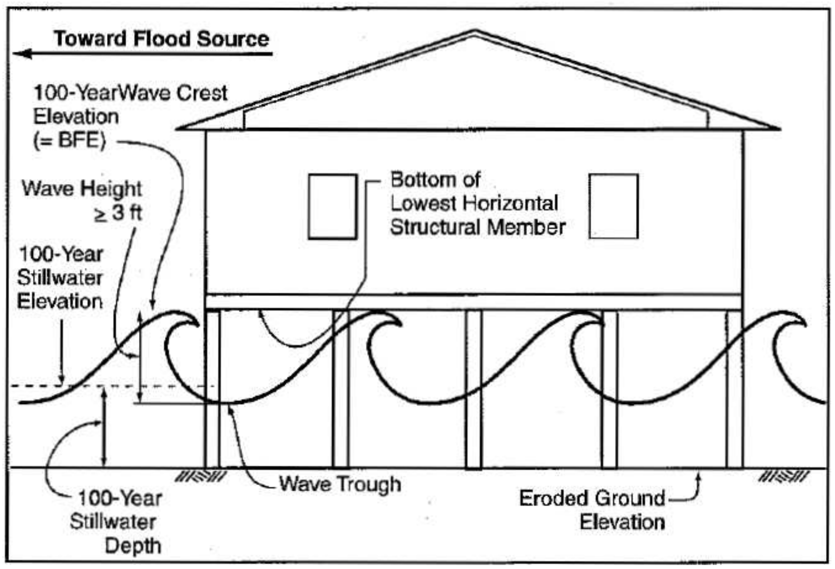


Figure 4-1. FEMA diagram showing waves riding on surge water level, and showing schematic freeboard of building lowest horizontal structural member above Maximum Wave Crest Elevation

Additionally, steeper eroded ("scarped") beach slopes and structures will result in higher values of runup and potential overtopping. Wave overtopping occurs if the potential wave runup exceeds the elevation of any shoreline topography or structure. Wave overtopping effects include wave splash as well as sheet flow of water behind the topography or barrier that may cause additional scour landward of the waves and can result in ponding in low-lying areas (refer to Figure 4-2, Bottom Panel).

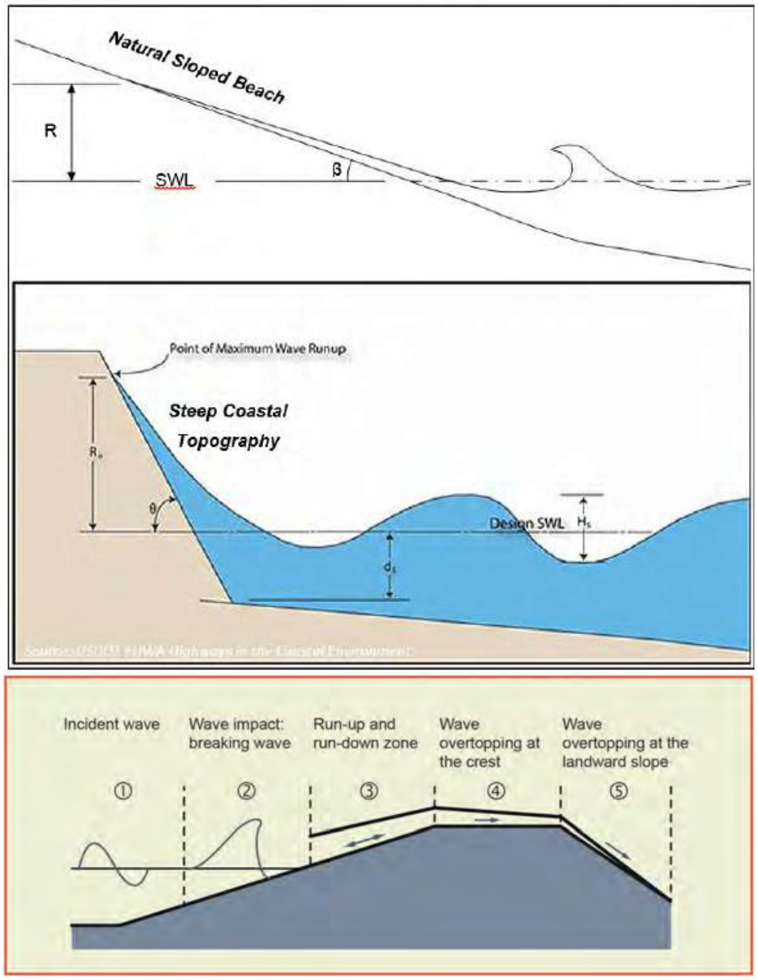


Figure 4-2. Wave Runup and Overtopping Examples

4.2 SBEACH Model Setup

ATM utilized CMS-Wave nearshore output results as wave inputs into the United States Army Corps of Engineers (USACE) Coastal Engineering Design and Analysis System's (CEDAS) SBEACH *(Storm-induced BEAch CHange*) numerical model to determine maximum wave crest elevations, runup, and resulting BFEs at the site. The SBEACH model was used to simulate storm waves, water levels (including wave setup), and cross-shore beach and dune erosion along two (2) selected transects at the project site as shown in plan view on Figure 4-3. Transects were selected to represent the typical conditions along the Nikki Beach shoreline based on the proposed site development plan, proposed grades, and locations of structures.

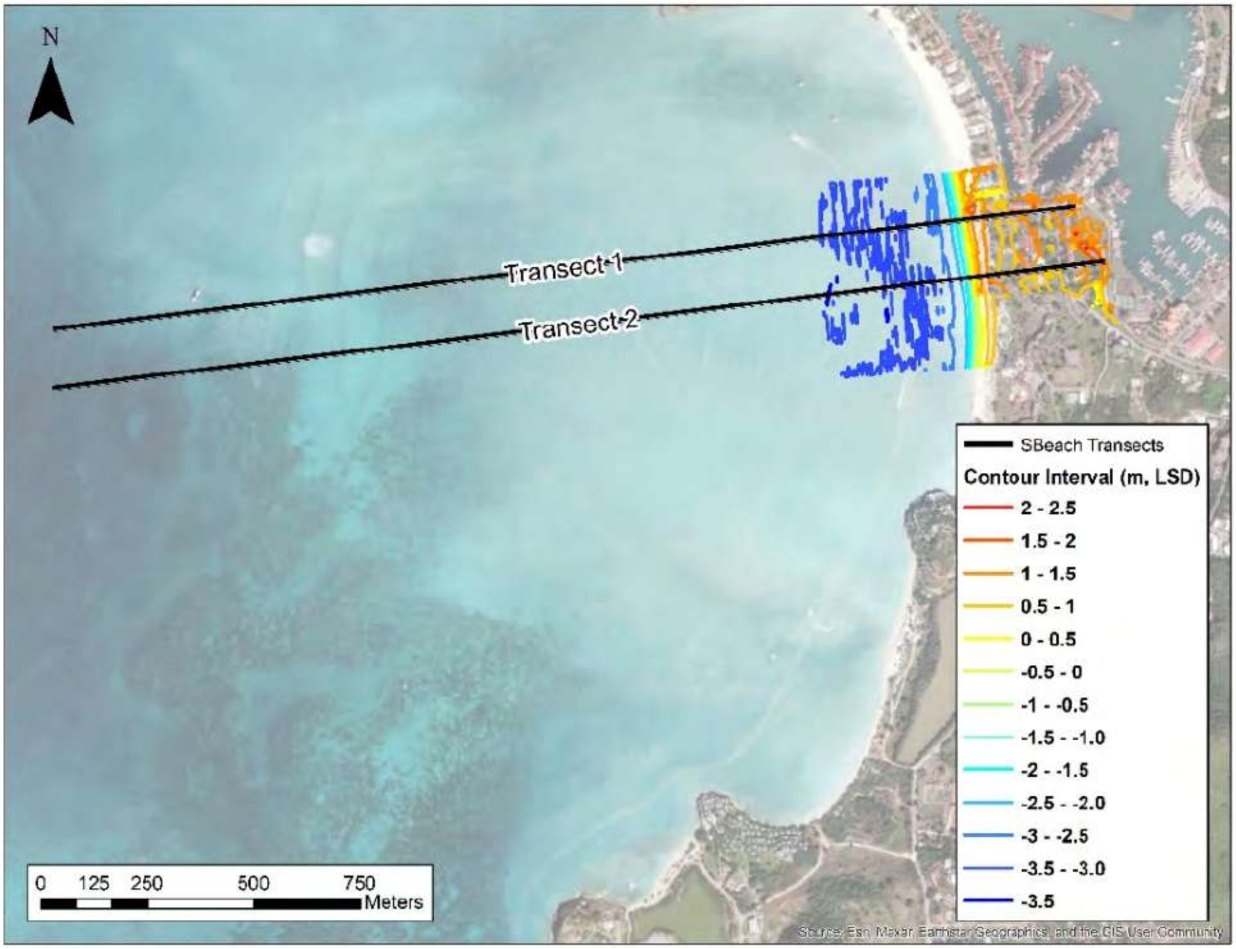


Figure 4-3. SBEACH Transect Locations Overlaid on Existing Topographic Contours

Based on the CMS-Wave modeling conducted for the site, governing 100-year nearshore wave conditions in this location at the center of the bay and approximately 1.6 km (~1 mi) offshore are H_s = 4m, T_p = 12s, generally from the west direction, but have the potential to approach from varying directions (these can be assumed to act shore perpendicular along the site coastline). The SBEACH model is 1D and depicts a "slice" of the beach and dune at each selected transect (cross-section) location. The transects cover a range of representative site shoreline conditions and SBEACH results show erosion, flooding inundation, and propagation of wave effects moving from offshore to inland for each location.

With passing hurricanes, the water levels and wave conditions will rise to and fall from the peak values over time, with the peak occurring only for a finite period (typically less than ~ 2 hours). SBEACH simulations were run for a 12-hr duration, 100-year storm with a peak surge level of 1.34 m (4.4 ft) LSD and constant initial wave conditions (H_s = 4 m [13 ft] and T_p = 12 sec).

The above inputs represent existing (i.e., present-day) 100-year storm conditions. For consideration in future planning, a 50-year SLR projection of 0.4 m (1.3 ft) was added in preliminary analysis to develop an input “future” peak water level of 1.74 m (5.7 ft) LSD. Coordination with the Client after initial analysis, based on Client accepted balance of acceptable risk versus project economics and other factors, indicated a directive to not explicitly include SLR in the flood hazard analysis. Therefore, only present day 100-year storm event scenarios (i.e., without SLR) are presented herein.

SBEACH simulations also estimate additional water level increases along the shoreline due to wave setup (an increase in local increase water levels due to breaking waves) on the order of 1.5 ft (~0.5 m) or more.

Model simulations were run for present-day 100-year storm condition scenarios for both the existing site topography and under post-project conditions using a proposed site development and grading plan (including building layouts) provided by the Client and Project Team. Seaward structures in closest proximity to the shoreline, will in general be founded on piles which allow flood waters to pass below the structure. Based on information provided by the Client team, ATM understands the following are proposed:

- all buildings and pool decks are currently proposed to be elevated and founded on piles due to geotechnical requirements, with retaining walls minimized to the extent possible for the seaward most line of construction;
- Finished Floor Elevation (FFE) is currently proposed at 2.44 m for most habitable/residential buildings closest to the beach;
- the Beach Club deck (NW corner of site), and the pool deck (middle of site plan) have FFEs proposed at 1.25 m and 1.82 m, respectively.

For post-project simulations, Transect 1 was modified from existing conditions to include the proposed grading contours which include a 1V:6H typical seaward slope of sand fill from the existing beach grade up to just under the substructure of the proposed buildings and decks (Figure 4-4). This was extended per sections provided by the Project Team at Transect 1 to represent the most seaward building locations on the site plan (which occur between the Beach Shack and Villas just south of it) and allows for assessment of wave and water level impacts on the most vulnerable proposed buildings.

Transect 2 is located along a proposed storm water drainage/wetland feature, where inland elevations do not reach 2 m until 110 m from the property line. This represents the most conservative estimate for potential wave and water level impacts, as wave impacts may extend farther landward with no structure and/or significant grading in place. Figure 4-5 shows the proposed site grading plan and building layouts, relative location of SBEACH transects, and the Line of Permanent Vegetation (LPV, provided by Client). The LPV is also shown on the cross-section figures which follow and used for reference in setback distances analysis and discussion, provided in subsequent sections.

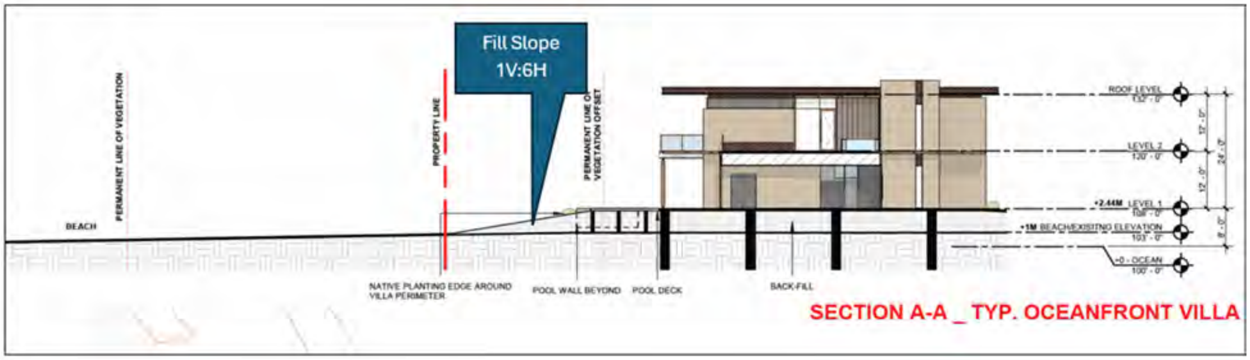


Figure 4-4. SBEACH Transects Overlaid on Portions of Proposed Study Site Topographic Contours (in meters, LSD) and Site Development Line Work.

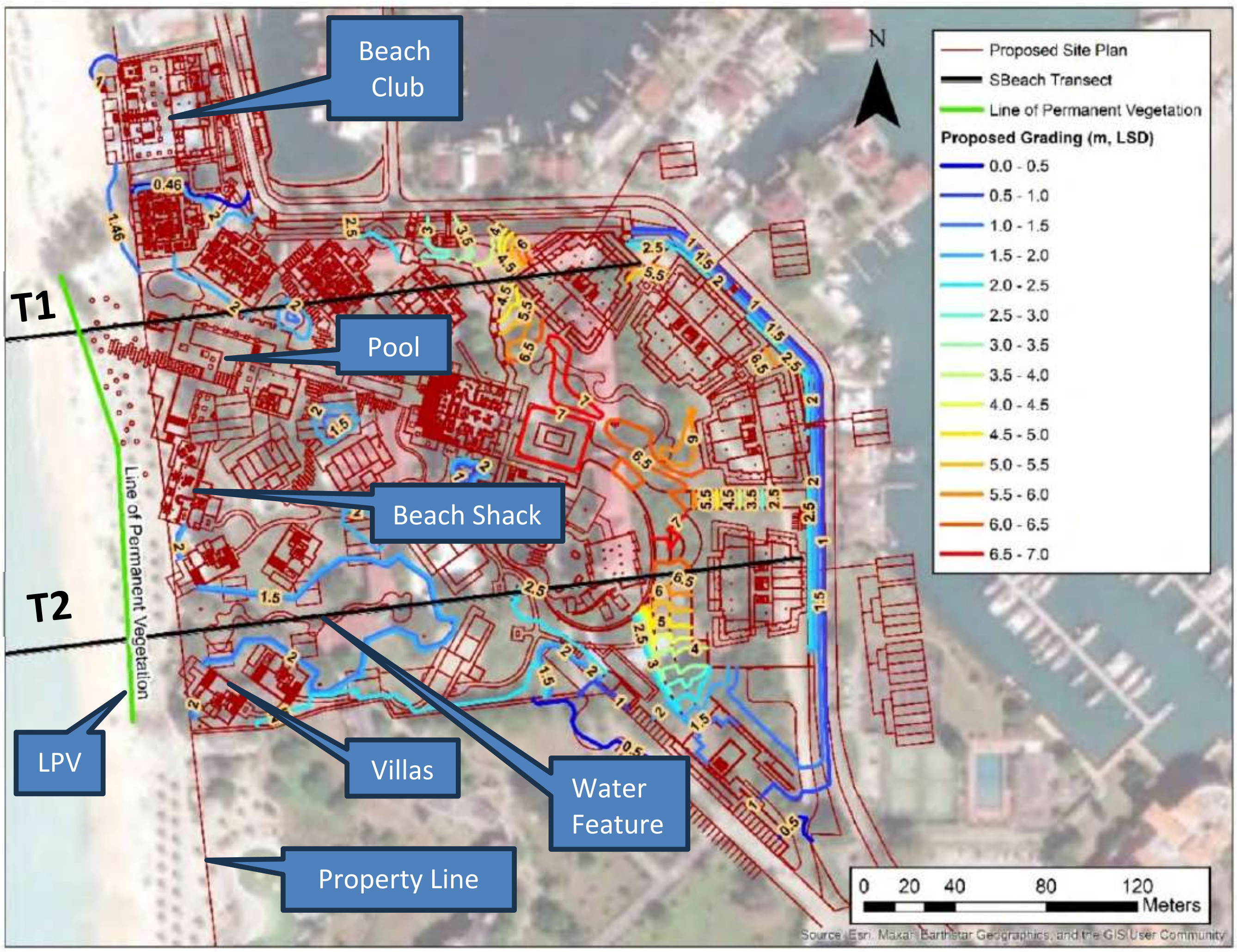


Figure 4-5. SBEACH Transects Overlaid on Portions of Proposed Study Site Topographic Contours (in meters, LSD) and Site Development Line Work.

4.3 SBEACH Results

Cross-section exhibits of SBEACH 100-year storm simulation outputs for "present-day" (i.e., no SLR) scenarios are presented on the following pages. Results analyzed under existing site topographic conditions simulations and for proposed project conditions are shown on Figures 4-5 and 4-6, respectively.

Topography, flood levels, and maximum wave heights are graphed in section along the transect, moving from deeper nearshore water onto the site shoreline and upland. For each simulation run, the cross-section exhibits depict the pre- and post-storm/eroded profile as well as the maximum still water level (SWEL) and wave heights, which are combined to develop the controlling BFEs (depicted as a solid blue line) which vary along the transect.

In general, the maximum wave crest elevations result in the governing BFEs at the site, however, wave runup elevations can govern near vertical retaining walls, as described in the proposed conditions simulations below. The location of the LPV (black dashed line) and the 30 m setback line from the LPV (solid red line) are shown on the cross-sections for reference. General discussions of the results for each scenario run are provided below.

Existing Site Conditions ("Present-Day")

Under the 100-year storm scenario without SLR for existing site conditions, the inland extent of significant erosion for both transect locations aligns closely with the location of the 30 m setback line. Overwash is observed landward of this setback for both transects, and the maximum water level and wave crests exceed the ground elevation, meaning inundation and overland wave propagation would be anticipated.

For both transects, BFEs seaward of the LPV and dune/beach berm are typically +3 m LSD or higher. BFEs decrease from +2.7 LSD to +2.4 m LSD within the 30 m LPV setback. Approximately 120 m landward of the LPV, the BFE reduces further to a minimum of +2.1 m LSD, which is conservatively extended to the landward extent of the subject property. In general, the existing grades are low across the site, thus significant inundation is anticipated during 100-year conditions.

Proposed Site Conditions ("Present-Day")

Results for proposed conditions under the 100-year storm without SLR scenario show for Transect 1 that the proposed grading around the proposed buildings maintains the same BFE characteristics as the existing conditions. Erosion and scour would be anticipated to extend under the seaward most deck and building footprints, which are in general approximately at the 30 m LPV setback line. Figure 4-7 presents a more zoomed in view of Transect 1. Ideally the buildings would be elevated so the horizontal lowest supporting structure of the building and deck are above the BFE, but if they extend below the BFE, the structures just need to be designed to withstand the associated flood forces.

At Transect 2, erosion is also observed landward of the 30 m LPV setback line, though this is relatively minor and no buildings or habitable structures are planned in this area. This observed erosion, taking place farther landward than observed under existing site conditions, is likely a result of the proposed higher grading elevation which provides greater upland protection but can induce additional wave breaking and results in some additional shoreline scour.

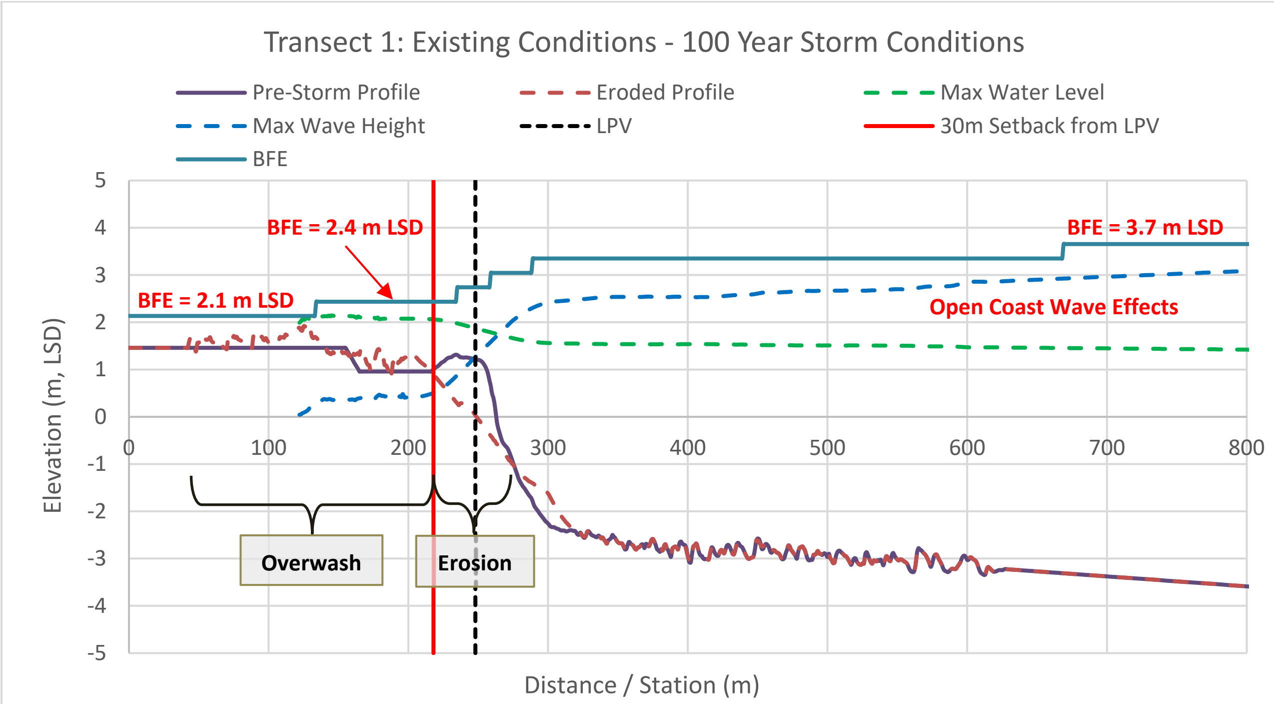
Also note the model assumes the entire Transects 1 and 2 are erodible sandy material and as portions of this area will likely be vegetated (grassed/sodded) or hardscaped, this extent of erosion may be conservative. Planting stabilizing vegetation, hardscaping, and/or enhancing the dune system will help to mitigate erosional damage in this particular area.

At both transects, wave propagation, runup, and overwash are observed landward of the 30 m LPV setback line; however, the upland portions of the site are not fully inundated and exhibit limited overland wave propagation as a result of the proposed grading.

Under a 100-year flood scenario (no SLR) for both transects, base flood elevations driven by overland inundation and wave propagation decrease from +2.7 m to +2.4 m within the 30 m LPV setback area.

Farther inland, BFEs reduce to a minimum of +2.1 m approximately 65 m landward of the LPV at Transect 1 and 85 m landward LPV at Transect 2. Following FEMA methodology, this inland BFE is conservatively extended to the landward edge of the property, even if proposed fill grades are above this elevation.

Existing Site Conditions (no SLR / "Present-Day")



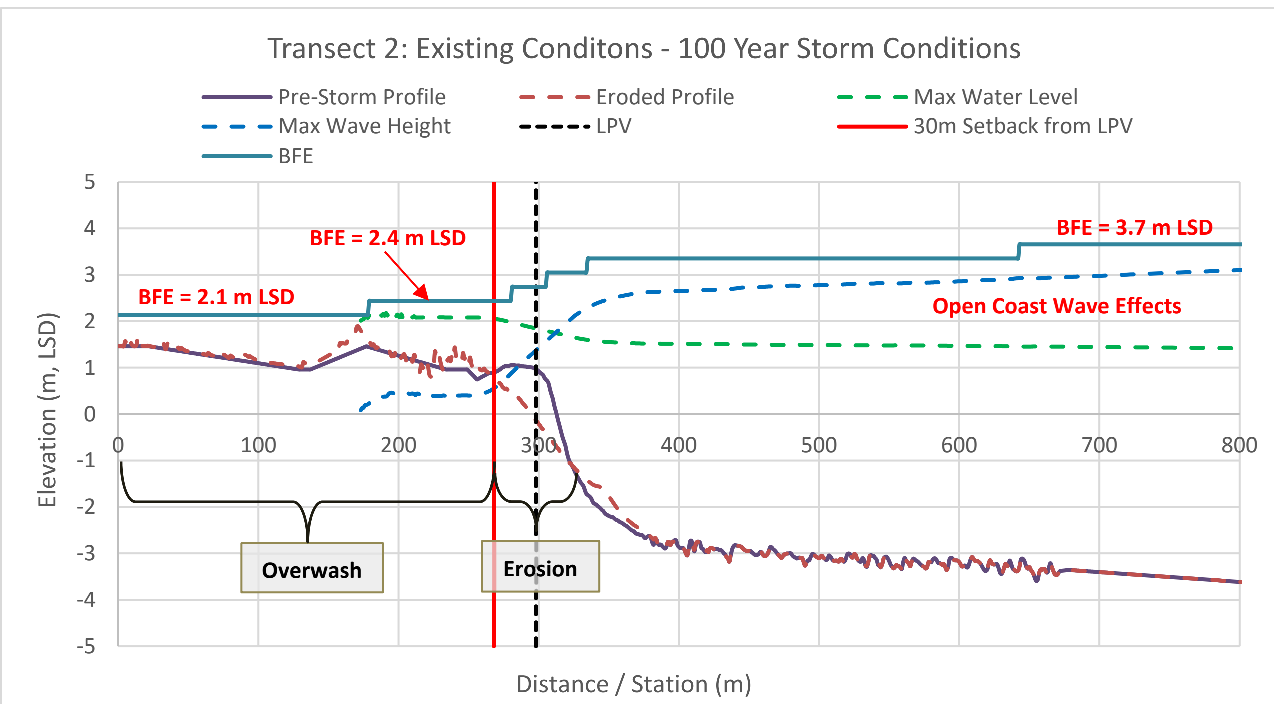
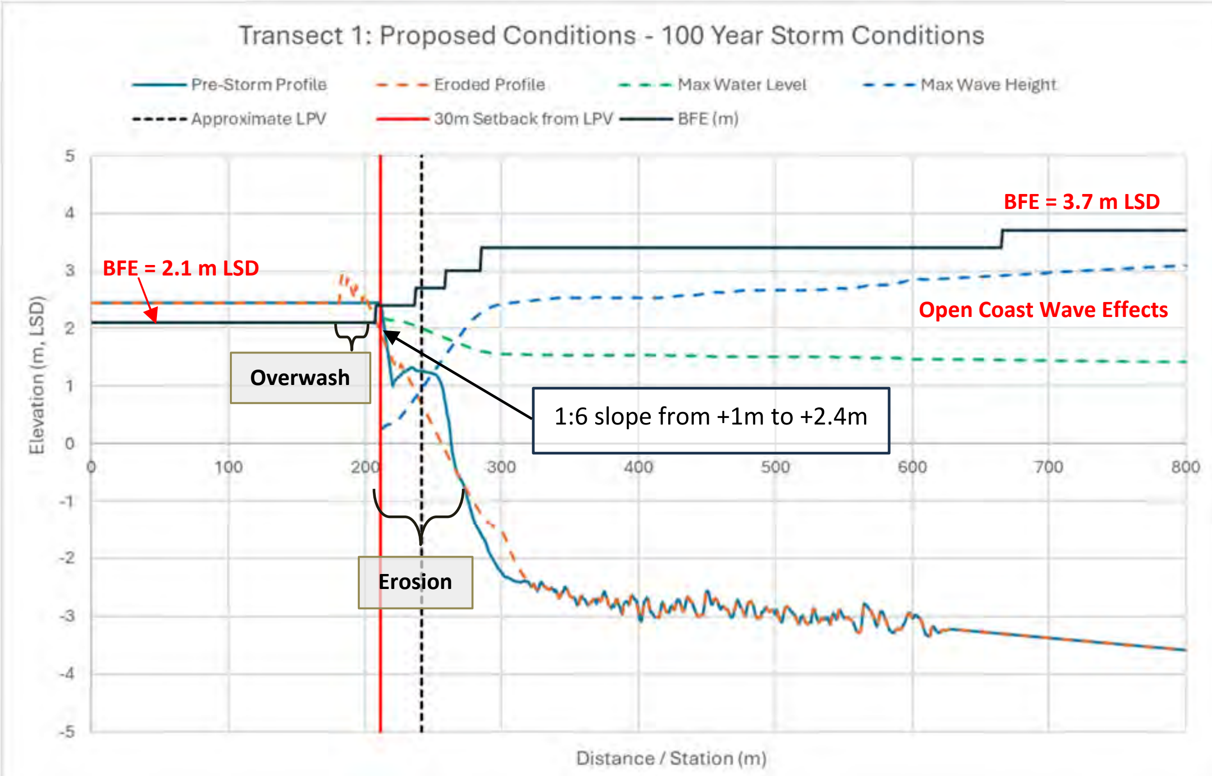


Figure 4-5. Existing Conditions (Present-Day / No SLR) 100-Year Scenario. SBEACH Outputs, Pre- and Post-Storm/Eroded Topography and Calculated BFEs

Proposed Conditions (no SLR / "Present-Day")



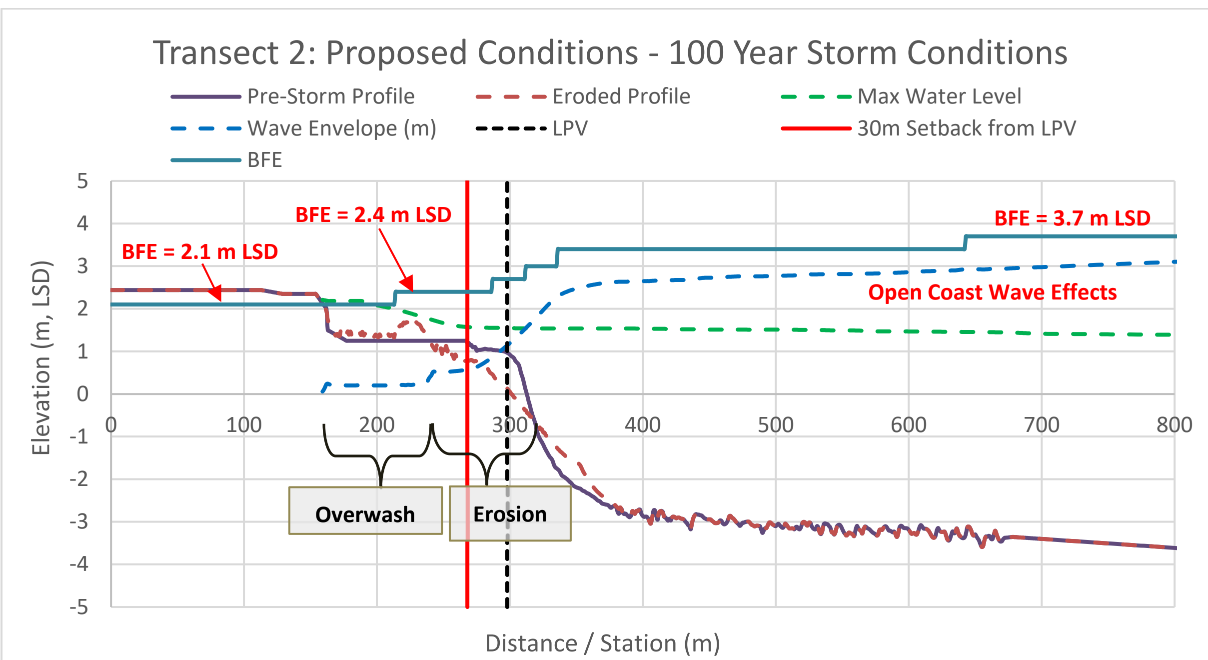


Figure 4-6. Proposed Conditions (Present-Day/No SLR) 100-Year Scenario. SBEACH Outputs, Pre- and Post-Storm/Eroded Topography and Calculated BFEs

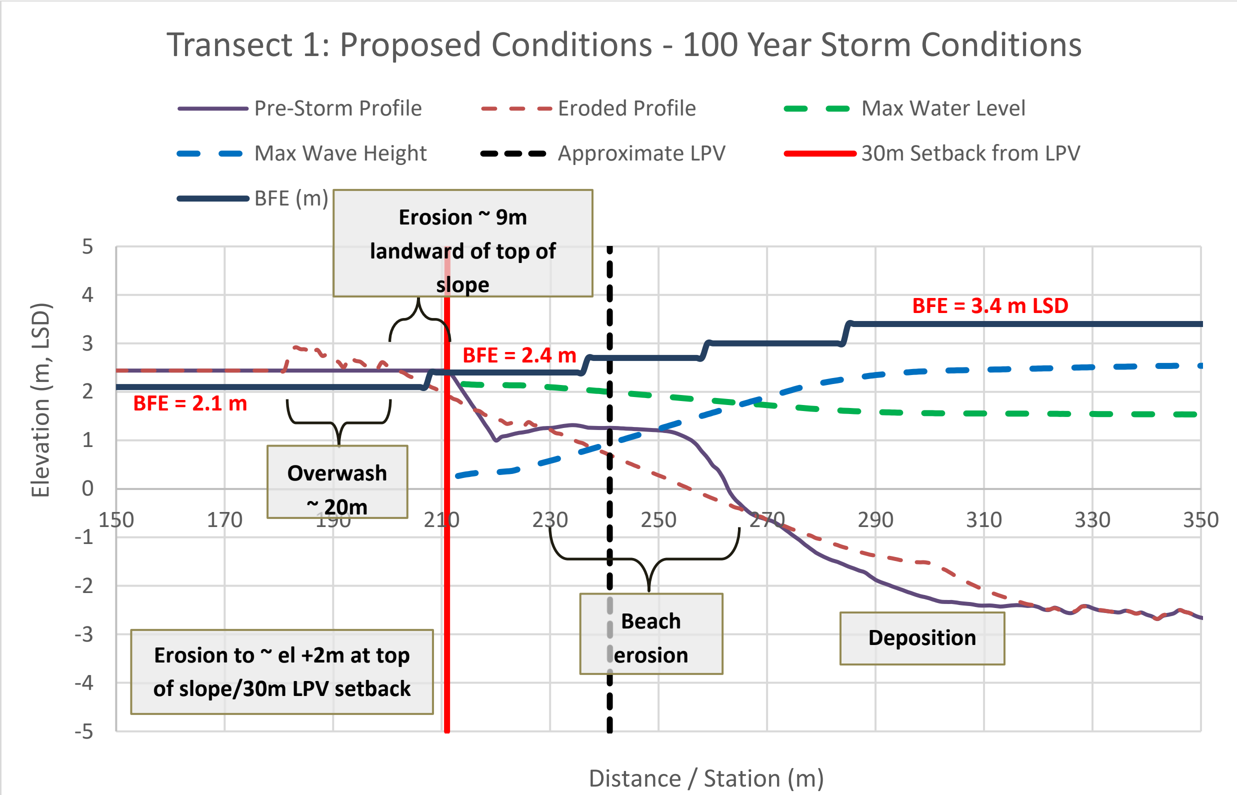


Figure 4-7. Zoomed View, Proposed Conditions (Present-Day/No SLR) 100-Year Scenario for Transect 1.

4.4 Coastal Construction - Best Practices

4.4.1 Design Flood Elevations

The flood elevations presented in the Section 4.3 for the present-day (no SLR) 100-year condition cases are comparable to what FEMA guidelines establish as the Base Flood Elevation (BFE) that account for surge and wave effects (e.g., wave runup, overtopping, overland wave propagation).

These are minimum FEMA required elevations, and state or local guidelines in the US generally require a BFE plus a safety factor to achieve the Design Flood Elevation (DFE). The recommended design flood elevation (DFE) includes a minimum additional 0.3 m (1 ft) factor of safety (i.e., freeboard) to provide a conservative account for uncertainty in the analysis. Due to increased awareness of future SLR, many communities now require a minimum 0.6 m (2 ft) freeboard above BFE. Alternatively, the BFEs resulting from “future” 100-year storm scenarios which include SLR may be considered an acceptable DFE.

Design Flood Elevations are used as a basis for project design, particularly with respect to lowest horizontal member elevation (LHME) and/or finished floor elevation (FFE) of upland buildings and critical infrastructure. In practice, and subject to appropriate insurance requirements and risk management review, the lowest FFE or LHME is typically located at or above the DFE elevation.

Nonessential elements like parking, landscaping, temporary structures, etc., may be sited at lower elevations if the associated risk is deemed acceptable by the owner/operator. All developers should consult the local governing authority regarding construction setbacks and other guidelines.

Any planned construction in the beachfront areas would need to adhere to certain construction guidelines. Specific construction techniques and precautions (such as those found in the Coastal Construction Manual, FEMA-55) should be implemented in the development of the site to help decrease risks associated with coastal hazards and damage during extreme events. For example, disallowing structural fill for constructing “on-grade” foundations of structures in vulnerable areas will ensure that, even if the adjacent grade is eroded, and the floor/slab undermined during an extreme event, the structure is “self-supporting” (i.e., pile-supported) and would not be catastrophically damaged.

Elevated buildings (on piles or open wall structures with LHME above the DFE) are common in coastal flood zones in the US and offer additional covered “open-air” spaces below the first finished floor. The use of break-away non-structural partition walls also allow for privacy and mixed use at lower levels. These construction techniques allow extreme wave and flooding effects to pass under the structures without damage to critical or finished areas. All developments should consult the local governing authority regarding construction setbacks and other guidelines.

4.4.2 Coastal Setback Considerations

In the United States, most setback guidance is based on long term shoreline change rates projected over a period of 30 to 40 years and may be verified with an extreme storm. Setbacks generally refer to a static vegetation line, however, other lines of reference (“baselines”) can be used in place of a vegetation line (e.g., high water lines, HAT / spring tide line, etc.) when limited vegetation exists as may currently be the case for portions of the site shoreline.

This would need to be confirmed with the local jurisdiction having authority. Alternatively, a “hard line”, coinciding with some sort of shore protection structure (possibly buried), if constructed, may also be considered as a baseline/reference line for setbacks.

Setback guidance recommended to the DCA (Development Control Authority) by COSALC/Cambers (1998) utilized a somewhat similar method and recommends a setback of 30 m (~100 ft) landward of the line of permanent vegetation (LPV) specifically for Lignum Vitae Bay / Jolly Beach. This includes allowances for historical erosion, plus 1 ft (0.3 m) of sea level rise over 100 years, and storm effects.

The Draft Coastal Development Setback Guidelines (JECO Caribbean, 2015) proposes much larger setbacks, incorporating a wide range of SLR projections for the year 2100. The JECO Caribbean report does not include site specific erosion projections, long-term shoreline changes, existing development at the site, and projects setbacks which in ATM’s opinion are very conservative for the proposed development.

Based on discussions with the Client and Deborah Brosnan & Associates (DBA), it is ATM’s understanding that the government recommended setback for this area is 30 m from the LPV, based on Cambers (1998), and that this setback has been used for development planning to date. The LPV and 30 m setback lines for the site were provided by the Client and are shown as a solid red line on the cross-section figures in the previous section. Based on discussions with DBA, it is ATM's understanding that the proposed "Nikki Beach Bar" extends seaward of a 30 m setback, but because a bar/restaurant is considered a non-permanent structure, the setback only needs to be 8 m from the LPV, based on Cambers (1998).

Additionally, best coastal engineering practice would site all habitable structures and critical infrastructure landward of the potential limit of 100-year erosion and significant overwash, and/or ensure that they are constructed or on pile supported foundations which allow for the projected erosion to occur and have their lowest horizontal structural member elevated to account for wave runup, overwash, and wave splash. Any structures not founded properly on piles must be considered expendable or temporary, unless adequately protected by a shoreline structure.

4.4.3 Shoreline Protection Structures

Installation of shoreline protection structures, such as rock revetments, seawalls/bulkheads, or retaining walls can help to reduce risk to upland properties. Based on review of the proposed development plan and in discussions with the Client, it is ATM's understanding that some development is planned seaward of the 30 m LPV setback.

Construction of oceanfront buildings seaward of the setback on-grade is never recommended and it is our understanding that due to geotechnical requirements all buildings and decks in and near the setback will be founded on piles. Any structures waterward of the limits of anticipated erosion must be capable of withstanding the vertical and horizontal flood forces during the design storm event. Where retaining walls are proposed, any habitable buildings should be set back at least 9.1 m (30 ft) from the wall (splash zone due to wave runup at the wall) and be pile supported with the lowest horizontal member elevation (LHME) above the DFE or to at least 1 m above the retaining wall elevation, whichever is higher. The LHME should be set at or above this minimum design elevation to account for damaging wave runup and splash over the wall. It is noted that Government or local authorities may have additional requirements and/or restrictions regarding construction within the LPV setback.

SBEACH results show that under 100-year storm conditions, erosion to and under the proposed seaward buildings can be expected with overwash extending landward of and between the buildings.

4.4.4 Dune Enhancements

Dune enhancements through renourishment and stabilization with vegetation can help to limit erosion and reduce risk by buffering storm impacts to upland areas. Dune building, enhancement, and planting of native dune grasses is recommended for the subject shoreline. Regular assessments of dune health can occur as part of the beach monitoring plan, and restoration and enhancement efforts are suggested and may be needed following large storms to mitigate future damage. Additionally, dune reinforcement through buried geotubes or other means are another potential strategy for maintaining a desired shoreline.

5.0 OVERVIEW AND DISCUSSION

5.1 Summary and Recommendations

This coastal analysis provides a site-specific shoreline change assessment, storm surge and wave height estimates, and recommended construction setback and building elevations of major and/or habitable structures elevations for the Nikki Beach Hotel project site. Key recommendations and observations are summarized below.

Long-term shoreline assessment suggests the site shoreline has experienced net accretion over the past ~20 years and is currently relatively stable. A Beach Monitoring Plan is proposed to assess overall health and determine when future maintenance renourishment may be needed. No new shoreline stabilization structures (e.g., groynes, breakwaters) are suggested at this time, however, it is recommended that the existing rock structures on the property shoreline be left in place. These can also potentially be rehabilitated to improve functionality in the future, if necessary.

Short-term (episodic) shoreline change from an extreme storm event at the site and Base Flood elevations (utilizing a 100-year return period storm event as the base flood, following FEMA methodology) were assessed using the SBEACH model.

- The SBEACH 100-year model simulations suggest minimum setbacks of ~ 30 m (100 ft) from the existing approximate permanent vegetation line on the beach (delineation provided by Client) for the proposed development.
    - Erosion was observed landward of this setback under proposed conditions scenarios in areas where no retaining wall will be located, however, this is relatively minor and no buildings or habitable structures are proposed in these areas.
    - Planting stabilizing vegetation, hardscaping, and/or enhancing the dune system will help to mitigate erosional damage along the site's shoreline/upland transition.
- It is recommended that any habitable and permanent structures at or seaward of these minimum setback limits are founded on piles or other foundation which can accommodate the anticipated potential storm scour/erosion and wave/overwash loads.
- Model results for Existing and Proposed Conditions under 100-year storm conditions (no SLR), suggest a BFE of +2.4 m, LSD for the seaward-most areas of planned development near the 30 m LPV setback. Model BFEs farther inland reduce to +2.1 m under present-day and proposed (no SLR) conditions.
- Explicit consideration of future SLR would result in higher BFEs for the proposed project.
- Design flood elevations (DFEs) typically include a minimum additional 0.3 m (1 ft) factor of safety (i.e., freeboard) on top of modeled BFEs to conservatively account for uncertainty in the analysis.

Alternatively, the BFEs resulting from "future" 100-year storm scenarios which include SLR may be considered an acceptable DFE. These values would be a minimum target elevation for lowest horizontal structural members and/or finished floor to reduce loading on the buildings. Due to increased awareness of future SLR, many communities now require a minimum 0.6 m (2 ft) freeboard above BFE.

- Coordination with the Client after initial analysis, based on Client accepted balance of acceptable risk versus project economics and other factors, resulted in a Client directive to not explicitly include SLR or additional freeboard in the flood hazard analysis. Therefore, only present day 100-year storm event scenarios (i.e., without SLR) are presented.

Based on the 100-year results (without SLR), a minimum DFE of +2.4 m LSD is considered acceptable for the planned buildings/amenities, noting that this value does not include a freeboard/factor-of-safety.

In areas where oceanfront retaining walls are necessary, DFEs for planned buildings/amenities within 9.1 m inland from the wall are suggested to be established based on the following:

- As significant wave runup/overtopping is anticipated and following FEMA guidance, it is recommended DFE's within the 9.1 m splash distance be set to at least 1 m above the wall crest elevation — meaning for areas where an oceanfront retaining wall with a crest elevation of +2.4 m LSD is proposed, a DFE of +3.4 m LSD is recommended for anything planned to be built within a 9.1 m splash zone landward of the retaining wall. A recurved profile at the retaining wall crest could be considered to remove this requirement.
- Any habitable or non-expendable structures planned within 9.1 m inland of an oceanfront retaining wall should be pile supported with the lowest horizontal member elevation (LHME) set above the DFE or to at least 1 m above the retaining wall elevation, whichever is higher.

Stem walls are recommended at a minimum (as opposed to simple slab on grade) for all structures that are not required to be founded on piles to protect the foundation from scour/erosion from sheet flow (e.g., overtopped flowing water, return flow as flood waters recede) adjacent to buildings.

The above recommendations are based on the 100-year design condition (1% chance of occurring in any given year). The Developer/Owner may choose to adopt more or less conservative DFEs and/or construction approaches based on their goals and acceptance of risk.

The setbacks described above are recommendations unless the Government requires another specific setback. Proper construction methods and accepted risk may also dictate less restrictive setbacks and design elevations in localized areas. Building closer than the recommended minimum setbacks and/or constructing below the recommended minimum elevations means the project Developer/Owner must accept the risk of erosion/damage and/or design the structures to resist the associated loading.

Maintaining a healthy beach and vegetated dune system will also help reduce risks associated with coastal hazards. Setbacks are meant to protect the "sacrificial" dune or coastal strand systems from development as well as protect potential development from severe wave impacts near the shoreline. Less severe wave effects are possible beyond this setback but are generally limited to shallow flooding and less severe overwash.

At the discretion of the Owner/Developer (and in accordance with local guidelines), less critical infrastructure (such as walking paths, detached patios/decks/pools, etc.) may potentially be placed seaward of the setback line, since damage to or failure of these elements does not represent potential loss of life during an extreme storm event and may be less of an operational issue to repair/replace.

Note that if/where retaining walls, bulkheads or other shore parallel structures are sited – there is potential for increased erosion and the need for beach/dune maintenance to avoid impacts to the native beach. In addition, siting of a building within 9.1 m (30 ft) of a retaining wall or other coastal armoring structure may result in overtopping splash and runup which can damage windows, foundations, decks, etc.

Proper coastal construction methods (FEMA 55, ASCE 24) are recommended whenever possible in order to reduce risks. Constructing more liberally will result in a higher risk of loss. If/where more liberal construction takes place, strategies such as "wet floodproofing" (designing flood openings below DFE to reduce loads, siting of HVAC and electrical systems above DFE, etc.) can and should be implemented to minimize flood damage to a building and its contents. Wet floodproofing strategies will help to minimize floodwater damage only, but will not ensure a building is adequately designed for scour/erosion and high velocity flood loads.

5.2 Coastal Development Risk Potential

While the recommendations for coastal development setbacks, base flood elevations, etc. described herein are based on reasonably conservative values and according to standard coastal engineering practice, the forecasted conditions described herein are by no means absolute. The data provided herein are minimum recommendations based on the best available information and methods at this time. The predicted water level elevations are not absolute; extreme storms may cause conditions which exceed those forecasted at any time during the lifespan of the facility.

Such an occurrence can cause partial or even complete destruction of the facility, and the owner/developer and operator must realize and accept this fact. In addition, the owner/developer must consider insurance requirements and adopt facility design and operational procedures to address the risks associated with facility siting within a coastal zone influenced by tropical storms.

There is always some risk of damage and even total loss of a coastal facility, which can be estimated by the following equation:

$$R = 1 - (1 - 1/T_r)^n$$

where R is the probability or risk that an event with a return period of Tr years will occur at least once during a time period (project life) of n years.

This means that statistically, there is roughly a 1-in-4 (26%) chance of at least one 100-year design condition (1% chance of occurrence in any year, on average) occurring over a consecutive 30-year period, which is the length of a typical mortgage in the US. Similarly, there is a 9.6% chance of the 100-year design condition occurring during a consecutive 10-year period. Decreasing the return period of the design condition increases the risk as discussed in the previous section.

Table 4-2 presents some theoretical examples of risk of occurrence for particular design levels and project design lives.

Table 4-2. Theoretical Occurrence Percentages for Varying Time Spans

Event Return Period (Years)	Theoretical Occurrence over 1 Year	Theoretical Occurrence over 5 Years	Theoretical Occurrence over 10 Years	Theoretical Occurrence over 25 Years	Theoretical Occurrence over 50 Years	Theoretical Occurrence over 100 Years
10	10%	41%	65%	93%	99%	100%
25	4%	18%	34%	64%	87%	98%
50	2%	10%	18%	40%	64%	87%
100	1%	5%	10%	22%	39%	63%

The Developer/Owner of the facility must consider and balance these risks with insurance premiums, available coverage, design life, risk of life/safety, project requirements, and capital costs so that an informed decision can be made regarding the required robustness of the final design.

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APPENDIX A – BEACH MONITORING PLAN

NIKKI BEACH RESORT, ANTIGUA
PHYSICAL MONITORING PLAN

Introduction

A Physical Monitoring Plan is recommended for implementation as part of Nikki Beach Resort project on Jolly Beach. This Plan will track the condition of the project and adjacent areas beaches for future planning purposes.

Beach erosion and/or accretion and condition over time is highly dependent upon the annual metocean climate, which influences local and regional water levels, currents, wave conditions, and sediment transport. This monitoring plan will document future changes to the beach and also assist Nikki Beach Resort in determining the need to initiate planning for future beach improvements (e.g., beach nourishment, dune enhancement, structural measures) or other coastal maintenance activities.

The purpose of the Physical Monitoring Plan is to:

- monitor area beach conditions by data collection with beach profiles, tied to the local horizontal survey grid and vertical tidal datum;
- function as a database for future beachfront development, planning, and/or management activities; and
- provide design guidance for future beach and shoreline maintenance activities along the project area with specific emphasis on reducing the need for and costs of unnecessary work, as well as reducing potential environmental impacts.

Monitoring Program Components

Beach Profiles

PURPOSE: To determine seasonal beach characteristics, assess potential impacts/changes to adjacent beaches, and provide a quantitative basis for defining future beach maintenance or improvement activities. Beach profiles are topographic surveys along transects which extend from landward of the vegetation line into the sea.

FREQUENCY: Semi-annually for a period of 5 years after construction (see details below), and then annually at a minimum thereafter. The surveys shall be conducted during the same month each year (weather permitting) to remove seasonal bias, and during periods of limited wave action (to the extent possible).

Additional wading surveys are recommended following significant storm events which visually impact the beach.

NUMBER AND LOCATION: Total of 5 profile stations (NB 1 through NB 5): 3 along the Resort property and 1 each to the north and south of the resort shoreline. Refer to the Figure A-1, Proposed Beach Monitoring Stations, for proposed profile station locations.

DETAILS: Profiles shall extend from landward of dune feature or Line of Permanent Vegetation to wading depth, not less than -1.5 m (-5 ft) at low tide. Topographic spot elevations shall be collected at significant slope and angle breaks in the beach section, and not more than 6 m (20 ft) (+/-) intervals along each profile line.

The Resort shall establish permanent reference monuments at each monitoring profile station by a professional surveyor, in the local Government horizontal and vertical datum, to allow for repetitive surveys from common control points. Control points may be incorporated into permanent (concrete) coastal structures (decks or solid slabs, bulkheads) or established as stand-alone monuments. Any reference monuments which are lost due to construction or erosion shall be re-established. Final locations of the reference monuments shall be determined following Resort construction and memorialized as an addendum to this Monitoring Plan.

Photography

PURPOSE: Document changes along the project area as a supplement to beach profile data.

FREQUENCY: Semi-annual ground level photos of beach areas taken coincident with beach profile surveys when they occur. Commercially available satellite or high altitude drone rectified vertical photos should also be obtained to generally coincide with annual profile surveys.

DETAILS: Ground level photos shall be taken from approximately the same general locations (at a minimum at each beach profile survey station) and view to provide qualitative comparisons between events. Photo stations shall be established immediately prior to construction and a log shall be created for future duplication, with photos looking south, east, west, and north from each survey station.

Bathymetric Surveys

PURPOSE: To document changes in offshore conditions beyond the wading profile limits.

FREQUENCY: Comprehensive hydrographic survey extending from wading depth out to -6m (-20 ft) at low water every 2 years following construction of the resort. Additional surveys may be required following storms if significant beach erosion is observed.

DETAILS: Surveys shall be conducted utilizing current hydrographic surveying techniques, specifically International Hydrographic Organization standards (IHO, 2008). This includes total vertical uncertainty of less than 0.25 m at a confidence level of 95%. Transect/track lines shall be run generally perpendicular to shore with a maximum spacing of ~ 30 m. Bathymetric surveys shall be conducted generally concurrent with the associated beach profile surveys described above and merged with the profiles.

Reporting and Analysis

An annual summary report shall be prepared which includes plots of survey profiles and graphic presentations of temporal and cumulative volumetric and shoreline positions change for the monitoring area. Volumetric and shoreline changes at each survey profile shall also be presented in tabular form. Analyses shall discuss the data, shoreline change trends, and the performance of the project and adjacent monitored areas. Erosion and accretion patterns shall be identified along with any potential cause and effect relationships, where storm or other publicly available metocean data (i.e., WavewatchIII data) is available. In addition, the report shall identify any potential adverse shoreline impacts that may be attributable to the project. Needs for any changes to the monitoring program, based on observed changes, shall be identified.

Any requirements for future or additional monitoring beyond that described in this plan would be coordinated between the Resort and Government following review of each annual monitoring event.

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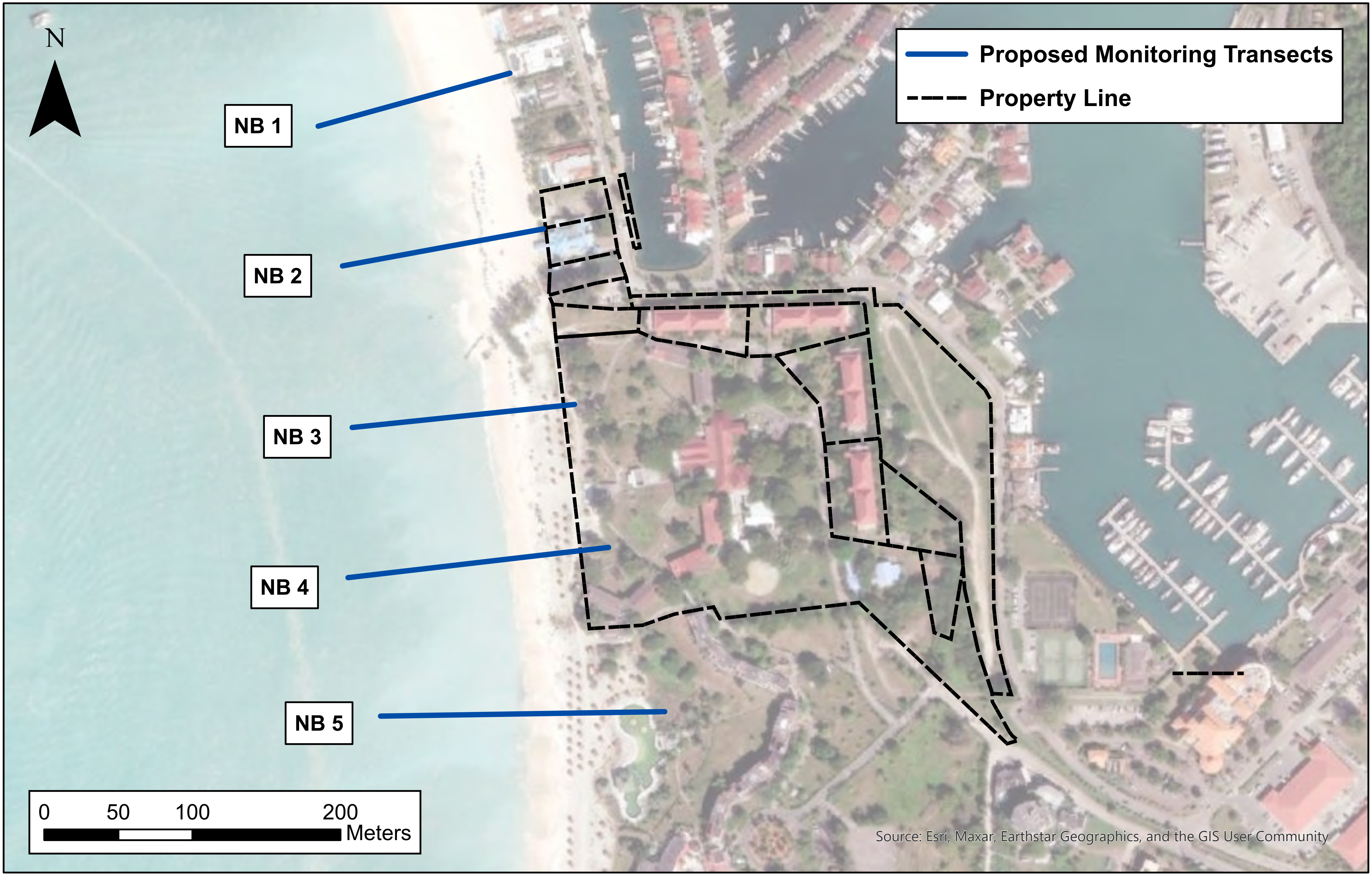

Figure A-1. Proposed Beach Monitoring Stations for Nikki Beach Resort, Antigua.

ATM
A Geosyntec Company

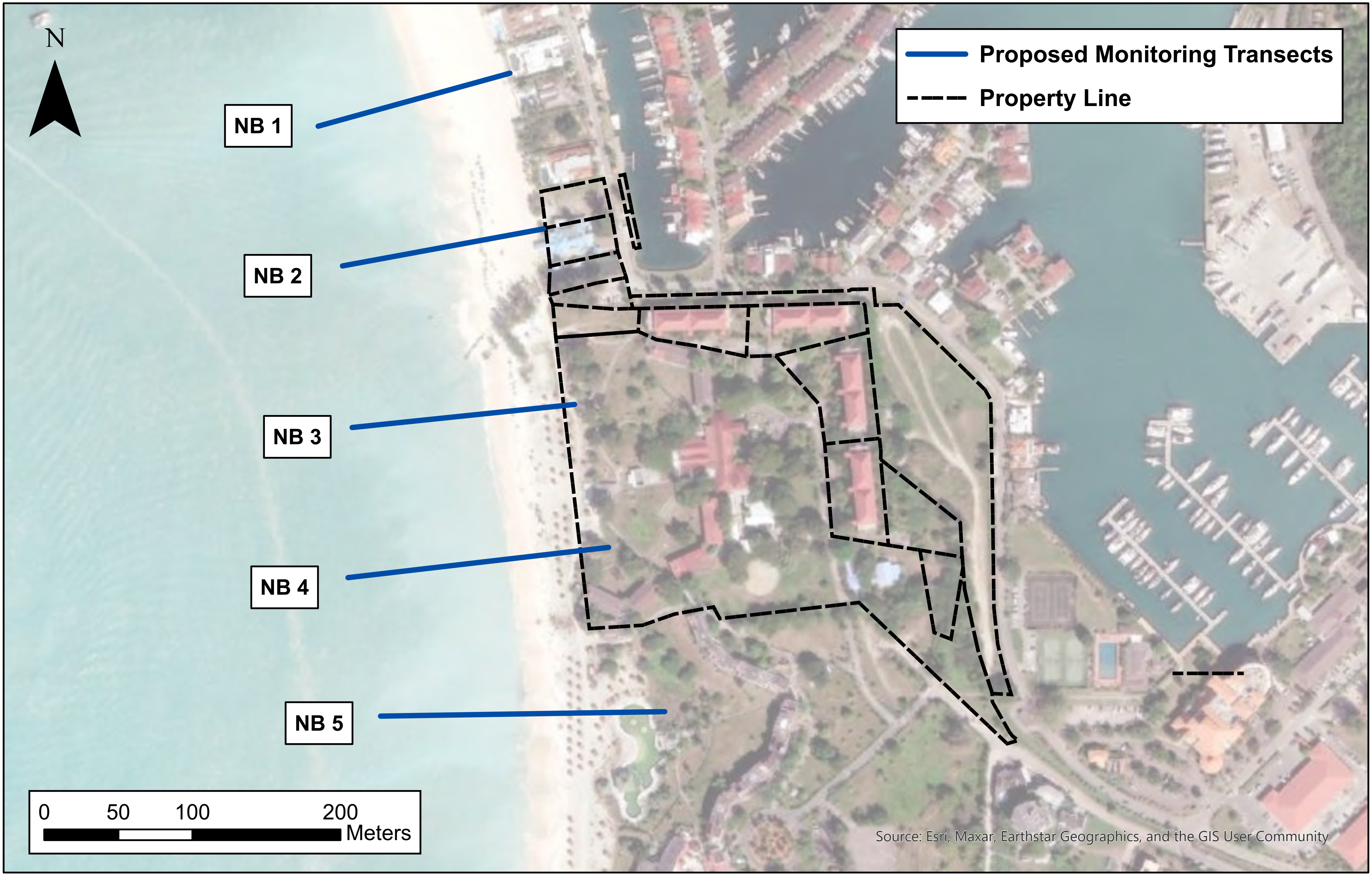

Figure A-1. Proposed Beach Monitoring Stations for Nikki Beach Resort, Antigua.

ATM

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APPENDIX B – CMS-WAVE MODEL OUTPUTS

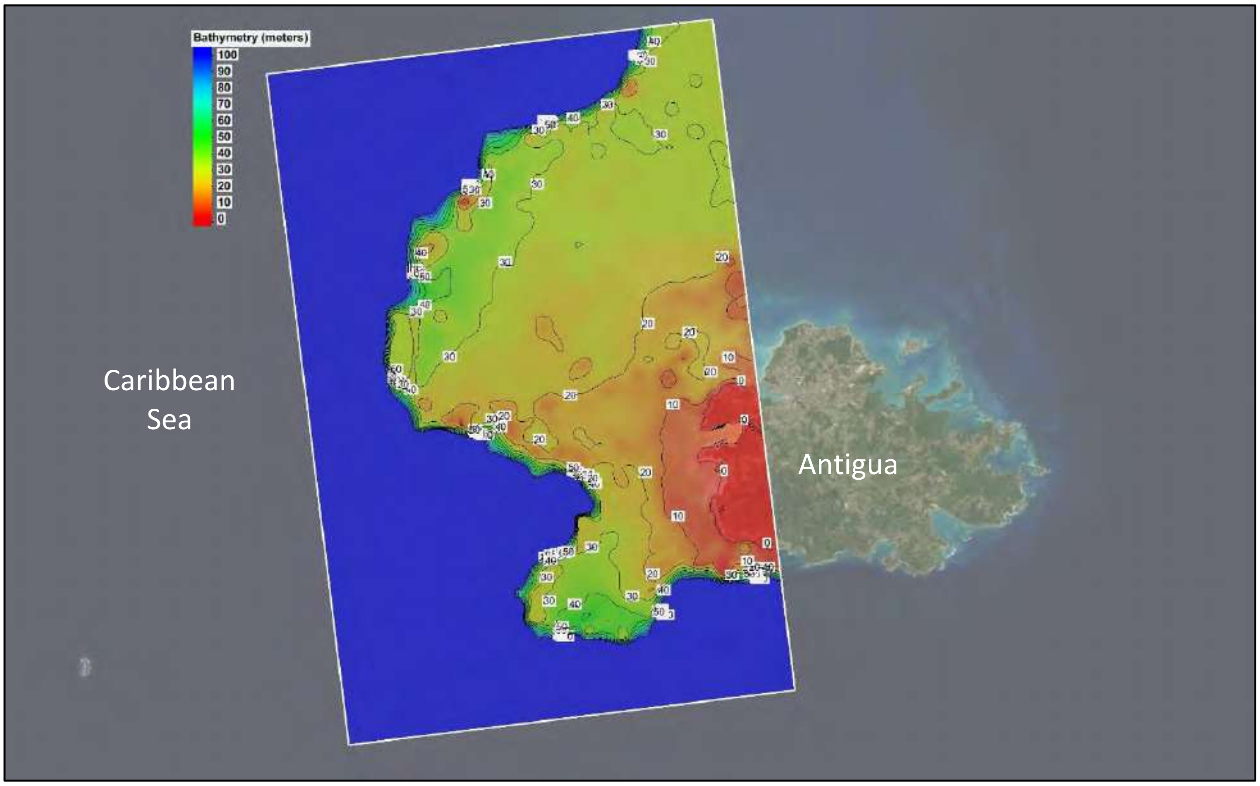

Figure B-1. CMS-Wave Model Grid and Bathymetry (depths in meters, MSL)

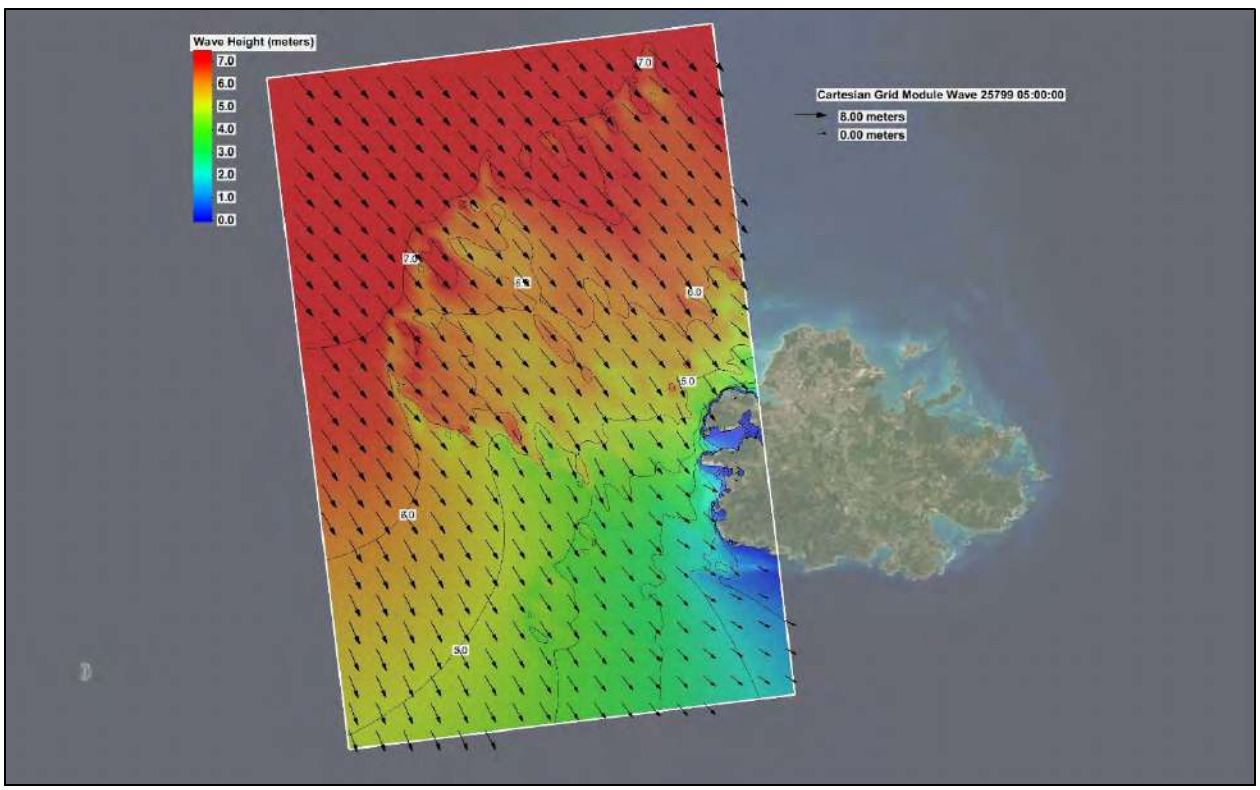

Figure B-2. Case 1 – NW 100-Year (H_s = 7.3m, T_p = 12s)

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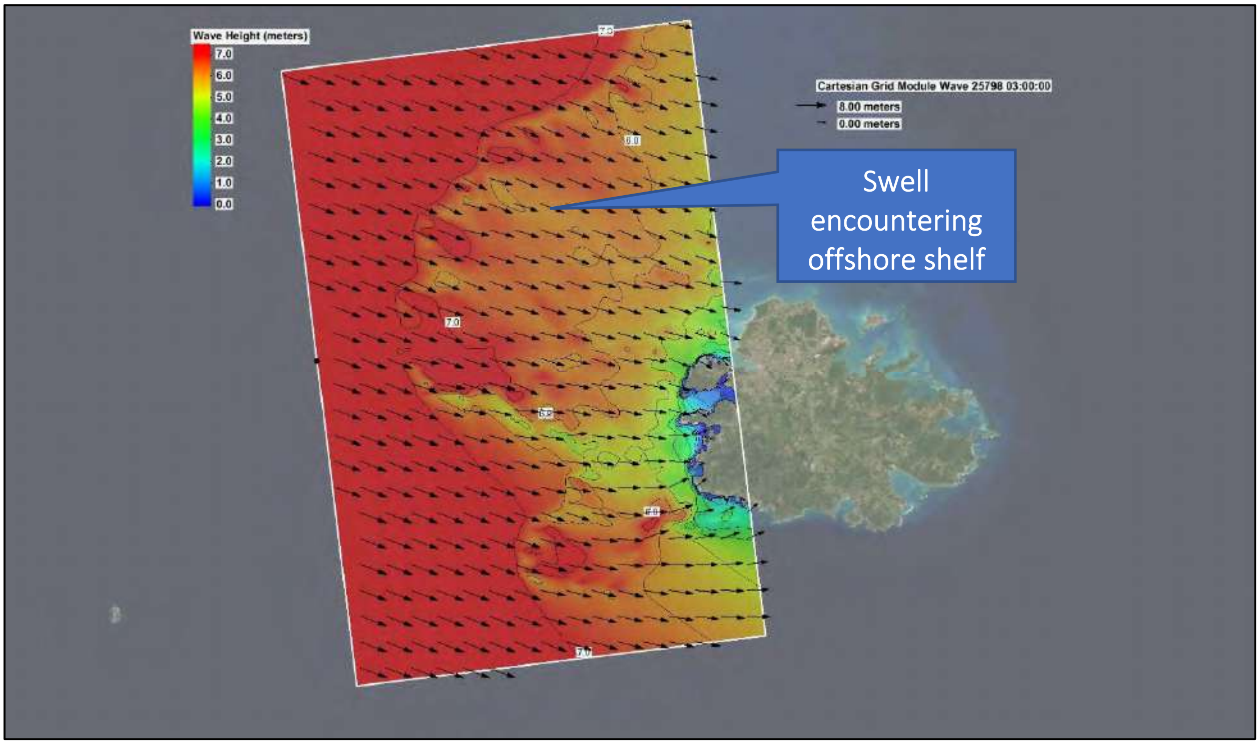

Figure B-3. Case 2 – WNW 100-Year (H_s = 7.3m, T_p = 12s)

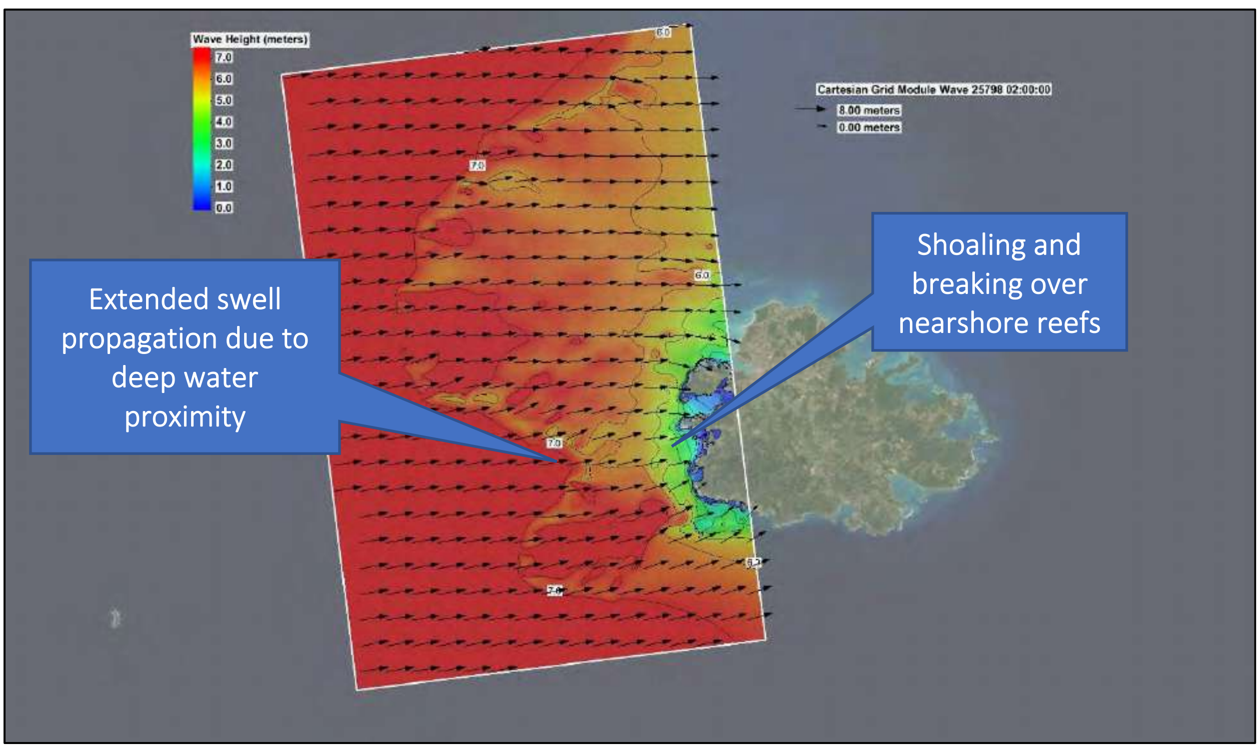

Figure B-4. Case 3 – West 100-Year (H_s = 7.3m, T_p = 12s)

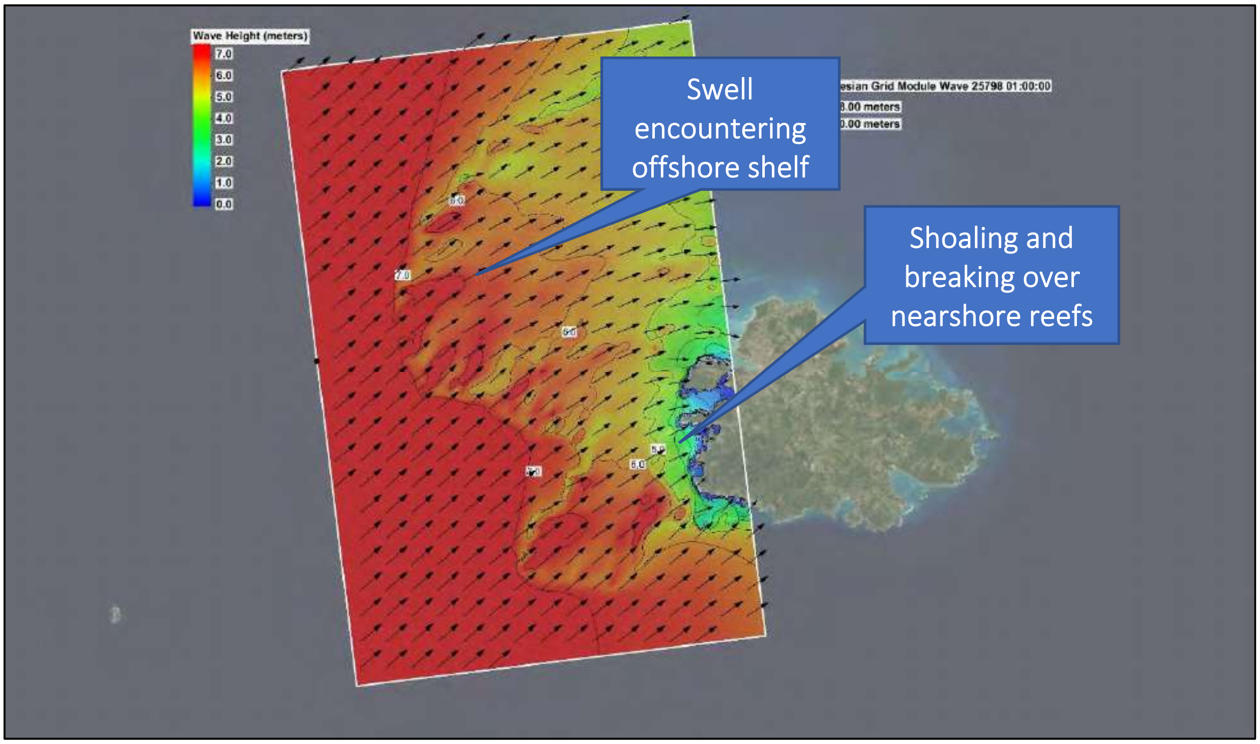

Figure B-5. Case 4 – WSW 100-Year (H_s = 7.3m, T_p = 12s)

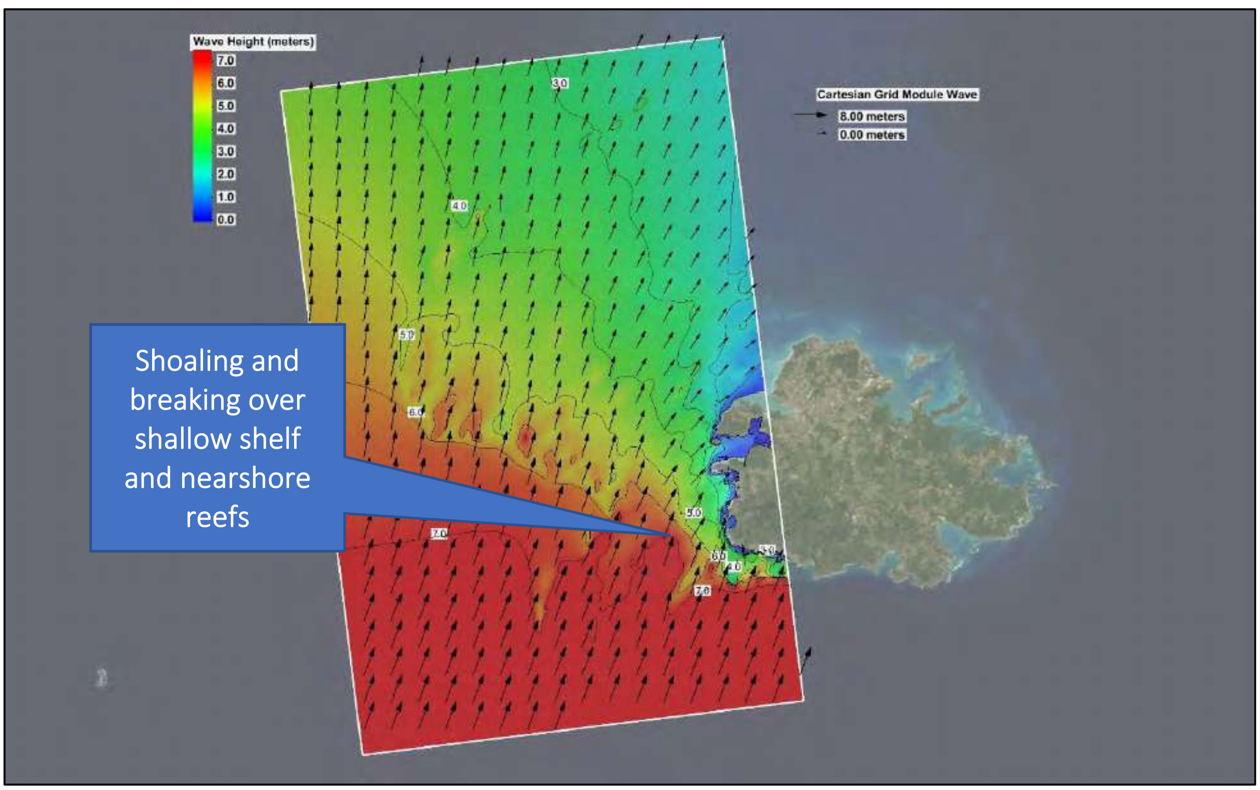

Figure B-6. Case 5 – SSW 100-Year (H_s = 7.3m, T_p = 12s)

Appendix 6 – Caribbean Disaster Mitigation Project Hurricane Procedures Manual

Caribbean Disaster Mitigation Project
Implemented by the Organization of American States
Unit of Sustainable Development and Environment
for the USAID Office of Foreign Disaster Assistance and the Caribbean
Regional Program

In the fall of 1998, the Caribbean Hotel Association (CHA) and the Caribbean Tourism Organization (CTO) produced a* Hurricane Procedures Manual *as a guidebook for tourist establishments in the Caribbean.
The Caribbean Disaster Mitigation Project supported the development of a chapter on 'Structural Vulnerability and Loss-Reduction Techniques' for inclusion in this manual.

Hurricane Procedures Manual

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The Caribbean Hurricane Experience

Hurricanes are a fact of life in the Caribbean (See Appendix 1). Within the past nine years, from 1988 through 1997, several hurricanes have unleashed their fury on the islands of the Caribbean. Hurricanes David in 1979, Allen in 1980 Gilbert in 1988, Hugo in 1989 and Luis and Marilyn in 1995 caused significant damage to hotels in Dominica, St. Lucia, Jamaica, Montserrat, Antigua, and St. Thomas respectively. Marilyn also caused damage to beaches in Barbados. In 1995 and 1996, thirty-one storms crossed the Caribbean, the Atlantic and the Gulf of Mexico, causing the Regional Mechanism (Caribbean Disaster Response Agency) to be placed on alert nine times over the two years.

The 1995 Hurricane season was the most active, and perhaps the most destructive in recent decades. Hurricane Luis was the most destructive since Hurricane Hugo of 1989, with estimated damages of $2.5 billion occurring in the Caribbean from Luis alone. Following on Luis, Hurricane Bertha affected the region in 1996. Wind damage, storm waves, heavy rains and flooding caused major losses within the tourism sector. In addition, inadequately designed and constructed buildings, damaging media reports and inadequate insurance coverage in some instances have aggravated the financial and social consequences of these events. Recovery for some islands has been slow and some territories have had more than one impact in a single year or in consecutive years.

This hurricane procedures manual, first published in 1990 following Hurricane Hugo, has now been revised to meet the recurring needs of the tourism/hotel sectors for hazard mitigation. Hazard mitigation is defined by the Federal Emergency Management Agency (FEMA) of the United States as " actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects". This goal can best be achieved by applying various strategies though structural and non-structural measures. Prevention and preparedness planning can help to reduce loss and most importantly will assist speedy resumption of business after the event.

There are some initiatives which need to be taken by the individual hotelier; others require partnerships among hoteliers or between hoteliers and selected stakeholders within the community; and still others require national and even regional collaboration.

This revised edition of the manual includes a chapter on structural vulnerability and loss reduction. One of the most cost-effective measures for mitigating disaster damages is to design and construct hazard resistant structures.

The time to prepare or plan for a hurricane is **before** the Event. The manual therefore, outlines the steps and activities which need to be taken before the hurricane season and certainly before a hurricane threatens. Managing the property and guests **during** an event is crucial to business continuity after the hurricane. Procedures are outlined for all phases of hurricane management. **Immediately following** a strike, there are several critical issues to be dealt with - these are described in the Section entitled **Recovery and Restoration.** Section IV entitled, **Structural Vulnerability and Loss Reduction**, outlines procedures to be followed by the hotelier to assess vulnerability.

The Manual

The manual has been designed to provide recommendations, tasks, and responsibilities for each major department within the facility. It allows for distribution of sections of the plan to the relevant departments, while at the same time allowing for the security and confidentiality of the entire plan. Procedures and responsibility for preparedness, and procedures for vulnerability assessment, appropriate design and retrofitting are outlined.

The prevention and preparedness phase includes: structural and non structural vulnerability assessments, maintenance requirements, retrofitting requirements, emergency supplies, mutual aid agreements, guest information, training, insurance, community liaison, vital records, guest security, weather information, and media communication requirements.

The hurricane phase includes tasks for each department, form hurricane alert to strike. The recovery phase embodies guest relations, damage assessment, impact evaluation, clean-up and salvage, business restoration, and community relations.

The section on structural loss reduction details procedures to be followed for design, maintenance, repair and retrofitting before a hurricane strikes.

Testing, Maintaining, and Upgrading Procedures

This manual is a written document, and not a plan. The procedures detailed must be tested, and the details for each property and department worked out and corrected through training drills and simulation exercises.

Additionally, the procedures must be integrated into the overall management plan for the organization in terms of company policy, operational budget, training, and job descriptions. Training is vital to the success of hurricane preparedness and disaster management and properties should seek to communicate requirements to the respective staff and to implement training programmes for the relevant procedures.

Testing of the Plan Should:

➢Confirm that ALL personnel understand their responsibilities and can successfully carry them through.

➢ Serve as training for personnel.

➢ Be conducted on an annual basis, preferably before the onset of the hurricane season.

➢ Include consideration and review of the plan, incorporating changes as these are found necessary.

➢ Evaluate vulnerability assessments and requirements for maintenance, repair and retrofitting.

Acknowledgment

The revision of this Hurricane Procedures Manual has been a professional pleasure given the increasing exposure of the Caribbean Hotel sector to more intense and frequent hurricane activity within the region. I congratulate the Caribbean Hotel Association (CHA), and the Caribbean Tourism Organization (CTO) for this timely and well needed initiative. Special tribute to the Caribbean Disaster Mitigation Project (CDMP) which joined forces with the CHA and CTO. The CDMP is funded by the Office of Foreign Disaster Assistance (OFDA) of USAID and executed by the Organisation of American States (OAS).

I am grateful to Ms. Kelly Robinson, and Messrs Bill Moore and Alec Sanguinetti of the CHA and Mr Michael Youngman of the CTO for their valuable contribution.

Mr Al Wason, Professional Engineer and Disaster Mitigation Specialist, provided the substantial technical input for the section on Structural Vulnerability and Loss Reduction.

Mr. Joseph Murray of the Murray Group and Mr Luis Flamand of the CHA Insurance Company provided information for the Insurance component and WRH & Associates assisted with design and information for the communications plan.

Mr. Jerry Collymore and Ms. Audrey Mullings of the Caribbean Disaster Response Agency, CDERA, were generous with their reports on hurricane activity for the past 4 years.

Sarah Bell, Lovelette Brooks, and Sharonmae Shirley of Environmental Solutions Limited deserve special thanks for their revised design of the manual.

Grateful thanks to all who have contributed to making this manual a reality.

Eleanor B. Jones
Environmental Solutions Limited
Kingston, Jamaica W.I.

Letter from CHA

Dear Hotelier:

If the primary responsibility of a Trade Association is to respond to the needs of its members, then there could have been few more powerful imperatives than to assist the Hotel & Tourism Industry in dealing with the damage inflicted by hurricanes and other natural disasters in the Caribbean region.

Our sincere thanks must go to the International Hotel Association, whose generous donation from their Fund For the Future started the ball rolling; to American Express Travel related services and USAID/OFDA , who have supported this endeavour by including the chapter on structural loss reduction and picking up the printing bill. With help from CHA's own reserves, and matching support from CTO; this Hurricane Procedures Manual has thus become a reality. Our goal in bringing this project to fruition was to help you better protect the safety of your guests, your property, and certainly to strive to enhance the perpetuation of Caribbean Tourism.

Our thanks also to the professionalism and hard work of Eleanor Jones and Environmental Solutions for making our Manual a reality.

Signed,

John Bell

Executive Vice President

Letter from CTO

Dear Reader:

The Caribbean is blessed with such a glorious and delightful climate most of the time that, were it not for the occasional intrusion of hurricanes, we might be tempted to believe that we have already achieved heaven on earth. However, first Gilbert in 1988, Hugo in 1989, Luis and Marilyn in 1995 and 1996 respectively, are sad reminders that hurricanes do happen in the Caribbean, and that those unfortunate enough to encounter such violent forces of nature in an unprepared state can suffer considerable - and probably unnecessary damage. This Hurricane Preparedness Manual, which CHA and CTO have had prepared, with the technical expertise of Eleanor Jones and Environmental Solutions Ltd., is a timely and useful tool for the tourism sector. However, its real value lies in it being studied, and its action programme being complied with. For both tourism organizations, CHA and CTO, it is the first step in a total programme of education, training, and public relations, in meeting, coping with, and recovering from disasters.

I hope to hear from you readers how you value this document, and I would welcome any ideas on how it might be improved.

Yours Sincerely,

Jean Holder

Secretary General

Executive Summary

Hurricane Characteristics

In preparing for hurricanes, it is important to have some basic knowledge of hurricane characteristics and effects. The short section entitled Hurricane Characteristics provides just that information. The section describes the characteristics of a hurricane, hurricane effects, hurricane categories and the hurricane warning system.

Before a Hurricane

This phase should be ongoing throughout the year. Full preparation is the key to minimizing loss of life and property, and to ensuring speedy resumption of business. All Departments have tasks - but leadership is given by the General Manager, and the Emergency Coordinating Committee. During this stage, attention should be given to:

- Creation of the Emergency Coordinating Committee
- Vulnerability Assessment, including maintenance and retrofitting requirements
- Emergency supplies
- Mutual aid agreements
- Guest Information Packets
- Committee liaison policy
- Vital records protection
- Guest security protection
- Obtaining up-to-date weather information
- Training of staff
- Media Communications requirements*
- Insurance Coverage**

**Media Communication requirements will be discussed in Section V*
***Insurance Coverage will be discussed in Section VI*

During the Hurricane

The Hurricane section includes several phases of activity, from the period when the hurricane approaches the region, to the actual strike. Time is critical, and keeping tuned to weather information and national emergency procedures is important.

Section II - During the Hurricane, outlines the responsibilities of the Emergency Coordinating Committee and each of the departments by hurricane phase.

After the Hurricane

Safety of guests, communication with the outside, and prompt resumption of business are the major considerations in the period following the hurricane. Therefore the following elements require attention immediately after the hurricane:

- Activate the Communications Plan.
- Brief assessment of damage.
- Document (photograph) damage.

- Prioritize clean-up and salvage.

- Security of property, and safety of guests. Carry out head count.

- Seek mutual aid as needed, especially for comfort of guests.

- Facilitate contact between guests and organizations to enable communication with relatives and friends.

- Liaise with travel services concerning arrangements for guests.

Structural Vulnerability & Loss Reduction

Review of damage to buildings from recent events indicate failure of aspects of the structure to resist hurricanes. Hoteliers should be made aware of how hurricanes affect buildings so as to be able to effect quality control in roofs, windows, doors, foundations and other elements of structures. Design criteria to withstand both hurricanes and earthquakes are presented and procedures for assessing vulnerability and retrofitting are outlined. Maintenance plans are important to structural soundness.

Hurricane Characteristics

Hurricane Characteristics

SEASON: Commences June 1 and ends November 30, but storms may occur at other times of the year.

SPEED: Speed of advance of approximately 20-25km/hr (12-15 Knots).

COURSE: Normally moves from East/Southeast towards West/Northwest and Northwest during initial stages but curves towards the North as it progresses (in the Northern Hemisphere).

WIND SPEED: Wind speeds generally in excess of 135 km/hr (75 Knots) but may gust up to 315 kn/hr (175 Knots) (GILBERT Sept. 1988).

SURGE: Storm Surge may be experienced if hurricane passes close offshore 3-10m (10-33 feet) and conditions are conducive.

WIDTH: Width of destruction 170-250 km (106-155 miles).

RAINFALL: Up to 450 mm (18 in) in the first two (2) hours.

LULL: A deceptive lull lasting approximately 30 minutes occurs when the centre (the EYE) of the hurricane passes. Wind speed resumes intensity and quickly, immediately after the eye passes.

EYE: Is the centre of the hurricane where there are no winds and where barometric pressure is very low.

Hurricane Effects

- **Wind damage** - This is potentially one of the most destructive aspects of the hurricane. It can result in loss of roofs, windows, doors and vegetation.

- **Collapse of buildings**

- **Damage by fallen trees** - Disruption of electricity and telephone facilities, damage to buildings and blocking of roads.

- **Flying debris** - Zinc sheets, tree limbs, timber, roofing materials, fruits etc. can cause further damage to other structures.

- **Rain Damage** - Otherwise sturdy trees and light poles may collapse earlier than expected due to water saturation around their bases. Leaking roofs, from torrential downpour can saturate walls and destroy contents of buildings and cause the destruction of structures.

- **Flood Damage** - Disruption of surface communications. For example, roads, flooded or washed away; landslides; bridges destroyed; railway lines flooded or washed away; contamination of drinking water supplies.

- **Storm Surge** - Heavy seas, storm waves and storm surge can cause extensive damage and completely destroy structures and coastal features. The direction of approach of the hurricane and the physical form of the coastal area will influence the potential destructive force of the waves.

Hurricane Categories

Category 1 Winds 119-152 km (74-95 mph) or storm surge 1 -1 1/2 m (4-5 ft) above normal.

Category 2 Winds 154-177 km (96-110 mph) or storm surge 1 1/2 -2 1/2m (6-8 ft) above normal.

Category 3 Winds 178-209 km (111-130 mph) or storm surge 2 1/2-3 1/2m (9-12 ft) above normal.

Category 4 Winds greater than 249 km (155 mph) or storm surge greater than 51/2 (18 ft) above normal.

The Warning System

The following warnings will be issued prior to a Hurricane. Members of staff should pay careful attention to these warnings as there are certain procedures to follow after each warning. Some radio and television stations in the region have a special signal which precedes warning messages. Become familiar with them.

Phase A **HURRICANE ALERT -** Hurricane entering the region.

Phase B **HURRICANE WATCH** - 36 hours to landfall.

Phase C **HURRICANE WARNING -** 24 hours to landfall.

Phase D **EMERGENCY PHASE** - Strike.

Section I: Before the Hurricane Strikes

The Emergency Management Team

In order to ensure that this emergency manual is an integral part of the culture and practice in your establishment, an emergency coordinating (EC) committee should be established. This committee will serve as the overall coordinating and executing body for all emergencies and will be responsible for managing and implementing emergency preparedness mechanisms at all stages of a hurricane.

EC Committee Structure

The members of the emergency coordinating committee should be appointed by management. At the head of the committee, is the Emergency Coordinator. An Alternate Emergency Coordinator should also be designated in the event that Emergency Coordinator is absent. The committee should also consist of a public relations person, the environmental person (if your facility has one) and at least one representative from each of the departments (or areas of the hotel or resort. These department representatives need not be managers or heads of the management team but should be any member of staff who knows the department integrally and is capable of carrying out the requirements of a committee member. Figure 1 outlines a possible structure of the emergency coordinating committee.

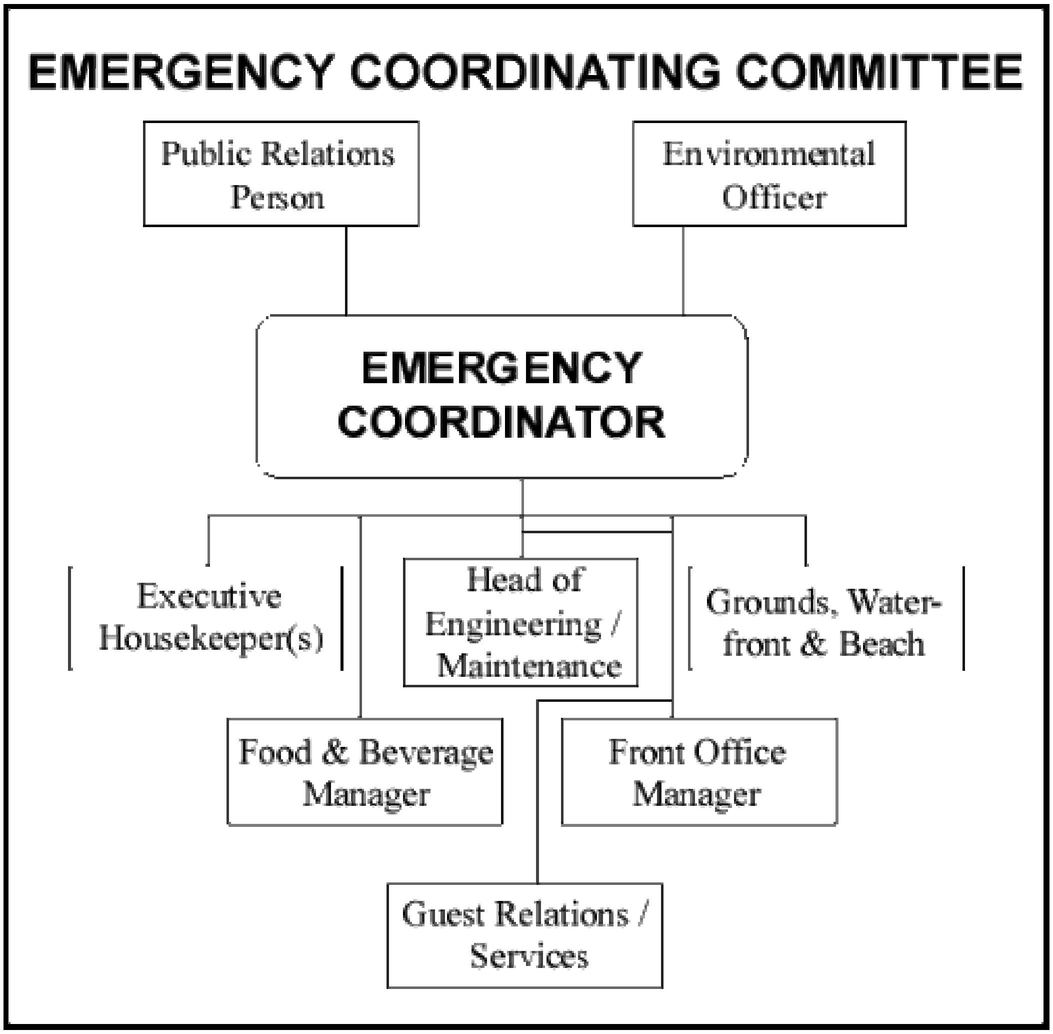


Figure 1: Emergency Coordinating Committee Structure

Committee Responsibilities

The first four projects of the EC Committee should be to:

(1) Familiarize themselves with the plan;

(2) Help the rest of the staff to become familiar with the plan;

(3) Designate responsibilities for action before, during and after a hurricane; and,

(4) Get first aid training.

All departments at your resort or hotel should be included when responsibilities are being assigned. These responsibilities should be made clear to each department and displayed in an openly accessible place within the department.

Suggestions for the EC Committee

- The EC Committee should meet at the end of March to review the maintenance report, review priority areas for action and review hurricane procedures with all staff.

- A second meeting must be held at the beginning of June, at the start of the hurricane season, to review and assess the level of preparedness, and fine-tune procedures.

With respect to the members of the Emergency Coordinating Committee, specific responsibilities are outlined as follows:

Emergency Coordinator (General Manager)

- Create the Emergency Coordinating Committee in consultation with other management staff at the hotel or resort.

- Overall coordination of regular hotel or resort operations and hurricane procedures.

- Liaise with emergency and information services (e.g. the National Office of Disaster Preparedness and Emergency Services, the Weather Reporting Station, appropriate community contacts) as well as mutual aid partners.

- Institute preventative measures (as described throughout this manual) to minimise opportunities for emergency situations.

- Conduct vulnerability assessment of the facility in consultation with other EC members and external expertise where necessary.

- Document the incident.

- Administer First-Aid when necessary.

Environmental Officer

- Give advice to the Emergency Coordinating Committee regarding Hurricane related prevention measures and Environmental matters on the property.

Public Relations Person

- Provide the link between the resort or hotel and the community, media and international stakeholders through a Communications Plan.

- It is also the responsibility of the PR person to keep the Communications Plan alive and to activate the Plan at the relevant time.

Other Emergency Team Members

- Ensure execution of prevention and preparedness tasks.

- Supervise clean-up activities.

- Ensure that sufficient quantities of emergency supplies (e.g. batteries, band-aids, stored water, etc.) are in stock.

- Dispose of damaged material.

- Administer first-aid where necessary.

There are many tasks that must be undertaken in order to properly prepare for a hurricane. The following charts can be used as *handy checklists* for ensuring that all tasks related to hurricane preparedness are completed.

Staff Liaison

TASK	**RESPONSIBILITY**
General Manager should meet with Departmental Heads; and Departmental Heads with staff.	Emergency Coordinating Committee

Recommendations

- Conduct monthly meetings on hurricane procedures.

Assess Your Risk

TASK	**RESPONSIBILITY**
☐ Check all buildings in March each year for both structural defects and non structural vulnerability. Check windows, doors, walls, roof, equipment, furniture, documents, etc. Repair or correct problems before the hurricane season.	Chief Engineer Emergency Coordinator Obtain external expertise where necessary
☐ Utilize Building Assessment Safety Checklist (Form 1). ☐ Ensure compliance with National Building Code where it exists.	Chief Engineer

☐ Create and implement Hurricane Maintenance Programme (esp. roof, windows, doors, etc.)	Emergency Coordinator
☐ Basic maintenance budget required.	Emergency Coordinating Committee
☐ Utilise the assessment reports to determine: ➢ the most appropriate location within the facility which will serve as the HEADQUARTERS/COMMAND POST during the event; ➢ which room may be easily converted for use as a FIRST-AID CENTRE; ➢ which rooms are most appropriate for the safety of the guests during the hurricane.	Emergency Coordinator/Engineering Maintenance Personnel Emergency Coordinating Committee

Recommendations

➢ Vulnerability assessment (Structural) of all buildings must be instituted as a permanent function of the Engineering Department (where one exists), or given to persons with equivalent responsibility. (See Section IV). Findings should be acted upon.

➢ Check non-structural vulnerability assessments twice annually - March and July each year. (Use Checklist - Form 1). The results of these assessments must be incorporated into the building maintenance programmes.

Weather Information

TASK	**RESPONSIBILITY**
☐ Keep radio tuned to channel for news where appropriate. ☐ Install weather band for continuous reports during the Hurricane Season.	Emergency Coordinating Committee

Recommendations

➢ Acquire radio and place in main office to ensure continuous monitoring of weather information.

➢ If internet access is available, check the following web sites and share relevant data with EC Committee and staff.

National Hurricane Centre - http://www.nhc.noaa.gov/

Weather Net - http://cirrus.sprl.umich.edu:80/wxnet/tropical.html

Atlantic Tropical Weather Centre -
http://banzai.neosoft.com/citylink/blake/tropical.html

➢ If cable or dish is available to your television, keep regular check of the weather channel to obtain updated hurricane and storm tracking information.

Vital Records

Determine secure storage areas for **VITAL RECORDS** and use for permanent on-site storage. Vital records of the company must be duplicated and stored off-site. (All magnetic tapes and computer disks should have back-ups in safe storage).

Emergency Supplies

TASK	RESPONSIBILITY
☐ Inventory tasks to be carried out by head of each department (or the equivalent) in the organization/facility.	General Manager / Financial Controller
☐ Inventory existing supplies.	Department Heads / EC Committee Rep.
☐ Requisition for replacement supplies.	Department Heads
☐ Prepare emergency supplies purchase orders, and keep in stock for distribution.	Department Heads

Recommendations

➢ Earmark and allocate funds for procurement of emergency supplies, and for regular maintenance of facilities. See suggested Emergency Supply Checklist (Form 2).

➢ Determine policy for handling keys and access to emergency supplies.

- Ascertain major department priority supplies for emergencies: e.g. Kitchen, Housekeeping, Engineering/Maintenance, First Aid, etc; then include in emergency budget.

Mutual Aid Agreements

TASK	RESPONSIBILITY
☐ Discuss mutual aid possibilities with relevant selected persons according to need and read agreements as necessary.	General Manager
☐ Review agreements annually and update status.	General Manager
☐ Where possible, share resource inventories which relate to particular agreements.	General Manager
☐ Negotiate purchase agreements on a contingency basis where necessary, e.g. hardware supplies.	General Manager

Recommendations

Formulate and adopt specific Mutual Aid Agreements with goods suppliers, neighbouring facilities, and operators on other islands, where applicable (Use Form 3). Areas of importance include:

- diesel and gasoline suppliers
- transportation for workers and possible evacuation of guests
- potable water
- local bakeries and food supplies
- hardware supplies
- heavy equipment service and rental companies.

Community Liaison Policy

TASK	RESPONSIBILITY

☐ Hold discussions on community relations and determine policy to be followed in terms of emergency assistance to community members.	General Manager
☐ Implement policy as soon as a decision is reached, by informing the National Emergency Organization, Hotel Management, staff, etc.	General Manager under direction from Corporate Body

Recommendations

➢ Define policy on acceptance of local guests in the event of a hurricane, and responsibility to the community in terms of assistance, etc.

Communications

TASK	RESPONSIBILITY
☐ Section V outlines a communications strategy. Adapt this prototype to suit your property.	General Manger Public Relations Person

Recommendations

➢The General Manager in consultation with the Board of Directors should define hotel policy on communications. **Section V** outlines steps for a communications plan.

Insurance

TASK	RESPONSIBILITIES
☐ Hold discussions on insurance and determine policy to be followed. Seek advice from insurance companies.	General Manager under the direction of the Corporate Body
☐ Implement policy as soon as a decision is reached.	General Manager

Recommendations

➢ The General Manager in consultation with the Board of Directors should define hotel policy on insurance coverage on physical structure, liability, and loss of profit. **Section VI** outlines steps for insurance coverage.

Guest Information

TASK	RESPONSIBILITY
☐ Prepare hurricane emergency procedures for guests. Keep on file.	Guest Relations/Services (see Form 4)
☐ Adapt guest information kits for condominiums and villas (as appropriate).	"
☐ Prepare a disclaimer letter for guests. Keep on file.	"

Recommendations

➢ Prepare guest information (brochures and disclaimer letter) for distribution at an appropriate time. Form 4.

Training

TASK	RESPONSIBILITY
☐Provide briefing sessions for staff on hurricane procedures for the home.	Emergency Coordinator through relevant organizations, e.g. Emergency Management Agency, CHA, Red Cross.
☐Include training in emergency procedures in orientation programme for new employees.	Emergency Coordinator

Recommendations

Conduct on-going training programmes in the following areas for different categories of staff:

➢ CPR, Basic First Aid

- Response procedures outlined in the manual
- Conducting regular exercises (Drills).

Evacuation of Guests

TASK	RESPONSIBILITY
☐Establish conditions under which evacuation will be necessary and state these in the plan, determining responsibilities of members of the staff for this task.	General Manager under direction from the Corporate Body.
☐Determine appropriate shelter with National Emergency Organization.	Same as above.

Recommendations

- Evacuation of guests to designated national shelters should be carried out only when this is felt to be the only appropriate course of action, given conditions for guest and staff safety.

Section II: During the Hurricane

Emergency Coordinating Committee

Phase A: Hurricane ALERT

TASKS
Hurricane Information
☐Map should be posted in the room designated as Command Centre, as instructed by General Manager, and at the Guest Information Centre Desk.
☐Telephone Operators should be instructed to refer ALL queries on the hurricane to the General Manager or designated spokesperson. (See Section V)

Recommendations:

➢A hurricane tracking map should be duplicated and used to track hurricane paths in the Caribbean.

➢Record information and establish and maintain contact with National Emergency coordinator and other local responsible authorities.

➢Make contact with the National Emergency Office and local authorities.

➢Ensure that all members of Coordinating Committee are made aware of hurricane developments.

Phase B: Hurricane WATCH

TASKS
Guest Information & Security
☐Locate pre-published guest emergency procedure letters.
☐Determine number of SAFE rooms for those persons that do not want to move to the central area. SUBMIT TO EMERGENCY TEAM. Give priority to disabled guests.

Recommendations

Make arrangements to:

➢Distribute to each guest room (with assistance from General Management Personnel) a Memo and the brochure instructing guests on hurricane procedures, as it affects them. ONLY DISTRIBUTE WHEN DIRECTED TO DO SO BY GENERAL MANAGER.

TASKS
Vital Records
☐Assist in securing all important files and equipment
Other Responsibilities
☐Maintain hurricane tracking map at Command Post as policy dictates.
☐Develop current list of key employees of Departments and contact addresses, phone numbers, etc.
☐Request all needed materials and supplies based on inventory provided; should include potable

water
☐Arrange worker transportation

Recommendations

➢General Manager, as head of Emergency Coordinating Team, meets with Team; discusses priorities for action based on activities achieved to date and staff/resource availability.

Phase B: Hurricane WARNING

➢Emergency Coordination Committee should lead the hurricane preparation procedures for each department. (*See each department's responsibilities for details*)

Phase C: EMERGENCY Phase

Special Note: During the Emergency Phase a skeleton Emergency Team of at least the General Manager and two other Committee members (preferably the Maintenance and the Kitchen Person) should remain.

TASKS
Guest Safety & Comfort (4-2 hours)
☐Evacuate guests to designated in-house shelter: a) alternatively, to designated safe rooms b) solicit voluntary assistance from guests as may be deemed necessary.
☐Check and ensure all rooms not designated safe are secured, unoccupied, and locked.
☐Address guests on activities for duration of hurricane.
☐Distribute games and/or initiate schedule of activities for guests (with assistance from volunteers).

General Manager / Offices

Phase A: Hurricane ALERT

➢Provide assistance and information to the EC Committee where and when - ever necessary.

Phase B: Hurricane WATCH

TASKS
Guest Information & Security
☐Determine number of guests likely to be resident at landfall of hurricane.
☐Liaise with sales and marketing personnel.
☐Determine schedule of events/ entertainment etc. available for guests to be included in guest memo.
☐Obtain list of all the guests and their room numbers. All EC Committee members should get a copy.

Recommendations

➢Review and backup computer files. Place existing hard copies, accounts, receipts, etc., in secure filing cabinets, away from areas subject to flooding etc.

➢Ensure staff on hand to settle guests’ bills where this has been adopted as established procedure.

TASKS
Mutual Aid
☐Reconfirmation of Mutual Aid Agreement, if necessary, and revision of requirements as perceived.
Staff Roster
☐Develop list and submit to Emergency Team.
☐Recall all key personnel as deemed necessary.
☐Make tentative arrangements for those who will stay on premises.
☐Distribute all key personnel as deemed necessary.

Recommendations:

➢Check and revise phone numbers of all Department Heads, Supervisors, and key personnel. Develop alternate list chart, dependent on those persons available (i.e. not on vacation, sick, etc.).

➢Make arrangements for employees to manage facility and guests during the crisis. Develop Staff Roster.

➢Allow employees time to make emergency preparations of their homes, ensuring they leave contact addresses, and are aware of possible rotation of staff roster.

Phase C: Hurricane WARNING

TASKS
Protection of Equipment, Supplies, and Vital Records (18-12 hours)
☐Secure and make sure adequate supplies of polyethelene sheeting available to cover desks, and equipment as needed.
☐Where necessary, prepare area for storage of small electrical items-(e.g. Calculators).
☐Disconnect and store all electrical appliances which will not be used up to the point of electrical failure.
Guest Accounts (12-6 hours)
☐Secure and lock away all vital records that are not necessary for usage within the next 24 hours.
☐Ensure all guest bills are paid or locked away in filing cabinets.
Staff Duty
☐Discharge all staff not required to be on hand.
☐Record and verify names of staff on duty.

Kitchen

Phase A: Hurricane ALERT/WATCH

TASKS

Food and Water Supplies
☐Take inventory of canned meats, vegetables, drinks, disposable sanitary ware, etc. (See Form 2).
☐Report status to General Manager or Team Leader, request additional supplies as necessary.

Recommendations

➢Conduct briefing meeting with kitchen staff, identifying priority tasks and delegate according to specific time requirements.

TASKS
Menu
☐Create cycle menu based on inventory.
☐Serve buffet style meals as determined necessary.
☐Sterilize and fill all available water containers; store in a safe place.
☐Make tentative arrangements with staff concerning possible rotation; establish contact addresses for key persons.
☐Allow staff to make personal emergency preparations.

Phase B: Hurricane WATCH

TASKS
Lighting, Cleaning, Mopping
☐Ensure provision of Emergency Lighting.
☐Place mops, buckets, garbage cans, etc. in strategic locations.

Recommendations:

➢Prepare for service during emergency phase.

Phase C: Hurricane WARNING/EMERGENCY Phase

TASKS
Food and Drink Service (12 hours up to Emergency Phase)
☐Set up tea/coffee/drink stations in or near designated shelter area, or safe blocks of rooms, using vacuum containers.
☐Raise or remove all items on floor areas subject to flooding
☐Prepare safe dining area and set up tables for guests
☐Arrange sterno heating with safe guard sternos. Arrange dishes and food
☐Close bars- no alcohol to be available
☐Serve sandwiches, soups, cold drinks- if all else fails
☐Chill canned juices/sodas to reduce demand for ice

Maintenance & Engineering Department

Phase A: Hurricane ALERT

TASKS
Cleaning
☐Clean all drains and remove debris on roofs/ drainage ditches
☐Clear or prepare rooms appropriate for storage of pool furniture

Recommendations:

➢Alert staff and brief them on developments.

➢Delegate and assign specific tasks, and define objectives in terms of time.

TASKS

Storage
☐Store pool chemicals
☐Clean out all floor drains
☐Prepare plywood and plastic sheeting to cover transformers in the event of leaks.
Emergency Supplies
☐Inventory existing emergency supplies and detail requests for additional supplies as necessary.
Standby Generators
☐Service plant and emergency generators. ➢Replenish diesel fuel ➢Service all cables and oil filters.
☐Test generator to check output reliability.
☐Provide rain/wind protection around plant.
Transport Vehicles
☐Check operating condition and service all transport vehicles.
☐Fill vehicles with fuel

Phase B: Hurricane WATCH

TASKS
Grounds
☐Trim limbs from large trees or those near buildings.
☐Remove coconuts from trees.
☐Clear drains -- including roofs.
Water Tanks

☐Fill water tanks with emergency water supplies.
Emergency Equipment
☐Service and test emergency power generators under load, prior to emergency use.
☐Check conditions of emergency equipment to ensure it is operable.
☐Secure emergency lighting supplies for kitchen, if generator not available.
☐Remove and store wind breaks from fences.
Flooding
☐Fill sandbags to protect areas from flooding, where appropriate.

Phase C: Hurricane WARNING

TASKS
Air Conditioning
☐Operate air conditioning/boilers until power fails.
Shutters
☐Install plywood or storm shutters to areas of glass or deemed most vulnerable to breakage.
Drains (12 Hours)
☐Ensure final check of drains cleared, including roof drains.
Tennis Courts
☐Remove nets from courts and store in secure area.
Swimming Pool (As necessary)
☐Lower water in pool by 2-3 feet.
☐If flooding begins in critical areas, use pumps to discharge storm water.
Satellite Dishes, Flags, Sign Boards, etc. (6-12 hours)

☐Dismantle satellite dishes, antennas, umbrellas, flags, sign boards, etc.
Pool Furniture (6 hours)
☐Store pool furniture not stored in pool. Secure those that need be, with rope.
Other Preparations
☐Tie down all other equipment which needs to be secured.
☐Load cameras with film.

Housekeeping / Laundry

Phase A: Hurricane ALERT

TASKS
☐Compile updated list of housekeeping staff, and establish a tentative roster.
☐All linen to be secured.
☐Distribute Guest Emergency procedures on direction from the Emergency Coordinator.

Recommendation:

➢Alert staff of conditions, and delegate tasks with respect to securing laundry facilities. Ensure that adequate linen, etc. are available.

Phase B / C: Hurricane WATCH / WARNING

TASKS
24 hours
☐Remove all patio furniture and pots and place in rooms.
☐Begin to secure rugs (roll up) drapes or remove and store in secure position in unoccupied guest rooms.

18 hours
☐Ensure that emergency lighting is available in all designated safe rooms.
☐All television sets (alarm clocks, radios etc.) should be secured in garbage bags, taped/stored in cupboards starting with unoccupied rooms.
☐Guests should be provided with large garbage bags to wrap suitcases.
8 hours
☐Finish securing all room furniture, draperies, etc.
☐Close all louvers securely in rooms.
☐Close all doors in unoccupied rooms. ➢Place all small damageable items in rooms not occupied, in closets, e.g. lamps, bed linen, etc.
6 hours
☐Ensure all tubs are filled in guest rooms with water for guest use.
☐Housekeeping to use old sheeting to stuff windows and under doors to prevent rain from soaking (assisted by ground staff).

Grounds Staff

Phase A / B / C: Hurricane ALERT / WATCH / WARNING

TASKS
Trees & Shrubbery
☐Trim trees.
Secure Objects
☐Secure all outdoor signs.
☐Secure all big lighting fixtures that could be blown away or other wise damaged.

☐Secure nets/tennis courts.
☐All loose objects to be secured and stored indoors where possible.
Shutters
☐Raise emergency guest shutters in rooms where supply exists.
☐Ensure sandbags are in place in critical areas where required.
Assist Housekeeping
☐Assist housekeeping staff to secure rooms.

Security

Phase A: Hurricane ALERT

TASKS
Staff Schedule
☐Establish necessary rotation schedule for backup.
Emergency Lighting
☐Secure lighting for immediate use. Activate radio with battery, and alternative communication facilities where established.
☐Secure all important files, equipment, and data.

Recommendation:

➢Determine adequacy of backup personnel.

Phase B / C: Hurricane WATCH / WARNING

TASKS

Security Posts
☐Establish security posts.
☐Take all steps necessary to ensure safety of all personal property.
Emergency Phase
☐Be on the alert for damages in the area and record.
☐Be on the lookout for intruders who will take advantage of the uncertain situation.

Section III: Recovery and Restoration

Immediately after a hurricane there are many tasks that must be attended to in order that operations are returned to normal as soon as possible.

The following **TASK/ RESPONSIBILITY** checklists should be used to ensure that all necessary tasks towards full recovery and restoration are completed.

Immediate Post Hurricane Hours

TASKS	RESPONSIBILITY
☐Establish overall ability to provide service to guests, based on resource availability, including Mutual Aid Agreements.	General Manager and Emergency Coordinating Team
☐Review and assessment resources to assist in clean-up and salvage operations and detailed damage assessment.	General Manager and Emergency Coordinating Team
☐Deploy staff available into teams with responsibility for: ➢ Damage Assessments (use Damage Assessment Report Form) and	General Manager and Emergency Coordinating Team

➢Clean-up Salvage	
☐Assess shortfalls in returning to normal operations.	General Manager and Emergency Coordinating Team
☐Assess and negotiate for joint use, lending, borrowing, and sharing of facilities, equipment, and personnel services.	General Manager and Emergency Coordinating Team
Guest Relations	
☐Carry out head count of guests.	Emergency Coordinating Team
☐Find alternative accommodations for guests, if this proves necessary, utilizing mutual aid agreements.	General Manager and Emergency Coordinating Team
☐Use media, where necessary, to provide workers with information regarding resumption of duties.	General Manager and Emergency Coordinating Team
☐Liaise with travel services and provide guests with information on possible travel arrangements, given the state of these services.	General Manager and Emergency Coordinating Team
☐Facilitate contact between guests and those organizations which may be able to facilitate communication with their relatives and friends, for example; local Embassies, the Red Cross, or American Express.	General Manager and Emergency Coordinating Team
☐Provide guests with information on interim arrangements being provided for their comfort and safety.	Emergency Coordinating Team

Recommendations

➢The Emergency Management Team members should make a brief assessment of the damage then meet to discuss and agree on priority activities to be taken.

➢The Manager should activate Mutual Aid Agreements (inter-hotel/company agreements for recovery operations.)

➢Provide information to guests to reduce their anxiety and to assure them that their interests are not being neglected.

➢Accurate information to the media should be provided as requested. Ensure that statements to the press are accurate, and brief, and without exaggeration. Be positive. (See the Communication Plan - Section V)

➢The loss of credibility with the public and guests following a crisis, such as a hurricane, could affect future operations, market share, and customer base.

Damage Assessment

TASKS	**RESPONSIBILITY**
☐Consult Priority Repairs Needs Report, developed by the initial inspection team immediately following the event (See Damage Assessment Report).	General Manager and Engineering and Maintenance
☐Photograph damage	Damage Assessment Team
☐Survey properties on basis of priority identified above. Insurance under-writer to accompany team/or retained quantity surveyor.	Damage Assessment Team
☐Itemize structural and non-structural damage.	Damage Assessment Team
☐Itemize damage to specific building equipment.	Damage Assessment Team
☐Itemize damage to utilities and communications system.	Damage Assessment Team
☐Identify need for contracted services.	Engineering and Maintenance
☐Identify labour and material needs for damage repair.	Engineering and Maintenance
☐Estimate each building’s repair costs.	Engineering and Maintenance
☐Summarize damage survey with estimated repair cost.	Engineering and Maintenance
☐Develop recovery schedule.	Engineering and Maintenance
☐Request advice on redesign or modification of vulnerable elements.	Engineering and Maintenance

Recommendations

➢Assess structural and non-structural weaknesses which contributed to damage.

Impact Evaluation

TASKS	RESPONSIBILITY
☐Identify disrupted telephone and power services, water shortages, damage to major transportation routes, and disruption of public transportation facilities.	General Manager and Emergency Coordinating Team
☐Ascertain projected restoration period.	General Manager
☐Contact employees to ascertain extent to which personal damage and dislocation will prevent work resumption.	Emergency Coordinating Team
☐Assess level of human resources needed for recovery work.	General Manager
☐Make decision relative to hiring temporary personnel.	General Manager
☐Assess reallocation of resources and unplanned expenditure.	General Manager

Recommendations

- Identify effect of event on total environment within which each property is located.
- Determine emergency measures needed to facilitate business restoration in the interim short-term period prior to full recovery.
- Identify areas of dislocation.

Clean Up And Salvage

TASKS	RESPONSIBILITY
☐Establish temporary dump on premises, where necessary.	Emergency Coordinating Team
☐Activate clean-up and salvage team.	General Manager
☐Activate mutual aid for transportation and other support for	General Manager

recovery activities.	
☐Clean-up facilities; utilize voluntary assistance of those guests with any interest.	Clean-up and Salvage Team
☐Secure contractor services where needed.	General Manager
☐Request professional assistance if necessary.	General Manager

Recommendations

➢Identify, remove, and dispose of rubble and debris.

Business Restoration

TASKS	RESPONSIBILITY
☐Activate plan for temporary front office, in the event of damage.	General Manager
☐Ensure that key personnel (or back-up staff) report to headquarters, provide assistance where necessary.	General Manager
☐Provide transportation for movement of key personnel and supplies.	General Manager
☐Implement recovery plan for business operations, revising marketing strategy as opportunity presents itself.	General Manager

Recommendations

➢Examine possibilities for change in marketing strategies, as in many instances, accommodation facilities for relief and rehabilitation workers are required.

Community Relations

TASKS	RESPONSIBILITY
☐Obtain information on extent and magnitude of damage to overall area in which the properties are located.	General Manager and Emergency Coordinating Team

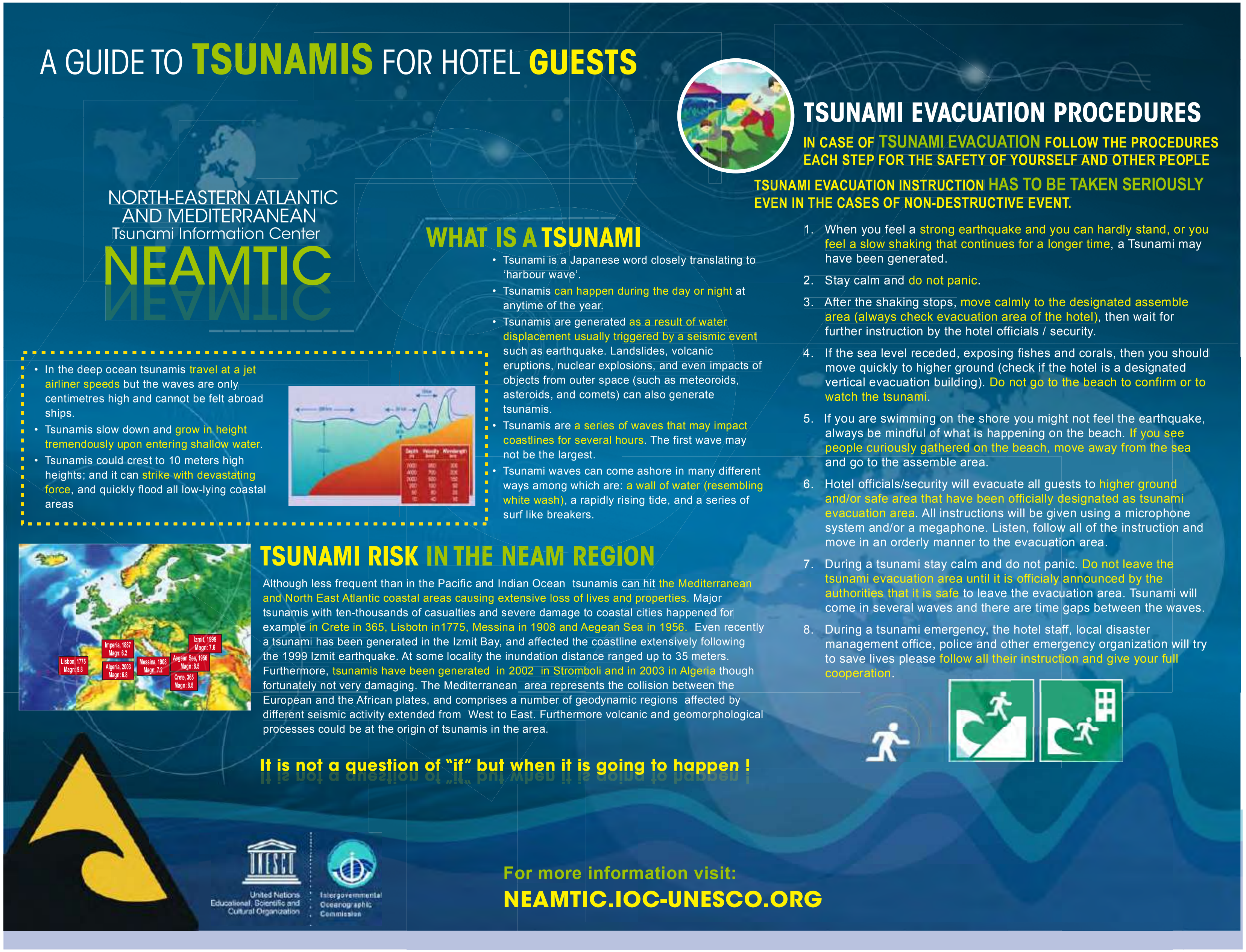
☐Obtain information on governmental action schedule to restore roads and utilities.	General Manager
☐Negotiate assistance for structural inspection and demolition, where necessary.	General Manager
☐Negotiate several permits, as may be required, for recovery operations.	General Manager
☐Make known any assistance which the hotel can provide to the community, e.g. shelter, food, etc.	General Manager or Public Relations Person

Recommendations:

➢Establish and maintain means of communication exchange with relevant public sector agencies.

➢Consult matrix of responsibilities in local National Disaster Plan to determine which agencies to contact in case of need.

Appendix 7 – A Guide to Tsunamis for Hotel Guests



A GUIDE TO TSUNAMIS FOR HOTEL GUESTS

NORTH-EASTERN ATLANTIC AND MEDITERRANEAN
Tsunami Information Center
NEAMTIC

WHAT IS A TSUNAMI

- Tsunami is a Japanese word closely translating to 'harbour wave'.
- Tsunamis can happen during the day or night at anytime of the year.
- Tsunamis are generated as a result of water displacement usually triggered by a seismic event such as earthquake. Landslides, volcanic eruptions, nuclear explosions, and even impacts of objects from outer space (such as meteoroids, asteroids, and comets) can also generate tsunamis.
- Tsunamis are a series of waves that may impact coastlines for several hours. The first wave may not be the largest.
- Tsunami waves can come ashore in many different ways among which are: a wall of water (resembling white wash), a rapidly rising tide, and a series of surf like breakers.

- In the deep ocean tsunamis travel at a jet airliner speeds but the waves are only centimetres high and cannot be felt abroad ships.
- Tsunamis slow down and grow in height tremendously upon entering shallow water.
- Tsunamis could crest to 10 meters high heights; and it can strike with devastating force, and quickly flood all low-lying coastal areas

TSUNAMI RISK IN THE NEAM REGION

Lisbon, 1775 Magn: 9.8
Imperia, 1887 Magn: 6.2
Algeria, 2003 Magn: 6.8
Messina, 1908 Magn: 7.2
Aegean Sea, 1956 Magn: 8.5
Izmit, 1999 Magn: 7.6
Crete, 365 Magn: 8.5

Although less frequent than in the Pacific and Indian Ocean tsunamis can hit the Mediterranean and North East Atlantic coastal areas causing extensive loss of lives and properties. Major tsunamis with ten-thousands of casualties and severe damage to coastal cities happened for example in Crete in 365, Lisbotn in1775, Messina in 1908 and Aegean Sea in 1956. Even recently a tsunami has been generated in the Izmit Bay, and affected the coastline extensively following the 1999 Izmit earthquake. At some locality the inundation distance ranged up to 35 meters. Furthermore, tsunamis have been generated in 2002 in Stromboli and in 2003 in Algeria though fortunately not very damaging. The Mediterranean area represents the collision between the European and the African plates, and comprises a number of geodynamic regions affected by different seismic activity extended from West to East. Furthermore volcanic and geomorphological processes could be at the origin of tsunamis in the area.

It is not a question of "if" but when it is going to happen !

TSUNAMI EVACUATION PROCEDURES

IN CASE OF TSUNAMI EVACUATION FOLLOW THE PROCEDURES EACH STEP FOR THE SAFETY OF YOURSELF AND OTHER PEOPLE

TSUNAMI EVACUATION INSTRUCTION HAS TO BE TAKEN SERIOUSLY EVEN IN THE CASES OF NON-DESTRUCTIVE EVENT.

1. When you feel a strong earthquake and you can hardly stand, or you feel a slow shaking that continues for a longer time, a Tsunami may have been generated.
2. Stay calm and do not panic.
3. After the shaking stops, move calmly to the designated assemble area (always check evacuation area of the hotel), then wait for further instruction by the hotel officials / security.
4. If the sea level receded, exposing fishes and corals, then you should move quickly to higher ground (check if the hotel is a designated vertical evacuation building). Do not go to the beach to confirm or to watch the tsunami.
5. If you are swimming on the shore you might not feel the earthquake, always be mindful of what is happening on the beach. If you see people curiously gathered on the beach, move away from the sea and go to the assemble area.
6. Hotel officials/security will evacuate all guests to higher ground and/or safe area that have been officially designated as tsunami evacuation area. All instructions will be given using a microphone system and/or a megaphone. Listen, follow all of the instruction and move in an orderly manner to the evacuation area.
7. During a tsunami stay calm and do not panic. Do not leave the tsunami evacuation area until it is officialy announced by the authorities that it is safe to leave the evacuation area. Tsunami will come in several waves and there are time gaps between the waves.
8. During a tsunami emergency, the hotel staff, local disaster management office, police and other emergency organization will try to save lives please follow all their instruction and give your full cooperation.

UNESCO United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission

For more information visit:
NEAMTIC.IOC-UNESCO.ORG

Appendix 8 – UNESCO-IOC: A Guide to Tsunamis for Hotels

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

NORTH-EASTERN ATLANTIC AND MEDITERRANEAN Tsunami Information Center

NEAMTIC

A GUIDE TO TSUNAMIS FOR HOTELS

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A GUIDE TO TSUNAMIS FOR HOTELS

Tsunami Evacuation Procedures

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Foreword

Following the disastrous 2004 Indian Ocean tsunami, the Intergovernmental Oceanographic Commission of UNESCO (UNESCO-IOC) was given a mandate by its Member States to facilitate the expansion of global coverage of Tsunami Warning and Mitigation Systems (TWS) and to co-ordinate the establishment of a TWS for a region comprising the North-eastern Atlantic, the Mediterranean and Connected Seas. As part of this process, a Tsunami Information Centre (NEAMTIC) is being created to serve the needs of civil protection agencies and the public at large, providing information on warning systems, risks and good practices in respect of tsunamis and other sea-level related hazards. This guideline forms a foundation for these objectives. It provides guidance for hotel managers to assist and guide their guests for evacuation in case of a tsunami event. This is particularly important in the NEAM region considering that the Mediterranean is the first tourist destination in the world. As highlighted in the UNESCO/UNU Symposium "The Great East Japan Tsunami on 11 March 2011 and Tsunami Warning Systems: Policy Perspectives" final statement, tsunami preparedness involves also the awareness component which may be improved by educating the public about the nature and threat of the hazard but also on safe behavior to be adopted in case of an event. Early self-evacuation is of major importance.

Wendy Watson-Wright

Assistant Director General, UNESCO

Executive Secretary of IOC

Executive Summary

This booklet summaries steps that will guide hotels to prepare for tsunami hazards. This guidebook is to be use by hotel management; it is intended to direct them on how to build the hotel's capacity in evacuation planning for tsunami emergency. The guidebook outlines the necessary steps to be undertaken, such as preliminary preparedness assessment using a checklist from the "Tsunami Ready" Toolbox, understanding the warnings (natural warning and official warning), deciding on an evacuation strategy, consideration for a hotel to be an evacuation area and the standard operating procedures for tsunami emergency.

This guidebook is devided into five parts. The first part provides a brief information of what is a tsunami and why it is important for hotels to address this hazard as part of their business. Part 2 decribes the tsunami hazard in the North-Eastern Atlantic and the Mediterranean Seas and efforts that has been taken in response to mitigate the hazard. Part 3 focuses on aspects that hotels need to take into consideration in building tsunami preparedness. This part also elaborates three different situations that influences evacuation strategies. Part 4 elaborates on considerations for a hotel to decides if the hotel could be a tsunami evacuation area, including determining the evacuation place in the hotel premises and on the signage needed for the evacuation place. Finaly, part 5 highlights the evacuation planning and procedures for the hotel that may serve as their standard operating procedures in tsunami emergency.

This guidebook explains the steps in building tsunami preparedness, however, to successfully develop the plans and procedures the hotel has to do all the ground work. It is recommended to work through participatory approach with all hotel stakeholders (staff and management) to simultaneously build in the capacity and ownership. At the same time, the hotel should also coordinates with the local disaster management office and/or other local authorities and stakeholders working on disaster and emergency management (for example red cross) to know more about the tsunami risks in the area as well as other local disaster management issues .

I. Introduction

Hotel is a part of the tourism industry that relies on guests/visitors. However, most hotels are located in tourist areas that are more and more exposed to disasters such as earthquake, volcano, sea level rise, and tsunami. Hotel guests, as tourists, usually are not familiar with the local situation and therefore are considered as one of the vulnerable group. Most of the times tourist are not aware of the nature and threat posed by the hazards in that particular area; thus the guess will not know what to do, and where to go if there is a disaster emergency. During emergency they came to a situation where they need to rely on those who know more about the local situation. In this case the hotel staff and management will be the most reliable source for the guests. Therefore, hotels need to include disaster preparedness as an integrated part of their business operation.

Although tsunami events occur less frequent compared to other disasters, recent tsunami events in the Indian Ocean (2004); Indonesia (2004, 2006, and 2010); Chile (2010); and Japan (2011) have shown that the effects of tsunamis can be catastrophic. The first priority when a tsunami occurs is the evacuation of the people in the tsunami risk areas. The time span between a warning and the impact of the first tsunami wave might be very short (especially for the locally generated tsunamis). This will affect on the when, how, and where the people have to be evacuated.

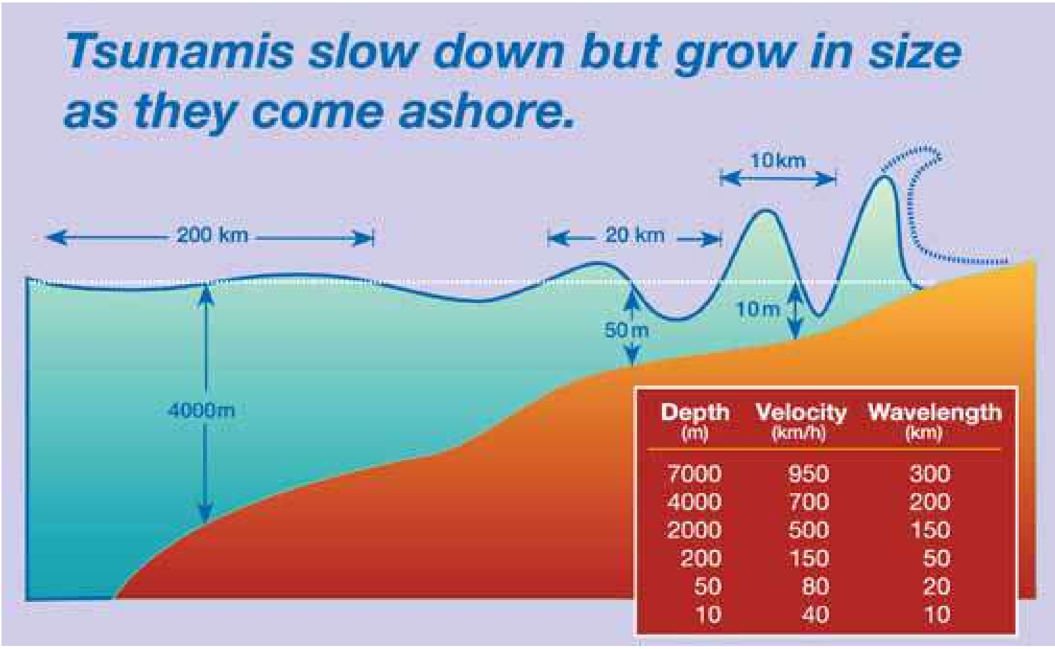
Once a tsunami early warning is received (either natural warning or official warning) hotels are responsible to assist and guide their guests for evacuation. It is very important for the tsunami evacuation plans and procedures to be integrated as one of the hotel's operational systems.

In the North-Eastern Atlantic and Mediterranean coastal areas, tsunami happens less frequently compared to the Pacific. Howeve , there are evidence and records that major tsunamis have happened and have caused fatalities and damaged, for example in Crete (365), in Lisbon (1775), in Messina (1908), and in Aegean Sea (1956). The most recent tsunami happened in 2002 in Stromboli and in 2003 in Algeria, fortunately are not too damaging. This historical record of past tsunamis, scientific trace of events, and written and/or oral reports, indicate a high certainty that another tsunami can happen in the future. It is not a matter of "*if the tsunami will happen*" but more of a question of "*when the next tsunami will happen*". Since most tsunamis resulted from an earthquake activity, it is not possible to predict when the next tsunami will happen. For this reason preparedness is the key for people to be able to respond to and recover from when the tsunami strikes again.

What is a Tsunami?

Tsunami is a Japanese word closely translating to 'harbour wave'. Tsunamis are large ocean waves generated by major earthquakes beneath the ocean floor or major landslides into the ocean. Tsunamis that are caused by severe nearby earthquakes are known as **locally generated tsunamis**; this type of tsunami may reach the coast within minutes. Tsunamis that are generated by very large earthquakes far away in other areas of the ocean are known as **distant tsunamis**. Waves caused by these earthquakes travel at hundreds of miles per hour, reaching the coast several hours after the earthquake.

In the deep ocean tsunami travel at jet airliner speeds but the waves are only a few centimeters high and cannot be felt aboard ships. When the waves enter shallow water, they may rise to several meters or, in some cases, tens of meters, striking the coast with devastating force. Tsunami waves can come ashore in many different ways among which are: a wall of water (resembling white wash), a rapidly rising tide, and a series of surf like breakers. The first wave may not be the largest and the series of waves may impact coastlines for several hours.

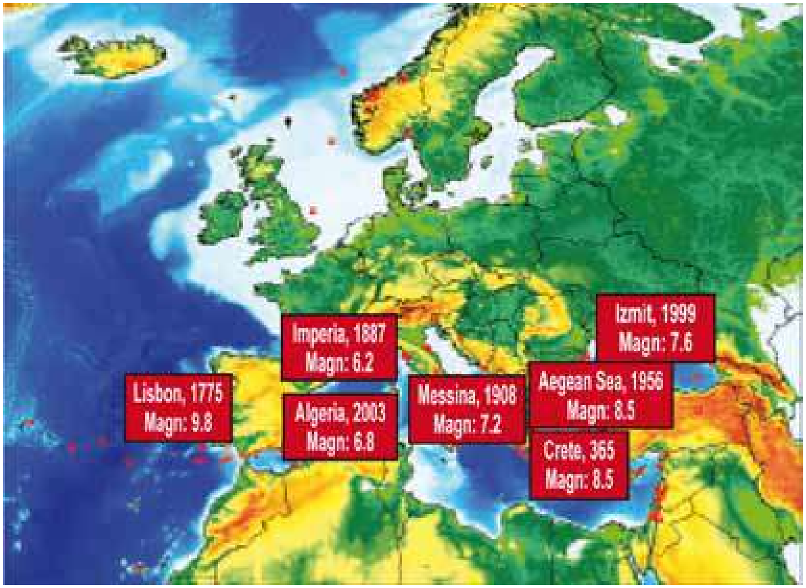


Depth (m)	Velocity (km/h)	Wavelength (km)
7000	950	300
4000	700	200
2000	500	150
200	150	50
50	80	20
10	40	10

II. Tsunami Hazard and Mitigation in the North-Eastern Atlantic and the Mediterranean Seas (NEAMS)

Tsunami Facts in NEAM Seas

Although it is less frequent than in the Pacific tsunamis can hit the Mediterranean and North East Atlantic coastal areas, causing extensive loss of lives and properties. Major tsunamis with ten-thousands of casualties and severe damages happened to coastal cities in the past such as in Crete (365), Lisbon in 1775, Messina in 1908 and Aegean Sea in 1956 . Even recently, a tsunami has been generated in the Izmit Bay it has affected the coastline extensively following the 1999 Izmit earthquake. At some locality the inundation distance ranged up to 35 meters. Furthermore, tsunamis have been generated in 2002 in Stromboli and in 2003 in Algeria though fortunately not very damaging. These historical record of past tsunamis, scientific trace of events, and written and/or oral reports, indicates that a high certainty that another tsunami can happen in the future.



The Mediterranean area represents the collision between the European and the African plates, and comprises a number of geodynamic regions affected by a different seismic activity extended from West to East. Furthermore volcanic and geomorphological processes could be at the origin of tsunamis in the area.

This geodynamic condition and the historical records confirmed us that it is not a matter of “if tsunami can happen” in these regions but it is a question of “when it will happen”. This also tells us

Tsunamis in the North-Eastern Atlantic and the Mediterranean (S.Tinti)

Because of the active lithospheric plate convergence, the Mediterranean Sea region is geodynamically characterized by high seismicity and significant volcanism. Furthermore, coastal and submarine landslides are quite frequent, partly in response to the steep terrain that characterizes much of the basin. Tsunamis are among the most remarkable phenomena associated with earthquakes, volcanic eruptions and landslides in the Mediterranean Basin. Until recently, however, it was a widely held belief that tsunamis either did not occur in the Mediterranean Sea or they were so rare that they did not pose a threat to coastal communities. Catastrophic tsunamis are more frequent on Pacific Ocean coasts where both local and transoceanic tsunamis have been documented. On the contrary, large tsunami recurrence in the Mediterranean Sea is of the order of several decades and the memory of tsunamis is short-lived. Tsunami catalogues for the Mediterranean Sea have been compiled by several authors [1].

[1] Strong Tsunamis in the Mediterranean Sea; A Re-evaluation; Gerassimos A. Papadopoulos and Anna Fokaefs, Institute of Geodynamics, National Observatory of Athens, Athens-11810, Greece. ISET Journal of Earthquake Technology, Paper No. 463, Vol. 42, No. 4, December 2005, pp. 159-170

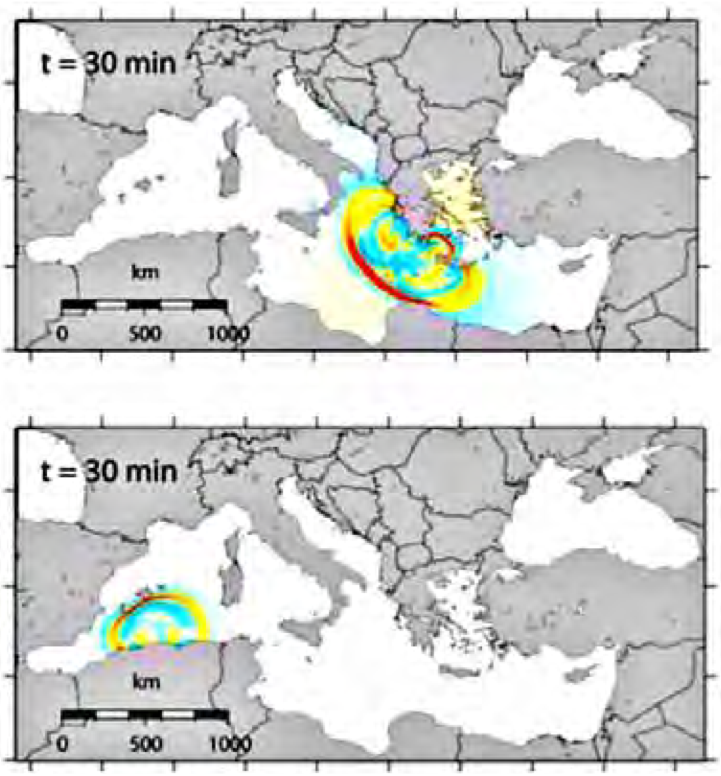
that tsunami risks exists. Therefore, hotels along the coastline facing the Mediterranean Sea and the North-eastern Atlantic need to understand this risks and make sure the preparedness and response capacity are build in their operational system.

Understanding the hazard and identifying the risks

To start to work on disaster management plan, disaster risk reduction, and evacuation planning hotels have to first understand what are the types of hazard that threat the hotel's area and what are the risks caused by these hazards. Tsunami has been identified as one type of hazard that is a threat to the North-eastern Atlantic and the Mediterranean Seas coastal area. Therefore, for hotels that are located in these coasts need to consider tsunami as one of the hazard and assess what are the risks.

Tsunami hazard is complex in nature for it can happen at any time and depending on the location it might only gives a very limited time for the people to evacuate. To assess this hazard one has to understand the geophysical condition of the source, to know how the tsunami is generated by the source, and to know the extent of the inundation that can happen as the tsunami reaches the coast. To have a better understanding the tsunami hazard in the area the hotel needs to:

- Coordinate with local disaster management office and policy makers to understand tsunami hazard in the area and what have been done to mitigate the hazard;
- Know about tsunamis that have come ashore in the hotel area in the past;
- Check hazard maps to know the hotel area's level of threat based on different scenarios: possible time frame of arrival, how the tsunami waves propagate to the area, as well as estimated inundation area and depth in the hotel area.



Example of Tsunamis propagation after 30 minutes from different sources, the scenario above the source is in the western Hellenic arc and bellow is in the north Algeria. (Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, NEAMTWS, Implementation Plan)

Once the hotel knows about the hazards that threaten the hotel's area, the hotel needs to assess what are the potential risk that will affect the hotel if a disaster strikes.

Risk identification and assessment is a process of measuring the potential of loss of life, injury, property damages and economic impact caused by the hazards. Risk assessments involve evaluation of the vulnerability of the people (among other staff, guest, visitors, including guest's children, and people with special needs) and building and facilities (such as integrity of the building structure, water supply, and power supply). Assessment should also consider the hotel's business risks, analyzing the impact if the disaster happens (for example post disaster tourism market and insurance coverage). The main important question to ask in identifying the risk is "what would happen if earthquake and tsunami strikes?" and elaborate the question with: what if it happened at night? what if it happened when the hotel were at the highest occupancy? and what if it happen during cold weather time?

Understanding the tsunami risks in the hotel area will be the basis for the hotel management to better focus on their activities and resources in building response capacity (such as develop tsunami emergency response standard operating procedures), take the necessary actions (for example make sure the building meet the criteria to be designated as vertical evacuation building, re-locate the hotel's power supply and communication system to a safer place), and working on tsunami preparedness (for example conduct regular tsunami exercise involving all staff, related stakeholders and if necessary the hotel guests).

Hotel guests and visitors should be consider as vulnerable group since they usually have limited knowledge of the area. Hotels have the responsibility to ensure the safety and wellbeings of their guests and visitors by informing of the potential disaster and actions to be taken in case of emergency.

Understanding the warning

Natural warning

An earthquake is one of nature's tsunami warning sign, when you feel a strong earthquake that makes you can hardly stand, or a slow shaking but for a longer time, a Tsunami may have been generated (locally generated tsunamis). Tsunami may be preceded by a rapid fall in sea level as the ocean retreats exposing fishes and corals on the sea bottom. In the deep ocean, tsunami wave travels in a speed of jet airplane and slow down as it comes to shallow water but the height of the waves grow in height with a strong and destructing force.

Under these circumstances (locally generated tsunamis), there may not be enough time for an *official warning*. There might be only a very short lead time between the earthquake and the first arriving tsunami wave. For locally generated tsunamis, the hotel should take this natural warning as a sign to evacuate their guests, visitors, and staffs immediately inland and/or to higher ground, and/or to the designated evacuation area.

Natural Warning Signs of a Tsunami:

- *An earthquake (strong shaking that make you can hardly stand, or a long slow shaking for more than a minute)*
- *Sea water receding, exposing the fish and corals at the bottom of the sea*
- *A strange loud sound coming from the sea (i.e. loud roar)*

Official warning

In case of distant tsunami (regional or ocean wide), earthquake might not be the first warning, an earthquake might occur far away across the sea and generated a tsunami wave that propagating toward the coastline in the hotel area. In this case, the hotel will receive the first warning from the responsible authority in the country, the National Tsunami Warning Center (NTWC) and/or the National Disaster Management Office (NDMO), depending on the country tsunami early warning system setting

The hotel should rely on this warning notification issued by the NTWC to decide when to evacuate their guests, visitors, and staff. Therefore it is important to understand the official warning system and meaning of the warning notification.

In the aftermath of the 2004 Indian Ocean Tsunami in December 2004, the Intergovernmental Oceanographic Commission (IOC) of UNESCO was given the mandate to coordinate and facilitate the global tsunami early warning system. The global coverage is divided into four major regions: the Pacific, Indian Ocean, Caribbean, and North-Eastern Atlantic and the Mediterranean Seas (NEAM). The Tsunami Early Warning System developed for the NEAM region known as North-Eastern Atlantic and the Mediterranean Seas Tsunami Warning System (NEAMTWS). Based on the experience in the Pacific, each region would also maintain a regional Tsunami Information Centre, in this case namely North-Eastern Atlantic and the Mediterranean Seas Tsunami Information Centre (NEAMTIC)

North-Eastern Atlantic and the Mediterranean Seas Tsunami Warning System (NEAMTWS)

The structure of NEAMTWS consist of Tsunami Watch Providers (TWPs), National Tsunami Warning Centers (NTWSs), and Tsunami Warning Focal Points representing each member states. For regular update of NEAMTWS please visit: *www.ioc-tsunami.org/neamtws*

Tsunami Watch Providers (TWPs)

Tsunami Watch Providers are National Tsunami Warning Centers (NTWCs) that are willing and able to provide tsunami alert information to the other Member States at the designated Forecast Points; Tsunami Watch Recipients are the Tsunami Warning Focal Points that will receive the information. TWPs will be responsible in:

- Collecting, recording, processing and analyzing of earthquake data for the rapid initial assessment (locating the earthquake, its depth, its magnitude and its origin time) as a basis for the alert system.
- Computing the arrival time of the tsunami in the forecasting points as listed in the Communication Plan.
- Collecting, recording, processing and analyzing of sea level data for confirming and monitoring the tsunami or for cancelling elements of the alert system.
- Making decisions in accordance with the Communication Plan to elaborate messages.
- Disseminating to the Member States focal points (and national warning centres) of the messages in accordance with the Communication Plan, including tsunami travel time, amplitude and period of the measured tsunami, and cancellation messages .

National Tsunami Warning Centres (NTWCs)

Each member country of the NEAMTWS is responsible for establishing their own National Tsunami warning Centres. The main responsible of NTWC is to provide warnings as soon as possible after a potential tsunami generation; to issue warnings for all destructive tsunamis; to make sure the warning centers operate continuously and the warning messages are sent and received promptly and is understood by the users of the system. Therefore these centers will have the function of:

- Collecting, recording, and processing of earthquake data for the rapid initial warning locating the earthquake, its depth, its magnitude and its origin time)

- Computating the arrival time of the tsunami in the national forecasting points
- Collecting, recording, and processing of sea level data for confirming or cancelling the warning.

Tsunami Warning Focal Point (TWFPs)

The Tsunami Warning Focal Point (TWFP) is a 24/7 contact person, or other official point of contact or address designated by a government. TWFP is available at the national level to rapidly receive and issue tsunami event information (such as warnings). The Tsunami Warning Focal Point is either the emergency authority (civil defense or other designated agency responsible for public safety), or has the responsibility of notifying the emergency authority of the event characteristics (earthquake and/or tsunami), in accordance with the national standard operating procedures. The Tsunami Warning Focal Point receives international tsunami warnings from the NEAMTWS or other regional warning centres.

North-Eastern Atlantic and the Mediterranean Seas Tsunami Information Centre (NEAMTIC)

The North-Eastern Atlantic and the Mediterranean Seas Tsunami Information Centre (NEAMTIC) is a part of the activities coordinated by the Intergovernmental Oceanographic Commission (IOC) of UNESCO and carried out by Member States to developing the NEAMTWS. The objectives of NEAMTIC are:

- Providing information to civil protection authorities and the general public on warning systems for tsunamis and other sea-level related hazards, and on the activities of IOC and European Union (EU) in the field of tsunami preparedness
- Building capacity through one training workshop on tsunami early warning systems, standard operating procedures, numerical models to determine tsunami travel time, and ISO signage;
- Making citizens, especially youth, aware of the risks of floods from the sea in coastal areas, such as tsunamis, storm surges and strong swells, providing them with knowledge on the phenomena and practices of safe behavior.
- Identifying, sharing and disseminating good practices in plans, methods and procedures to strengthen preparedness for sea level related hazards.
- Fostering linkages between the EU and IOC on intergovernmental and transnational actions to develop NEAMTWS.

For more information on NEAMTIC and get more awareness materials please visit: *www.neamtic.ioc-tsunami.org*

III. HOTEL PREPAREDNESS

What is Preparedness

Preparedness is activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warning as well as the temporary evacuation of people and property from threatened locations (UN/ISDR, 2004).

Disaster preparedness involves forecasting and taking preventive measures prior to an imminent threat. Preparedness comprises the ability to understand the warning (including the ability to receive and interpret the warning), to organize evacuation and/or other measures to be taken to minimize potential loss of life and damage during a disaster and to organize timely and effective rescue, relief and assistance.

Preparedness improves the response to the effects of a disaster; therefore, requires a standard operating procedure and regular testing of the systems and plans.

A disaster-prepared hotel is a hotel that has established its standard operating procedures, systems and plans. They are readily organized for the steps necessary in cases of a tsunami, including: emergency response, evacuation during disaster, and recovery plans after disaster. All of the hotel's stakeholders (management and staff) know how to prepare to, respond to, and recover from disaster.

Building Tsunami Preparedness

In general, hotel business has been characterized as business that has solid and consistent operating procedures and systems. Most hotels have established their emergency response system, especially to fire hazards. Therefore, building the tsunami preparedness should be embedded into the existing system. However, it still will require different adjustment and adaptation considering the complexity of tsunami hazard.

To build tsunami preparedness, the hotel needs to first assess its current capacity and to build based on the need to be more prepared. In Indonesia, to build tsunami preparedness in the hotel industry, the Indonesian Ministry of Culture and Tourism in cooperation with Bali Hotels Association, supported by the German Centrum für Migration and Entwicklung (CIM) has developed a checklist that enables hotels to assess their state of preparedness[2]. This checklist were implemented in several hotels in Bali under their "**Tsunami Ready"** programme (*www.tsunamiready.com*).

The checklist consists of six categories and in each category there are sets of questions to be answer to assess the state of current tsunami preparedness (see Annex):

- **Information Sources and Interpretation**, is to check the hotel's capacity to receive official tsunami warnings from the authority, interpret the warnings, and to disseminate the warning within the hotel.
- **Evacuation Procedures**, is to check the hotel's evacuation procedures from rooms, beach, and public places within the hotel.
- **Evacuation Route and Shelters**, is to check the hotel's evacuation route and signs, including the hotel as vertical evacuation.
- **Community Relations**, is to check external relations with the communities surrounding the hotel.
- **Cooperation**, is to check the cooperation amongst hotels in the surrounding area.
- **Post Tsunami**, is to check all of the preparation that needs to be considered post tsunami disaster.

This checklist is only a suggestion and to be use as a starting point. Each hotel might want to adjust and/or add more to the lists in accordance to the local context, regulation, hotel situation and needs. This checklist could also be use as tools to monitor and evaluate how the hotel is progressing in building their tsunami preparedness.

Once the hotel knows their current state of tsunami preparedness, the hotel can start to build their capacity to increase their tsunami preparedness. These are essential points the hotel needs to build in relation with the tsunami preparedness:

- **Early warning systems**: Hotels should be able to timely receive the warning, especially official warnings, have the ability to understand the warning, and are able to further disseminate the warning to reach all part of the hotel. All hotel guests, visitors, and staff need to be able to hear and receive the warning. To receive the warning, the hotels need to have a close cooperation with the national authorities who are responsible, at national level, for issuing the warning.

[2] *The Tsunami Ready Toolbox, Alexander Kesper, Ministry of Culture and Tourism Republic of Indonesia, Bali Hotels Association, Centrum fur Internationale Migration und Entwicklung, 2008*

- **Evacuation and Shelter:** This should be the primary concern of hotels, especially considering guest and visitors are considered vulnerable since they might not be familiar with the local situation. The hotel has to make sure that all guests, visitors, and staff could be safely evacuated to a designated safe area. Furthermore, taking into consideration that the hotel might be fully occupied, the safe area should be able to accommodate all evacuate. The hotel needs to assess if their building can be considered as vertical evacuation building (meeting all the criteria and standards) or not - in which they have to evacuate all guests, visitors, and staff out of the hotel premises.
- **Emergency Command Function:** In case of emergency hotels should have clear definition of the roles and responsibilities of each stakeholder. Each hotel unit / department should have a clear defined function what they have to do, who will do what and where, and whom they have to report to.
- **Emergency Personnel and Resources:** Hotels need to have procedures to mobilize staffs as emergency personnel with specific roles and ensure that all emergency response is carried out according to plan. Hotels need to ensure that the emergency personnel have the knowledge and skill to perform their duties as emergency personnel. Hotels also need to have all resources needed for emergency and during emergency is available at anytime.
- **Communication and supplies:** Public infrastructure might be paralyzed for several days after the disaster, communication may be cut off. Hotels need to make sure they have emergency communication equipment available, in working condition, and at hand, during and after the disaster, for example satellite phones. Past experience also shows that, in some cases, emergency supplies (water, food, and medical) can take several days before they can get through. Hotels need to ensure that they will have supplies to support them during emergency situation.
- **External Coordination:** THe hotels need to coordinate with local administration and disaster management office (DMO) in developing the hotel s evacuation plan and emergency response. Check the local DMO post tsunami emergency plans and make the hotel's emergency plan based on the DMO's capacity. Form alliance with other hotel and businesses in the area to have better coordination and cooperation and develop common strategy in responding to the disaster.
- **Department Close Down Procedure:** Most hotels might already have this Department Close Down Procedures such as for fire related emergenc , weather related emergency, and others. These procedures could be adapted for tsunami emergency. However, it is important to understand that in tsunami emergency, there might by only little time available, especially for the

locally generated tsunami cases. Therefore, it is important to concentrate on the essentials and/ or have specific procedures for tsunami emergenc .

- **Records Management:** Hotels needs to ensure that all important documents and records are well secured during emergency. Guests hotel records will be very important for post emergency response and reliefs as well as to make sure all people are accounted.
- **Restoring main functions and plan for recovery:** Hotels have to have plans on restoring their main function (water, sanitary, electricity, and communication) for emergency use after the disaster and have a short and midterm plan to recover from the disaster.

Evacuation Strategy

Tsunami threat in each countries are different, therefore, the setting of the tsunami early warning are different from one country to another. There are countries that have a National Tsunami Early Warning Centre with the capacity to detect, analyse, and issue warning when a tsunami is coming to their coastline. Other country, which has lower tsunami threat, might rely on information from the Tsunami Watch Providers (TWPs). These settings will affect the time line of how long they will be able to issue the warning. Therefore hotels need to understand the tsunami early warning setting in their country to decide on their evacuation strategy. There are three basic possible scenarios that can be taken as a consideration to decide whether guests, visitors, and staff need to do an evacuation:

1. Earthquake is felt in the hotel area, but no tsunami warning is issued.
2. Earthquake is felt in the hotel area and a tsunami warning is issued.
3. Tsunami warning is issued, although the earthquake is not felt in the hotel area.

These situations would require different decisions and actions by the hotel, especially if related to tsunami evacuation procedures.

1. Earthquake is felt in the hotel area, but no tsunami warning is issued

Hotels located in an earthquake prone area might feel the earth shakes as it happened. The hotel management needs to decide whether to evacuate the guests from the building or not. Depending on the intensity of the earthquake felt in the hotel area, the hotel management might want to decide to evacuate all guests, visitors and staff once the shaking stops. The hotel has to decide on which earthquake intensity strength they would like to do evacuation

Hotel management also has to understand that an earthquake can be a natural sign of a tsunami. There is also a possibility that the official warning mechanism did not work because of the earthquake. Therefore, even there is no official tsunami warning received, hotel management might still needs to consider doing tsunami evacuation procedures (See page 6).

as their standard operating procedures. Should the earthquake reach the level of intensity strength that the hotel has decided to do evacuation, they need to start to evacuate all guests, visitors and staffs once the shaking stops. Earthquake evacuation should be done from inside of the building to the designated assembly area outside the building (an open space).

In locally generated tsunami, time is very crucial. Hotel management has to consider that the first wave may arrive with minutes. There is only short time period between the time of the earthquake and the time of the arrival of the first tsunami wave.

The evacuation procedures involved evacuating guests from their rooms; from restaurants, lobby, function rooms (Ball room, meeting rooms) and corridors; from beach and pool areas; as well as evacuating the staff from the operating department of the hotel (diagram 3.1.). At the same time, after the shaking stops, the hotel management needs to confirm with the authorities whether the earthquake has generated a tsunami. If the authorities confirmed that **the earthquake did not generates a tsunami** and no tsunami warning is issued, then they should proceed with

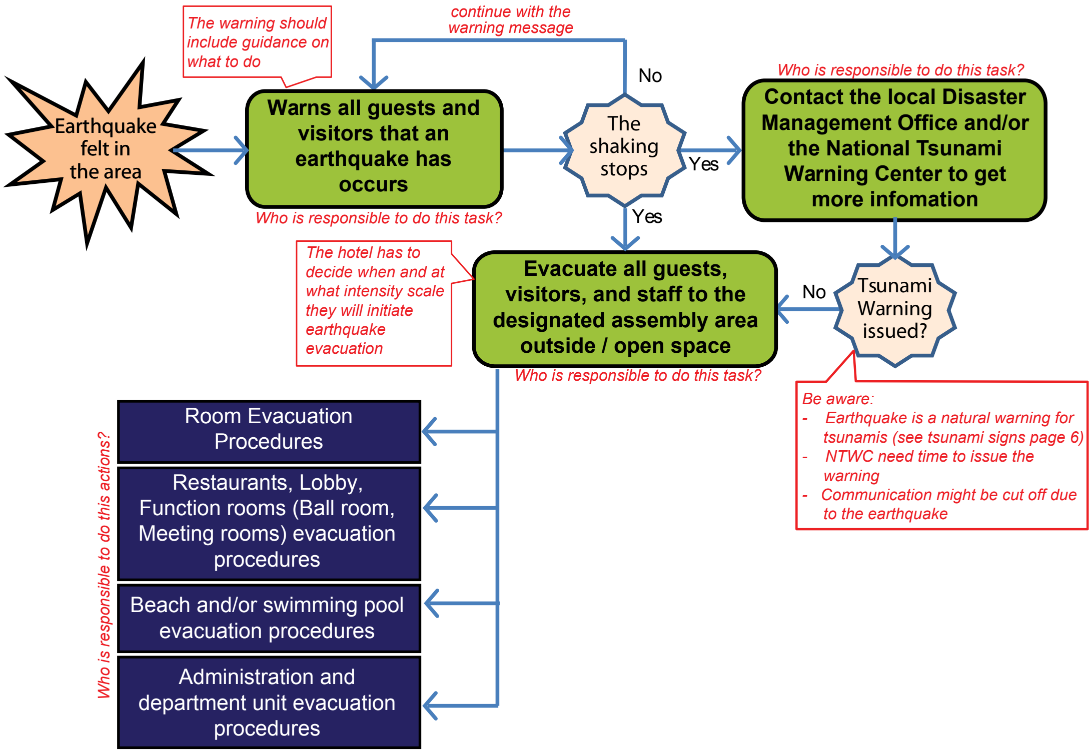


Diagram 3.1. Decision Making on Tsunami Evacuation When Earthquake is felt in the Area, no tsunami warning is issued

earthquake evacuation and emergency response. Hotel management needs to understand that it might take several minutes for the authorities to analyze and decide whether a tsunami warning would be issued or not. Hotel management also has to understand that there is a possibility that the official warning mechanism did not work because of the earthquake. Therefore, even if there is no official tsunami warning received, hotels management might still need to consider doing tsunami evacuation procedures.

2. Earthquake is felt in the hotel area and tsunami warning is issued

In the case that an earthquake is felt in the hotel area and confirmation is received from the authorities that the earthquake has generated a tsunami (locally generated tsunamis), the hotel management will need to immediately start to initiate their tsunami evacuation procedures (diagram 3.2.). While the earthquake evacuation is in process the hotel also needs to warn all guests, visitors, and staffs that a tsunami warning has been issued and tsunami evacuation procedures has been initiated.

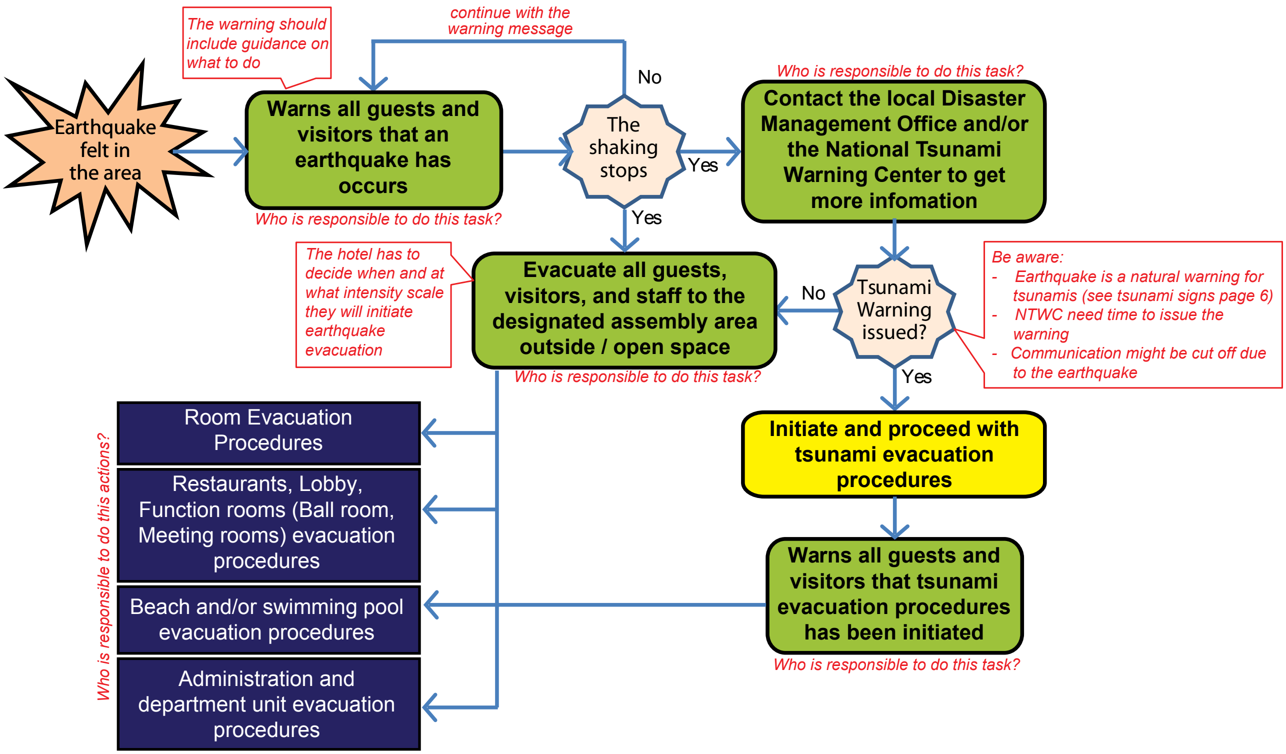


Diagram 3.2. Decision Making on Tsunami Evacuation When Earthquake is felt in the Area and a Tsunami Warning is ssued

3. Tsunami warning has been issued although no earthquake is felt in the hotel area

Tsunami threat in some countries is due to a regional or ocean wide tsunamis, a tsunami that is generated by an earthquake that happened across the ocean. The earthquake is not felt anywhere near the hotel area, therefore, nobody in the hotel is aware that a tsunami is heading toward the coastline. In this type of situation the only reliable information is the official warning issued by the National Tsunami Warning Centre (NTWC) of the country.

Once the warning is received, the hotel needs to understand the information/message specifically the level of the warning, the estimated time of arrival, and any advice issued by the National Tsunami Warning Centre. Depending on the distance, a threat of a regional or ocean wide tsunami, might take a few hours to arrive in the coastline. The threat might decreases or escalates as it travels through the ocean. Therefore, it is important to continue to monitor the warning that is issued by the NTWC. Should the warning be issued as a low threat (depending on the analysis and evaluation of the NTWC) there might not be a need to do a full evacuation. Evacuating people from the beach (for hotels located by the beach) might be sufficient. Other action that might be taken is to start all preparation for tsunami evacuation so when the threat escalates and tsunami evacuation procedure needs to be initiated all preparation has been done (diagram 3.3.)

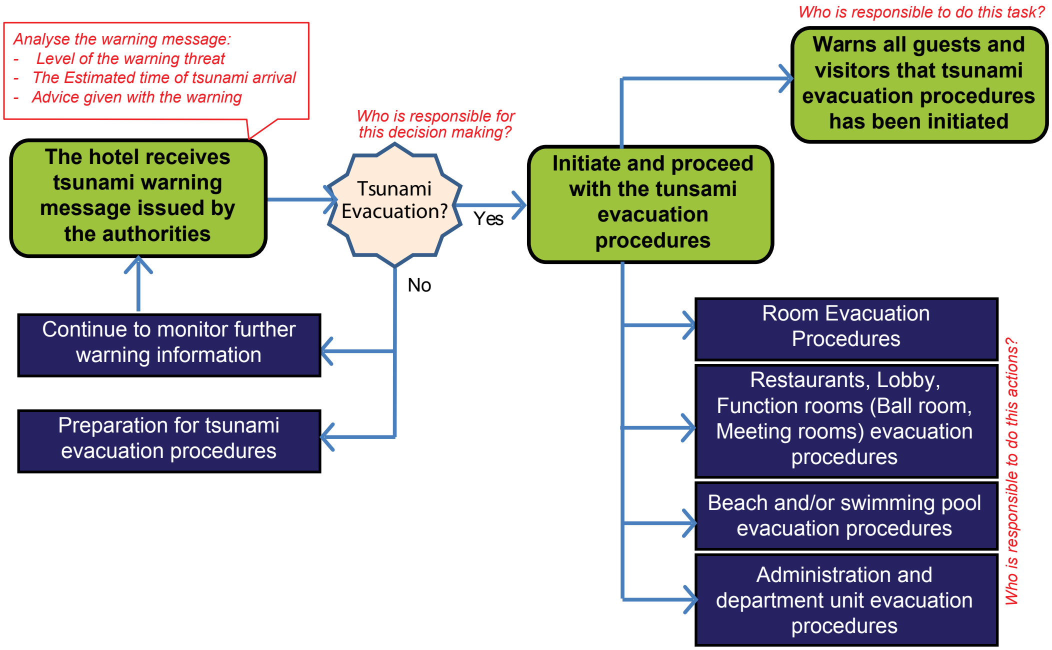


Diagram 3.3. Decision Making on Tsunami Evacuation after a Tsunami Warning is issued

IV. HOTEL AS EVACUATION AREA

General Considerations on Hotel as Evacuation Area

Hotels have to decide on the location where they will evacuate the guests, visitors, and staff during tsunami emergency situation. The area of the hotel can be considered as an evacuation area, whether horizontally to a higher ground within the hotel premises or vertically inside the hotel's building.

Multi-storey hotels located at the beach make an ideal evacuation structure. Thus the guests and other people in the area can easily and quickly reach these hotels. Hotel rooms, ballrooms, meeting rooms, restaurants, and parking garage that are located above the estimated tsunami inundation depth can be an ideal place for people to take refuge of during the tsunami. However, before deciding to designate the hotel as an evacuation area, there are criteria and measures to be consider. (Diagram 4.1.)

1. Hotel location

Location of the hotel will be the first consideration for tsunami evacuation. Howeve , before considering this the hotel needs to make sure that the hotel is not located in a tsunami risk area. This can be confirmed by the local authority/agency that is responsible in developing tsunami risk map of the area. The tsunami risk map will indicate if the hotel is indeed located in a tsunami inundated area and what is the estimated tsunami inundation depth of the area. Hotel that is considering to use their premises as an evacuation area needs to make sure that the area is outside the estimated inundation area and/or higher than the estimated inundation depth. Multi-storey buildings in the hotel premises such as the hotel building, parking garage building are potential to be the evacuation place.

In some cases, although the hotel is located in a tsunami risk area, the hotel ground area and lobby is higher than the estimated tsunami inundation depth because it is elevated in such a way. Hotel ground that is above the estimated tsunami inundation depth can be considered as the area for horizontal evacuation (evacuation area that can be reach horizontally, including running to higher ground), people and guests should be easily evacuated to this place.

Should the hotel is not located in a tsunami risk area, the hotel might still want to consider to become a tsunami evacuation area to safe the life of the people evacuating from a tsunami.

2. Hotel design and structures

Multistory hotel buildings that are built on concrete frame and/or steel structures, and meet the seismic standard and building codes, are potential location to be a vertical tsunami evacuation building. As a vertical evacuation building, the hotel structure must not only withstand the preceding earthquake with minimal damage and remain functional but also has to withstand the tsunami wave and debris it carried. Therefore it is important to first assess the hotel structure to be sure that it can serves as an evacuation building. Commonly the third floor and above of an evacuation building can be consider as a save place to refuge, however, it depend on the the estimated tsunami inundation depth of the area.

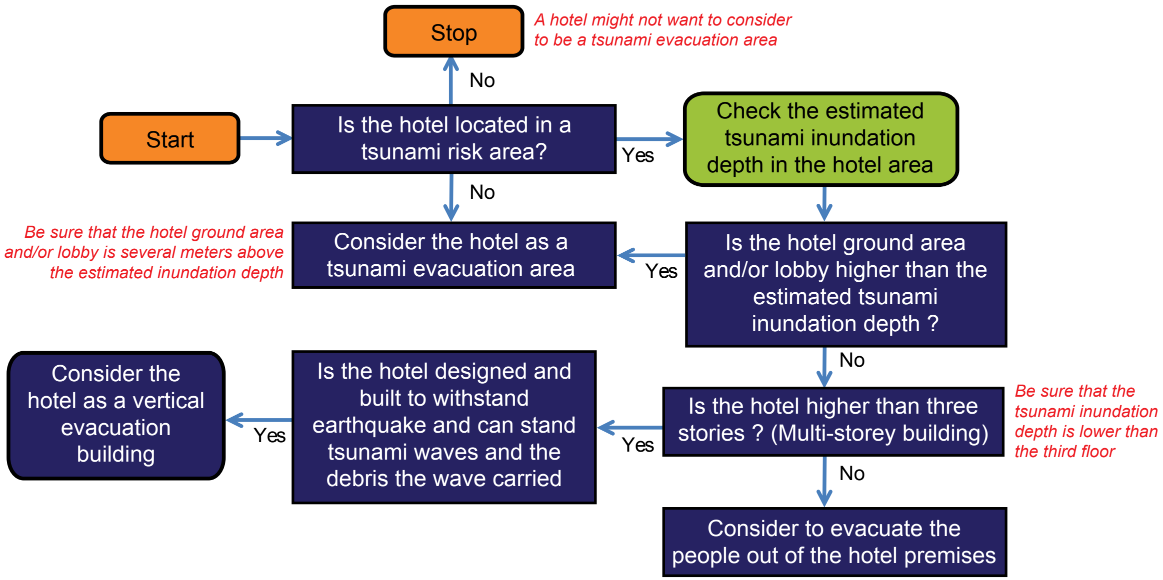


Diagram 4.1. Decision Making Process on Type of Tsunami Evacuation

Determining Evacuation Areas in Hotel Premises

1. On hotel a ground

Open spaces in the hotel premises, which are located on a higher ground above the estimated tsunami inundation depth, are potential to be tsunami evacuation areas. The advantages of using these open spaces as a tsunami evacuation area are as follows:

1. Open spaces can be easily accessed by hotel guests or visitors. Furthermore if an earthquake happens in the area, many people (especially hotel guests) might be reluctant to reenter the hotel building again.
2. Open space at a higher ground level can accommodate a large number of people.
3. Open space can be use as park, sport area, and/or jogging area.
4. Open space in the hotel premises can be a safe evacuation process (no traffic and transportation are involved).

The main consideration for hotel ground/open space as an evacuation area is that the location does not directly face the beach/open sea where the tsunami wave will approach. In addition of a higher ground location the evacuation area also should be well covered and be saved from incoming wave as well as retracting waves.

Some modifications might be needed to designate an open space as an evacuation area

1. Ensure that the open space is on a higher ground, above the inundation area and can withstand potential damage and/or erosion from the tsunami wave and the debris it carried.
2. Ensure there are clear access during day time and night time.
3. Ensure the safety and security of the people in this area during and after the tsunami strikes.
4. Ensure all the necessary equipments needed for emergency are available on the evacuation area.

2. On parking garage

Some hotels do not have open spaces on their premises, however there are parking garage/ building adjacent to their hotel. Parking garages are usually open space with vertical column as the structure. This allows for the water to flow over the building with minimal resistance. The parking garage should be designed and be built in accordance to the seismic standard and building codes and could withstand the tsunami wave and the debris it carried. The main disadvantage of a parking garage is when it is full of cars during the tsunami: it reduces the space, limits people circulation area and the cars can be a part of the destructing debris to the building structure.

3. Inside Hotel building

Evacuating vertically in the hotel has many advantages:

1. Evacuating to the upper floor in the hotel often is faster than evacuating to a higher ground outside of the hotel.

2. Evacuating within the hotel do not need vehicles therefore it is not affected by the traffi
3. Evacuation management will be easier
4. Evacuation routes and places are easy to mark

However, before deciding to use the hotel building as tsunami vertical evacuation building, the hotel has to make sure that:

1. The hotel has to withstand earthquake with minimal damages and can stand tsunami wave and debris carried by the water.
2. The evacuation location in the building should be as far as possible from the beach and are secured from the incoming tsunami waves.
3. The building must be strong, accessible in a short time and have enough capacity to accommodate all evacuees.
4. The evacuation location/floor should be higher than the estimated tsunami inundation depth
5. The evacuation building should have the necessary equipment and infrastructure for emergency situation, wide enough emergency stairs, emergency electricity, and other requirements.

4. Evacuation out of the hotel premises

Saving lives of the hotel guests, visitors, and staff should be the main concern of the hotel. If the hotel is not qualified as a tsunami vertical evacuation building and there are no higher grounds in the premises of the hotel, the hotel should consider evacuating all of the people out of the hotel premises to higher ground or to a designated evacuation area.

Evacuating out of the premises would require a more thoughtful steps and procedures such as considering the traffic, securit , and the safety of the people:

- The evacuation area should be out of reach of the tsunami waves either for horizontal or vertical evacuation. The evacuation area should consider the maximal expected wave height, the inundation area and inundation depth.
- The evacuation routes are free from the wave's path and are leading away from the incoming waves. If the evacuation area is out of the hotel premises, the evacuation routes should consider the traffic, road conditions and other obstacles that will a fect the travel time needed to reach the evacuation area.
- The evacuation area should be able to accommodate the expected number of people that are supposed to use the evacuation area. The hotel needs to ensure that the hotel's number of guests can be accomodate in the evacuation area. If it is a public evacuation area the hotel

need to take into account the number of people from other hotels, the community and people from the streets

- The evacuation area should be reachable and can accommodate people with special needs (disabled, pregnant woman or parent with babies, and the elderly).
- The hotel needs to consider the time between the warning is issued and the time of the arrival of the first wave, The hotel needs to make sure that people can reach the evacuation area could be reach in time.
- The tsunami evacuation area could be an assembly place during the tsunami and/or could be an emergency shelter for a longer period of time.

5. Vertical evacuation structures

Hotels that are not qualified as a vertical evacuation building and are located in flat areas that ar far away from higher grounds might want to consider to build a stand alone, simple and strong vertical evacuation structure. A vertical evacuation structure could be made of steel structure or concrete columns that are strong enough to withstand the tsunami wave. The hotels need to make sure that the evacuation structure can accommodate all the people in the hotel when the tsunami strikes.

Tsunami Evacuation Tower in Kushimoto Town, Wakayama Prefecture (http://www.icharm.pwri.go.jp/publication/newsletter/newsletter6_oct07_e.html)

Evacuation map, route, and signs within the hotel premises

If the hotel decides to use its premises as a tsunami evacuation area, the hotel will be responsible to ensure that guests, visitors, and staffs know where to go to in case of emergency. If the hotel decides to evacuate the people out of the hotel premises, to the guests, visitors, and staff should also know the information on the closest designated evacuation area.

The most visible way to let the guests, visitors, and staffs know about the evacuation area and routes are by providing hotel evacuation map that is readily available in each room and to posting signs in the hotel premises. Evacuation routes, safe locations, assembly points should be clearly marked on the hotel premises so those who evacuate will have no difficulties in finding where to go to the safe plac

There are different tsunami signs available however since 2008, UNESCO/IOC encouraged its member states to develop and use IOC-compliant tsunami signage and symbols in order to promote consistency in understanding and actions. Three are three basic signs within the ISO 20712 standard which provides specifications and guidance on safety sign for tsunami hazards

Tsunami Hazard Zone Sign

This tsunami sign informs the hotel guests that they are in a tsunami hazard area as has been identified by the local authorities. It is important to have this sign be visible and posted in the hotel premises as well as in the surrounding areas of the hotel especially in the area where many people usually gather such as open space, parks and on the beach.

Example of ISO 20712 Tsunami Hazard Sign Placement

Evacuation Place in High Ground Sign

This sign should be placed on the site that has been designated as a safe high ground for evacuation. High ground evacuation place can be a natural open space that is located beyond the reach of the estimated tsunami wave height, or an artificially/engineered high grounds (which can function as open space, sport area, or park) that are build as a tsunami evacuation place.

Vertical Evacuation Building Sign

This sign should be placed in the hotel building if the building has been designated as a vertical evacuation building (meeting all the criteria to be a vertical evacuation building). This sign informs the hotel guests that in case of tsunami evacuation emergency they should go to this building. Inside the building there has to be signs which indicate the floor they should to go to as the safe place. This sign has to be visible from far away as well as from an eye level as the people get closer to the building.

These tsunami signage should be placed at the evacuation place, indicating to the evacuatee that they have reached the designated save place. It is equally important is to also place the evacuation routes signs. There are also different evacuation route signs. The ISO 20712 approved evacuation routes should use the same basic signs as the above complementing with directions where the evacuatee have to go.

Example of ISO 20712 Tsunami Evacuation Map

V. EVACUATION PLANNING AND PROCEDURES

Evacuation Planning

A tsunami evacuation plan is a plan that will be the reference when a tsunami warning has been issued and an evacuation need to be done. Tsunami evacuation plan involves deciding and preparing the tsunami evacuation area (chapter IV), the decision making procedures to do the evacuation, and the evacuation procedures. The purpose of hotel tsunami evacuation is to save the lives of hotel guests, visitors, and staff. Therefore, the planning should be able to guide the management to decide when to evacuate, to guide all people to the designated evacuation area through the evacuation routes and to conduct everything based on the agreed procedures and processes.

Decision to Evacuate

The decision to evacuate is the first step of the evacuation process. During emergency situations (either experiencing the earthquake or receiving tsunami early warning – chapter III), the hotel management needs to analyze, makes assessment of the situation and decide whether to evacuate the people or not. These decision criteria should be noted as part of the standard operating procedures. Several factors the hotel needs to consider in deciding to evacuate are:

1. **The earthquake**; the hotel needs to decide to evacuate the people immediately after the event, (especially for locally generated tsunami) for example the decision might be based on the intensity of the earthquake felt during the event or how long they feel the shaking.
2. **Timeline**; the hotel needs to consider the time needed to safely and effectively evacuate the people, for example to consider the location of the evacuation area, is it near or far, whether the evacuation involves heavy traffic or not
3. **Location of the evacuation area**; is the evacuation area located in the hotel premises or outside of the hotel premises, will it be a vertical evacuation or using a high grounds?
4. **Evacuation routes**; special consideration might be needed for evacuation that is outside the hotel premises;
5. **Number of people to be evacuated**; the number of guests and visitors at the time of emergency;
6. **Hotel capacity and resources**; the personnel and recourses available at the time of the event.

Roles and Responsibilities

Tsunami evacuation is a complex process. Hotel tsunami evacuation also has its own complexity especially related to people it involves, for example the type of people (hotel guests might consist of people from different cultures with different languates) and the number of people to be evacuated. Hotel management has to clearly define the roles and responsibilities of their staff during emergency situation. The evacuation plan has to clearly designate specific tasks to the sta f especially who will do what, when, and where. This tasks will be a part of the hotel's standard operating procedures. Due to the nature of emergency, a less time consuming procedures might need to be established. However, these procedures and processes should continue to be a part of the roles and responsibilities of the specific functions of the hotel units / departments.

The hotel needs to make sure that no guests remain behind, including those who might need special assistance to evacuate. To ease the process of checking if all guests have been safely evacuated, the hotel might want to consider setting up a task team (for example guest evacuation team) that will be responsible in evacuating the guests from their rooms.

*The task of the "**guest evacuation team**" is not only to evacuate all guests from their rooms, but also to mind the visitor to the hotel as well as public who might seek shelter in the hotel. Therefore the hotel should make sure of systematic and easy procedures and should make use of the existing resources available. Special attention needs to be placed on the evacuation of guest rooms since this task requires a lot of time and human resources. Members of the guest evacuation team can be drawn from employees from relevant departments and shifts like housekeeping, bell service, room service, stewarding, duty manger, and night manager etc. Please note that the composition of the guest evacuation team during night shifts and on public holidays might be different from regular shifts and days. Every member of the team should have a realistic designated number of rooms and/or floors to check. Ensure the safety of the team and be aware of the very limited time. Members of the evacuation team should at least be proficient in basic English (The Tsunami Ready Toolbox) .*

Tsunami Evacuation Procedures [1]

Room Evacuation Procedures:

1. Knock on the door of the guest room and shout: 'Tsunami Evacuation!'
2. If there are no response, enter the room. Make sure the guest evacuation team has the master key to enter the rooms.
3. Search the bedroom and bathroom areas and check the walk in cupboard.

[1] The Tsunami Ready Toolbox, Alexander Kesper, Ministry of Culture and Tourism Republic of Indonesia, Bali Hotels Association, Centrum fur Internationale Migration und Entwicklung, 2008

4. If the room is empty, mark that the room has been checked and is empty (see "all clear tags"). Proceed to the next room.
5. If the room is occupied, tell the guest to proceed to the evacuation area immediately. Point out the direction to the evacuation route.
6. Tell the guests to leave their luggage and bring only their valuables and identification cards
7. As the guests leave the room, make sure they lock the door and mark the room as has been checked and move to the next room.
8. If there is a guest in the room who does not want to leave **DO NOT** mark the room as empty. However, do proceed to the next room.
9. When the whole floor has been checked, double-check the rooms without the mark and make sure the room is empty.
10. When all their designated rooms are check and clear, the evacuation team members should assist other team members or should proceed directly to the evacuation area.

*"**All Clear Tags**" can be placed on the doorknobs after a guest room is checked and cleared, or use a chalk mark on the door. This can avoid double checking and might help when searching for missing guests. All clear tags should be stored in fire hose cupboards, in room service trolleys as well as at the housekeeping department or wherever else the emergency keys are stored for collection. 'All Clear Tags' can also be used by other departments to mark those rooms and facilities are successfully shut down. Evacuation personnel should be informed about where 'All Clear Tags" are stored and make use of them wherever it makes sense (The Tsunami Ready Tookbox).*

Note: Some guests might also require physical assistance to evacuate

1. *Bring disabled guest or guests requiring additional assistance to evacuate to the emergency staircase.*
2. *Ask other guests to assist the person. If nobody could assist, leave these guests in the staircase area until all rooms on the whole floor are checked.*
3. *Return to assist the disabled guests to reach the evacuation area.*

Lobby, Restaurants, Bars, Ball Rooms, Meeting Rooms and Banquet Rooms Evacuation Procedures:

1. Cease all servings, stop any music, and turn on lights.
2. Inform the guests in the room of the tsunami alarm and tell them to proceed to the evacuation point. Point out the direction to the evacuation route or nearest emergency exit.
3. Direct all guests out of the room. Evacuate the guests sitting at tables closest to the exit first and then working down through the room.

4. If necessary inform all tables individually and tell the guests they must proceed immediately to the evacuation point.
5. If any guest needs assistance to evacuate, instruct other able persons to assist, if nobody could help, assist the guest once all the other people have been evacuated from the room.
6. If any guest refuse to leave the room, they must be escorted out by two waiters/employees.
7. Make sure to check public toilets, storage, or other enclosed rooms in the area.
8. Once all the guests have been evacuated, close the room and mark the room as has been checked and empty.

Beach and/or Swimming pool Evacuation Procedures

If the hotel is located on the beach and/or have swimming pool on the ground floo , the hotel is responsible to alert all the people on the beach and swimming pool of the tsunami warning and to continue with the beach and swimming pool evacuation procedures. Evacuating people on the beach and/or swimming pool could be the responsibility of the lifeguards or beach security.

As some of the guest might be swimming or do water sports (surfing or sailing), it is important for the lifeguards and/or beach security to be able to inform them using megaphones or other signals that can get their attention.

In the case that the earthquake is felt in the hotel area, make sure the beach personnel are familiar with the natural tsunami warning signs (see page 6) and to report any suspicious signs indicating a possible tsunami to the relevant decision makers

1. Get attention of the guest on the beach by shouting “Tsunami Evacuation!”
2. Make sure that the people on the water that a tsunami warning has been issued for the to get out of the water and start evacuating
3. Check all restrooms/toilets, changing rooms and showers in order to make sure that people are aware of the warning.
4. Guide the people around to the evacuation area.
5. Make sure that the beach and/or swimming pool is empty and nobody returns (for example to get their belongings or to watch the tsunami come)

Administration and Hotel Operation / Department Evacuation Procedures

Hotel management is also responsible to make sure that all staff is safely evacuated and all operations are securely close down in emergency. Most hotels probably have already established this department close down procedure for example in the case of fire emergenc , weather emergency. These procedures can be adapted for tsunami emergency.

Guidelines for Guest on Tsunami Evacuation

To ensure all guests and visitors are familiar with the hotel policy on safety for tsunami evacuation procedures, in addition to providing an evacuation maps and evacuation routes and signs, the hotel should also provide information on practical steps for tsunami evacuation to their guests. Having these steps will ease the *guest evacuation team* in ensuring that all guests understand, willing, and be cooperative during the evacuation process. Example of steps to guide hotel guests in tsunami emergency are:

1. When you feel a strong earthquake and you can hardly stand, or you feel a slow shaking that continues for a longer time, a Tsunami may have been generated.
2. Stay calm and do not panic.
3. After the shaking stops, move calmly to the designated assemble area (always check evacuation area of the hotel), then wait for further instruction by the hotel officials / securit .
4. If the sea level receded, exposing fishes and corals, then you should move quickly to higher ground (check if the hotel is a designated vertical evacuation building). Do not go to the beach to confirm or to watch the tsunam .
5. If you are swimming on the shore you might not feel the earthquake, always be mindful of what is happening on the beach. If you see people curiously gathered on the beach, move away from the sea and go to the assemble area.
6. Hotel officials/security will evacuate all guest to higher ground and/or safe area that have been officially designated as tsunami evacuation ar a. All instructions will be given using a microphone system and/or a megaphone. Listen, follow all of the instruction and move in an orderly manner to the evacuation area.
7. During a tsunami stay calm and do not panic. Do not leave the tsunami evacuation area until it is officialy announced by the authorities that it is safe to leave the evacuation are . Tsunami will come in several waves and there are time gaps between the waves.
8. During a tsunami emergency, the hotel staff, local disaster management office, police and other emergency organization will try to save lives please follow all their instruction and give your full cooperation

The guests need to be reminded that in case of tsunami evacuation they have to follow the procedures each step for the safety of themselves and other people, and all tsunami evacuation instruction has to be taken seriously even in the cases of non-destructive event.

Annex

This checklist gives an overview about the steps which are necessary in order to get a hotel tsunami ready. Supporting information is provided in the 'Tsunami Ready' fact sheets (www.tsunamiready.com). This list is only a suggestion. Please feel free to copy the list and alter it according to the needs. Should you have any comments or ideas for improvement please let them know so they can share your ideas with others (info@tsunamiready.com). Logo on the left is the certification branding use by the Tsunami Ready.

A. Information Source and Interpretation		
Task / Items	**Status**	**Follow up**
a. Hotel is connected to reliable early warning source		
b. Tsunami early warnings can be received despite power black outs		
c. There are at least two early warning sources available (e.g. SMS, TV, VHF)		
d. Early warning information can be received on a 24/7 basis		
e. Early warning information is monitored on a 24/7 basis		
f. Responsible staff knows how to interpret warnings in order to initiate evacuation		
g. Clear SOP's for interpretation of warning messages and decision making are in place and communicated		
h. Staff is familiar with natural early warning signs and general tsunami facts like likely arrival times etc.		
i. Communication devices like loudspeakers and/or sirens are available and operational to alert staff and guests, also on the beach (consider power outages)		
j. Staff knows how to communicate alarm to guests		
k. Staff and guests are educated on how to interpret tsunami alarm Guests are familiar with evacuation procedures		
l. Tsunami information material for guests is available in every room		

B. Evacuation Procedures		
Task / Items	**Status**	**Follow up**
a. Responsibilities and SOP's are clearly defined and communicated to all staff		
b. Guest and staff evacuation procedures are implemented and tested		
c. Department close down procedures are implemented and tested		
d. Beach Evacuation procedures are implemented and tested		
e. Official public evacuation routes are known and communicated		
f. Hotel management and staff are familiar with public emergency procedures and preparations		
g. Test alarms and evacuations are carried out on an irregular basis		

C. Evacuation Route and Shelter		
Task / Items	**Status**	**Follow up**
a. Decision on horizontal versus vertical evacuation has been made		
b. Internal evacuation routes are clearly marked		
c. Suitability of evacuation spot has been evaluated by expert		
d. Evacuation spot is easily accessible		
e. Evacuation spot is large enough for all guests and staff (at least 1 m^2/person)		
f. Shelter is equipped for emergency (water, food [for at least 3 days] communication devices, check lists, important contacts etc.)		
g. Shelter and equipment are checked at least every 2 weeks		

D. Community Relations		
Task / Items	**Status**	**Follow up**
a. Cooperation opportunities with the immediate general public have been explored		
b. Problem of how to deal with access demands of the general public to hotel has been addressed and a solution found		

E. Cooperation		
Task / Items	**Status**	**Follow up**
a. Hotel management consulted with neighbouring hotels, the local administration and relevant institutions on emergency cooperation and procedures		

F. Post Tsunami (the following questions need to be addressed)		
Task / Items	**Status**	**Follow up**
a. How can guests and staff be evacuated if transport infrastructure is destroyed		
b. Does it make sense to prepare post disaster plans with other hotels to share resources like equipment, emergency supplies, doctors etc.?		
c. Where can official disaster related information and instructions be obtained from?		
d. Which organizations can help and how can they be contacted? (e.g. US/Australian consulate/army, private organisations like Hills & associates etc.)		
e. Who are the official Indonesian search & rescue organisations and how can they be contacted?		
f. Who else needs to be informed (company headquarters etc.)?		
g. Where could the hotel evacuate to once the water receded if the building is not safe anymore and how can guests and staff be supplied with basic necessities?		
h. Does it make sense to collaborate with other hotels nearby		

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Appendix 9 – Environmental Management for Hotels: Hazardous Materials

ENVIRONMENTAL MANAGEMENT FOR HOTELS

International Tourism Partnership

THE **INDUSTRY GUIDE** TO **SUSTAINABLE** OPERATION

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This manual was published in 2014 when Sustainable Hospitality Alliance was known as International Tourism Partnership (ITP), part of Business in the Community (BITC).

Any substance that can cause injury, impairment to health or death to living organisms or which can damage the environment is **hazardous** and must be used, stored and disposed of in a responsible manner

8 HAZARDOUS MATERIALS

A number of substances found within the fabric of hotel buildings or that are used as part of the hotel operation pose potential hazards to human health, biodiversity and the environment. They must be handled, stored and disposed of carefully and replaced with less hazardous alternatives where possible. This approach should include phasing out the use of man-made chemicals that do not naturally degrade in nature and thus systematically increase in concentration over time.

This section examines the issues associated with various materials and substances and the practices you should put in place to manage the risks they present.

8.1 DEFINING HAZARDOUS MATERIALS

A hazardous material is any substance that can cause injury, impairment to health or death to living organisms, or which can damage the environment through, for example being toxic, flammable, explosive, corrosive or infectious.

In most countries there are legal requirements governing the responsible use, storage and disposal of hazardous materials. There are also international agreements covering the use of substances that pose a hazard to health and the environment. These include the **Stockholm Convention**, a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. The European Union has passed numerous directives and regulations to avoid the dissemination and restrict the use of hazardous substances, the best known being the **Restriction of Hazardous Substances Directive** and the **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)** directive which came into force in June 2007. To complement REACH, the United Nations has proposed a new regulation, the **Globally Harmonised System of Classification and Labelling of Chemicals (GHS)**, which will require enterprises to use standardised symbols and phrases on packaging and on Safety Data Sheets (SDS) to inform users about hazardous chemicals.

In the UK, several pieces of legislation apply such as the **Control of Substances Hazardous to Health Regulations 2002 (COSHH)**, **The Health and Safety at Work Act 1974**, **The Food and Environment Protection Act** and **The Control of Pesticides Regulations 1986**.

See FIGURE 8.1 for a list of definitions used for hazardous materials most commonly encountered in hotels, together with their identification symbols.

8.2 FUEL OIL AND OTHER OIL PRODUCTS

Fuel oil is the term used for any liquid petroleum product that is burned (in a furnace or boiler) in order to generate heat or used (in an engine) to generate power. Other oils derived from hydrocarbons are used for lubrication, to prevent corrosion, as a hydraulic medium or as solvents. These include lubricating oils and automatic transmission fluid.

8.2.1 The issues

There are a number of safety and environmental hazards associated with the storage, handling and use of oil, gas and oil products. In liquid form they pose a fire risk and if they escape as vapour or in gaseous form they can cause an explosion.

You should never allow any fuel to be emptied into drains leading to the public sewerage system or to your waste water treatment plant. Many drains lead directly to rivers, streams or lakes and fuel oil emptied into drains will have a similar effect to pouring it directly into the watercourse. If fuel oil is released into the ground, it coats the soil with which it comes into contact and seeps down to the water table. Because it is lighter than water it sits on top of the groundwater and

FIGURE 8.1

Hazard symbols

BELOW ARE THE DEFINITIONS USED FOR HAZARDOUS MATERIALS MOST COMMONLY ENCOUNTERED IN HOTELS, TOGETHER WITH THEIR IDENTIFICATION SYMBOLS.

These symbols are derived from the United Nations (UN) system of identifying dangerous goods. Not all countries use exactly the same graphics in their national regulations. Some use graphic symbols, but without English wording or with similar wording in their national language. You should refer to the Dangerous Goods Transportation Regulations that apply to your country as this is the most widely applied regulatory scheme.

CORROSIVE

A corrosive material may be defined as something that destroys other materials by chemical reaction. When in contact with human tissue, these substances may burn and destroy. At greatest risk are skin, eyes, the lungs and stomach. Oven and toilet cleaners are usually corrosive.

ENVIRONMENTAL HAZARD

A substance that can pollute nature, according to directive 67/548/EWG by the European Chemicals Bureau.

EXPLOSIVE

An explosive substance is capable of producing gas at such a temperature, pressure and speed as to cause damage to the surroundings.

FLAMMABLE

A substance that can be easily ignited by sparks or flames to cause fire, or which can spontaneously combust or which can react violently with water. Of particular concern are those liquids with low flashpoints, such as solvents and certain fuels.

HARMFUL

A substance which if inhaled, ingested or penetrates the skin may incur limited health risks.

INFECTIOUS

Substances that are 'biohazardous' such as virus cultures, pathology specimens and used intravenous needles.

IRRITANT

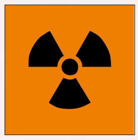
A non-corrosive substance which can cause inflammation through immediate, prolonged or repeated contact with the skin or mucous membranes. Certain acid cleaners can be irritants.

OXIDISING

An oxidising substance destroys organic matter by breaking down the cell walls. An example is hydrogen peroxide.

POISONOUS

A substance that is toxic to humans. Can cause damage to health, physical or mental impairment or even death when inhaled, ingested or absorbed. Examples include some pesticides and herbicides.



RADIOACTIVE

A substance or a combination of substances which emit ionizing radiation.

TOXIC

A substance that is liable to cause death or serious injury to human health if inhaled, swallowed or absorbed through the skin. Examples include potassium cyanide, mercuric chloride and certain pesticides.

tends to move with it, often over great distances. This can have serious implications especially where groundwater is the source of domestic water supply or is used for animals. One litre of oil can contaminate a million litres of water. Equally plants cannot survive in ground affected by fuel oil, as nutrients cannot move freely through the soil.

Because of these hazards, there are many regulations associated with the handling, transport, storage and use of fuels, for example in England if you store oil in containers with a capacity of more than 200 litres, the **Oil Storage Regulations** may apply. Generally In Europe, the USA and Canada the controls are very tight, but in some developing countries they may be negligible.

8.2.2 Fuel oil and your hotel

Hotels rely on fuel and other oils for a variety of applications such as:

- **oil** to fire boilers to provide heating, cooling, steam and hot water
- **diesel oil** to power emergency generators
- **fuel** to power lawn-mowers and other garden maintenance equipment such as saws and trimmers
- **diesel** or **petrol** for vehicles
- **lubricating oils**
- **transmission fluids**
- **oils** used as solvents such as paraffin (kerosene).

Many establishments store fuel on site in tanks either above or below ground. The tanks range in size from small day tanks with a capacity of 200 litres to large and multiple tanks of up to 50,000 litres each. The risk of fuel spillage and escape can occur at a number of points as outlined below. As a rule, primary containers (whether tanks, intermediate bulk containers, mobile bowsers or drums) should not be situated outside a building within 50 metres of any borehole or 10 metres of any inland freshwaters and coastal waters that any leaking oil could enter.

a RISKS IN HANDLING:

- spillage due to **overfilling**
- **lack of precautionary measures** when carrying out maintenance or repairs on equipment carrying fuel
- **misuse of fuel** for other purposes
- **mistakes** when cleaning out tanks
- **improper disposal** into the sewerage system.

b RISKS IN STORAGE:

- **internal or external corrosion** or rust perforation of the tank – the older the tank, the greater the likelihood
- **mechanical faults**
- **installation faults** in tanks, piping or pumps
- **disused tanks** that have not been properly decommissioned.

8.2.3 Good management practices

Good practice in fuel handling and storage should aim to:

- **Minimise the risk of fire and explosions.**
- Ensure that there is **no environmental contamination** resulting from current practice.
- Ensure that **future operations** do not cause contamination.
- Ensure that all storage facilities are **appropriately licensed** and **conform** to local regulations.
- Prevent financial losses from **product leakage** and the cost of **cleaning up** contaminated land and water.

8.2.4 The action plan

It may be necessary to engage external professional help in order to sort out any fuel storage problems you may have. Make sure any outside operators you contract are qualified and licensed to do the work through being registered with any applicable agencies. These criteria apply to consultants, contractors, vendors and suppliers of any fuel. Similarly, any equipment you purchase should be from reputable suppliers, and installed by qualified personnel to the manufacturer's exact specifications and in accordance with the appropriate codes and regulations.

a FIND OUT THE REGULATIONS THAT APPLY TO YOU:

Identify all the national, regional and local fire and environmental regulatory requirements as well as any company standards that are applicable for fuel storage, handling and use. Regulations vary greatly around the world. In the UK for example, businesses are subject to the **Control of Pollution (Oil Storage) (England) Regulations 2001** which apply to oil stored in tanks, intermediate bulk containers, oil drums and mobile bowsers.

b CARRY OUT A FUEL-STORAGE INVENTORY:

TANKS AND DISTRIBUTION SYSTEM

Collect and keep in one place information on the infrastructure as follows:

- ✓ **age** of the tank, **date of installation**, **supplier** and **installer**, any **warranties** or **guarantees**
- ✓ **material** from which the tank is made (this is usually steel, plastic or fibreglass)
- ✓ **corrosion protection** (cathode protection for example), coating, interior lining
- ✓ any **cleaning, repairs** or **modifications** that have been conducted in the past with the dates
- ✓ **condition** of the **tank, piping** and **pumps**
- ✓ **condition** of the **tank interior** (amount of water, deposits)
- ✓ any **history** of **leaks** or **spills**
- ✓ **geologic, hydrologic** and **soil characteristics** of the area surrounding the tank
- ✓ any **settlement** of the soil that has occurred that could have caused the tank to change position
- ✓ any **pressure exerted** on the tank from the top, sides or from below (by plant roots for example)
- ✓ the **height** of the **water table** in relation to the tank
- ✓ whether the tank is **positioned** in such a way that leakage could pose a threat to the water supply.

MAINTENANCE AND OPERATIONS

Gather operational information including:

- ✓ daily/monthly/yearly **throughput**
- ✓ **inventory records** (both via metering and manually logged records)
- ✓ **spill and leakage monitoring** both within and outside any secondary containment
- ✓ **operating procedures**
- ✓ procedures for **preventive maintenance**
- ✓ **records of inspections** and tests by relevant authorities
- ✓ **any additives** which may have been used to disperse sludge or prevent corrosion (what and when).

LEAK DETECTION / SPILL PREVENTION

Collate information on what is in place to prevent leaks and spills such as:

- ✓ **leak detectors**
- ✓ **secondary containment**
- ✓ **automatic tank gauging**
- ✓ **overspill protection** (and equipment for recovery and disposal of fuel spilled during filling)
- ✓ **interstitial monitoring** (monitors the space between the inner and the outer walls of tanks or piping systems, at least once every month, including sumps and any vertical pipes)
- ✓ **visual and electronic monitoring** of wells for underground storage (visual and electronic checks)
- ✓ **bunding** for above ground storage (and recovery and disposal of fuel collected in bunding)
- ✓ if you are only storing a small quantity of oil in a drum, then the drip tray should have a capacity of not less than 25 per cent of the drum.

C ASSESS WHETHER YOU ARE MEETING THE STANDARDS YOU HAVE IDENTIFIED:

If you are not meeting the standards outlined in **8.2.4.a** you will need to take swift corrective action. You need to assess how far you are from meeting the standards and to plan how you are going to achieve compliance.

IDENTIFY LEAKS AND SPILLS

If there is no immediate visual or other evidence (such as an odour), you should check to make sure there are no leaks through unexplained losses in inventory (such as discrepancies in deliveries which are due to changes in temperature, a sales error, or pilfering on a frequent or cumulative basis). If they are not already fitted, you should install meters to measure filling and consumption quantities). Leaks can occur if the tank is more than 10 years old or if there is visible structural damage on the surface or settlement. In addition to looking on the ground or in the drains (for above ground tanks), in monitor wells or extraction wells (for underground tanks), look in the soil downstream of the tank. Dying vegetation is often symptomatic of fuel spill, as are fuel odours in the basement or ground floor of buildings. **SEE FIGURE 8.2**

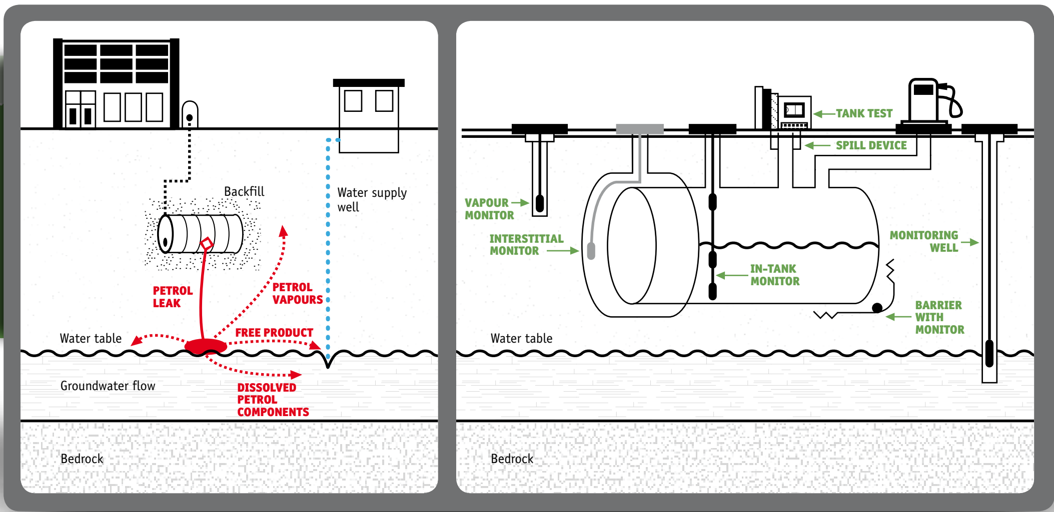


FIGURE 8.2

left: Leaking fuel and petrol underground flow

right: Leak detection alternatives

If your site investigation or fuel inventory suggests there may be a leak, the tank and supply lines need to be tested. Common techniques include pressure testing (with air or other gas) or hydrostatic pressure testing (using fluid). Hydrostatic testing requires the system to be emptied, filled with test fluid and then refilled with fuel, all of which is expensive and time-consuming, and reveals only major leaks. Neither pressure or hydrostatic testing is recommended as it may cause fuel oil to leak into the ground.

A precision test using the fuel that is being stored will account for all variables, such as volume change, pressure, temperature, tank deflection, etc. affecting the product and tank system. Such a test should include the complete underground storage and handling system. All devices and techniques used during the test should be able to detect leaks as small as 0.2 litres per hour. Since generally at least two tanks are installed, the standby tank should be filled up and also subjected to this test. Test results are valid for the time of the test only and offer no continuing surveillance and protection and monitoring systems should be installed for continuous control.

If a leak or spill is confirmed, you should notify the local fire department, the local regulatory authority and the company that owns the equipment (if applicable). Take all possible steps to contain the leak, and if vapours are present, ventilate the area. The tank will have to be emptied and cleaned internally. If any personnel have to enter the tank, you must ensure they have an adequate air supply and take full safety precautions, including having someone nearby at all times.

Assess the extent of the leak and take remedial action. Any spilt fuel will have to be removed and the contamination may require that the soil or groundwater be biologically reclaimed. This may involve excavation. Underground leaks can require extensive and long-term corrective action, especially where they have existed for some time before detection and the spill has spread. Surface spills or leaks from piping are usually detected quickly and their spread can generally be limited through prompt response.

- **REPLACE INSTALLATIONS**

  If you need to replace a tank or piping, the new installation should meet the latest regulations. Tanks should have double walls of either steel or reinforced fibreglass. Metal installations should have corrosion protection, with plastic cladding or cathodic protection with the installation of sacrificial anodes. Unless piping is made of material that will not corrode (such as plastic), it must meet the requirements for cathodic protection. Existing piping should be coated with a corrosion-resistant coating.

- **PROVIDE LEAK DETECTION DEVICES**

  Automatic tank gauging, monitoring for vapours in the soil, interstitial monitoring and monitoring for liquids on groundwater can all be done continuously by detection devices. SEE FIGURE 8.2

- **DECOMMISSION OBSOLETE TANKS**

  Disused tanks should be emptied, cleaned and filled with a non-corrosive substance (such as clean sand) until they are dismantled by a licensed contractor. Similarly, all obsolete piping should be removed, capped or filled.

8.3 LIQUEFIED PETROLEUM GAS (LPG)

Liquefied petroleum gas (LPG), in the form of propane and butane, is used by hotels principally for heating and cooking. It is also found in camping-style lamps and in pressurised lines transferring beverages such as beer from the cellar to the bar. LPG is either stored in large tanks or in more portable cylinders.

8.3.1 The issues

THE MAIN HAZARDS WITH LPG[1]

- impact from a **gas cylinder explosion** or the **rapid release of compressed gas**
- **impact from parts of gas cylinders** or **valves that fail**, or from any flying debris
- **contact with the released gas**
- **fire** resulting from the escape of LPG
- impact from **falling cylinders**
- **manual handling injuries**.

THE MAIN CAUSES OF ACCIDENTS

- **inadequate training and supervision**
- **poor installation** of the equipment
- **inadequate examination and maintenance**
- **faulty equipment** and/or **design** (e.g. badly fitted valves and regulators)
- **poor handling**
- **poor storage**
- **inadequate ventilation**
- **incorrect filling procedures**
- **unseen damage** to the cylinder.

8.3.2 How to reduce the risks

See **FIGURE 8.3** overleaf for information on how to reduce the risks associated with LPG usage.

[1] Much of the material in this section draws on the UK Health and Safety Executive (HSE) publication: Safe use of gas cylinders, June 2004.

FIGURE 8.3

LIQUEFIED PETROLEUM GAS (LPG)

REDUCING THE RISKS OF LPG USAGE

General guidelines

- Be aware of the **national** and **local regulations** covering the filling, use and storage of LPG on your premises.
- Make sure you are purchasing from a **reputable supplier** who is using gas cylinders that are designed and manufactured to an approved standard.
- **Cylinders** need to stand up to everyday use to prevent danger. They must be **inspected** before they are put into service and **examined** at appropriate intervals to ensure that they remain safe while in service.

Training

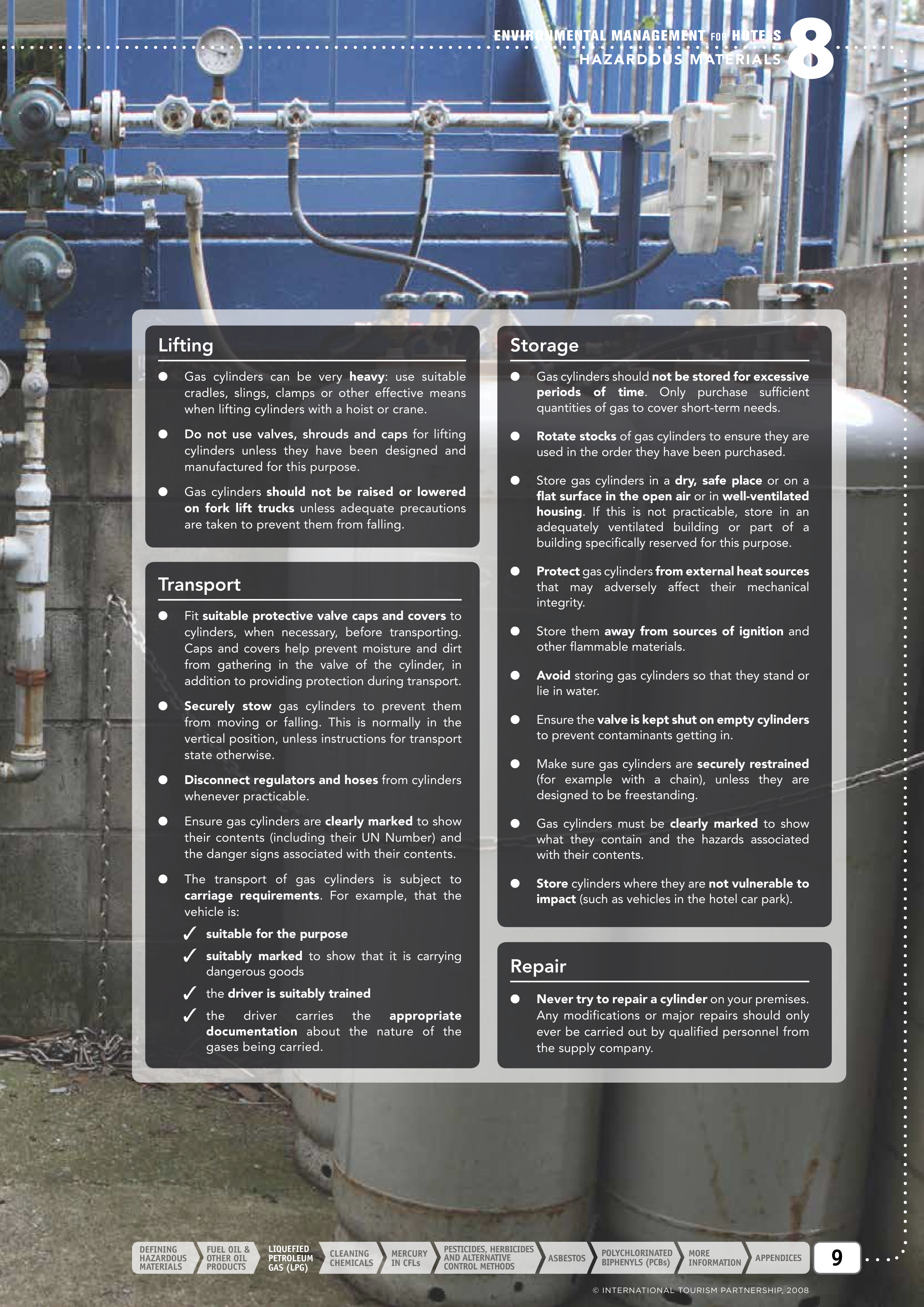
- Anyone who examines, refurbishes, fills or uses a gas cylinder should be **suitably trained** and have the necessary skills to carry out their job safely. They should understand the risks associated with the gas cylinder and its contents.
- **New employees** should **receive training** and be supervised closely.
- Users should be able to carry out an **external visual inspection** of the gas cylinder and any attachments (such as valves, flashback arresters, and regulators) to determine whether they are damaged. Visible indicators may include dents, bulges, evidence of fire damage (scorch marks) and severe grinding marks etc.
- **Valves** should only be removed by **trained personnel** using procedures that ensure that either the cylinder does not contain any pressure or that the valve is captured during the removal process.
- Cylinders should be **permanently marked** by the appropriate inspection body to show the date of the last periodic examination.

Handling and use

- Use gas cylinders in a **vertical position**, unless they are specifically designed to be used otherwise.
- **Restrain cylinders securely** to prevent them falling over.
- Always double check that the cylinder/gas is the **right one for the intended use**.
- Before connecting a gas cylinder to equipment or pipe-work make sure that the **regulator and pipe-work are suitable** for the type of gas and pressure being used.
- **Wear suitable safety shoes** and other personal **protective equipment** when handling gas cylinders.
- Do not use gas cylinders for any other purpose than **transporting and storing gas**.
- **Do not drop, roll or drag** gas cylinders.
- **Close the cylinder valve** and **replace dust caps**, where provided, when a gas cylinder is not in use.
- Where appropriate, fit cylinders with **residual pressure valves** (non-return valves) to reduce the risk of back flow of water or other materials into the cylinder during use that might corrode it (such as beer forced into an empty gas cylinder during cylinder change-over).
- Ensure that the valve is protected by a **valve cap or collar** or that the valve is designed to withstand impact if the cylinder is dropped.

Filling

- Make sure that your supplier adheres to the **correct filling procedures** as outlined in the relevant legislation. For example anyone filling gas cylinders should wear appropriate protective equipment. This may include safety shoes, protective overalls, gloves, and ear and eye protection.



Lifting

- Gas cylinders can be very **heavy**: use suitable cradles, slings, clamps or other effective means when lifting cylinders with a hoist or crane.
- **Do not use valves, shrouds and caps** for lifting cylinders unless they have been designed and manufactured for this purpose.
- Gas cylinders **should not be raised or lowered on fork lift trucks** unless adequate precautions are taken to prevent them from falling.

Transport

- Fit **suitable protective valve caps and covers** to cylinders, when necessary, before transporting. Caps and covers help prevent moisture and dirt from gathering in the valve of the cylinder, in addition to providing protection during transport.
- **Securely stow** gas cylinders to prevent them from moving or falling. This is normally in the vertical position, unless instructions for transport state otherwise.
- **Disconnect regulators and hoses** from cylinders whenever practicable.
- Ensure gas cylinders are **clearly marked** to show their contents (including their UN Number) and the danger signs associated with their contents.
- The transport of gas cylinders is subject to **carriage requirements**. For example, that the vehicle is:
  - ✓ **suitable for the purpose**
  - ✓ **suitably marked** to show that it is carrying dangerous goods
  - ✓ the **driver is suitably trained**
  - ✓ the driver carries the **appropriate documentation** about the nature of the gases being carried.

Storage

- Gas cylinders should **not be stored for excessive periods of time**. Only purchase sufficient quantities of gas to cover short-term needs.
- **Rotate stocks** of gas cylinders to ensure they are used in the order they have been purchased.
- Store gas cylinders in a **dry, safe place** or on a **flat surface in the open air** or in **well-ventilated housing**. If this is not practicable, store in an adequately ventilated building or part of a building specifically reserved for this purpose.
- **Protect** gas cylinders **from external heat sources** that may adversely affect their mechanical integrity.
- Store them **away from sources of ignition** and other flammable materials.
- **Avoid** storing gas cylinders so that they stand or lie in water.
- Ensure the **valve is kept shut on empty cylinders** to prevent contaminants getting in.
- Make sure gas cylinders are **securely restrained** (for example with a chain), unless they are designed to be freestanding.
- Gas cylinders must be **clearly marked** to show what they contain and the hazards associated with their contents.
- **Store** cylinders where they are **not vulnerable to impact** (such as vehicles in the hotel car park).

Repair

- **Never try to repair a cylinder** on your premises. Any modifications or major repairs should only ever be carried out by qualified personnel from the supply company.

8.4 CLEANING CHEMICALS

8.4.1 The issues

Around 1,500 new chemicals are marketed every year, adding to the 70,000 or more already in existence.[2] Many people believe that all chemicals are harmful to humans, animals and the environment. Some are known to cause health problems such as dermatitis, cancers, occupational asthma and reproductive problems and there may be much we still have to learn about the long-term effects of others. However, we have also come to rely on chemical products to maintain and improve our quality of life, particularly when it comes to delivering high standards of hygiene.

- Chemical products have **environmental implications throughout their life cycle** – i.e. from their design and development, through the raw materials used in their manufacture and for packaging, in transportation, in use (when the chemical product performs its job), and finally in disposal and recycling. In high concentrations, or if used in combination, some chemical cleaning products are potentially hazardous to human health and/or the environment.
- Many chemicals used for cleaning and other uses eventually **find their way into the environment** either in waste water effluent through drains or with solid waste to landfill or incineration. Some of these chemicals are known to 'bio-accumulate' in plants and animals and pose adverse long term effects. High concentrations of phosphate and nitrate have been the focus of debate about the increase of algal growth in some watercourses.
- Even cleaning products that are based on **natural ingredients** can have direct or indirect environmental implications which need to be considered. For instance, palm oil is a natural and key ingredient of soap, beauty products and foodstuffs. However, growing this lucrative crop in tropical areas such as Malaysia and Indonesia involves clearing natural rain forest to make way for palm oil plantations. This reduces the habitat for many animal and plant species, threatening their survival. Other issues include use of pesticides on the crop, which can poison animals such as the elephants that eat the leaves. Some producers and consumers of palm oil are now working to develop sustainable palm oil production methods.
- The **disposal of containers and packaging** can be problematic especially in resorts or environmentally-sensitive areas.

8.4.2 Benefits of minimising chemical use

a. **Significant cost savings** can be achieved by eliminating non-essential products, using products at the correct frequency and concentrations, buying in bulk or in concentrated form and using refillable containers to reduce waste disposal costs. Many hotels use more chemicals than are necessary to meet hygiene requirements. Excessive use of chemicals usually results from:
    - non-existent or poor dosing equipment (which can be due to lack of maintenance)
    - poor staff training
    - technical factors (such as low temperatures or an improper wash pressure).

b. Using less hazardous products or those which prevent or minimise skin contact will **minimise the health and safety** risks (and the associated potential liability) of your operation.

c. Reducing chemical use and selecting cleaning products with a lower environmental impact[3] will help protect the **quality of the aquatic environment** such as lakes and streams. Choose products that are not hazardous to the environment and optimise chemical use by using chemicals only when needed and in the correct doses.

[2] United Nations Environment Programme, May 2004: Stockholm Convention on Persistent Organic Pollutants Coming into Force. See **www.unep.org/Documents.Multilingual/Default.asp?DocumentID=398&ArticleID=4487&l=en**

[3] Note that in practice, it takes considerable competence to fully interpret the environmental impact of individual substances, and in many cases not even the scientists are categorically sure. For example, it is not easy to decide whether a highly acute aquatic toxic substance is more hazardous than one that is not, but is bio-accumulative, or non-biodegradable. If unsure, consult the MSDS (materials safety data sheets) and your supplier.

d. Using products with minimal packaging can help to **reduce pressure on landfill sites** and reduce any chemical run-off that can occur from such sites. Where possible, select products with minimal packaging that has been (or can be) recycled and is not hazardous to the environment.

e. Some chemical cleaning products will also kill the bacteria that are essential for breaking down and treating waste water effectively, which is an important consideration for **hotels that operate their own waste water treatment plant**. Used correctly, the small amounts released are insignificant, however large spillages can compromise local treatment plants.

8.4.3 Cleaning products commonly used in hotels and their impacts

Chemical cleaning products are most likely to be used by the housekeeping, kitchen, laundry and engineering departments. They are essential in hotel kitchens and outlets where food is being prepared, where hygiene is crucial and systematic operation and control methods are required in order to prevent food poisoning.

Chemicals are available in solid, liquid, powder, granules, tabs and gel forms. They include:

a. **laundry and dishwashing detergents** (which may contain some/any of the following: alkalis, bleaching agents, sequestering agents, surfactants, solubilisers and acids)
b. **toilet and bath cleaners** (acids, alkalis)
c. **bleaches** (may include hydrogen peroxide, sodium hypochlorite, sodium chlorite and sodium perborate)
d. **surface and floor cleaners** (alkalis, surfactants, solvents)
e. **disinfectants** (quaternary ammonium compound, chlorine, acids, alchohols, peroxygen)
f. **degreasers and oven cleaners** (alkalis, surfactants, solvents)
g. **descalers or delimers** (acids, such as hydrochloric acid)
h. **glass cleaners** (solvents, surfactants)
i. **metal cleaners** (solvents)
j. **dry-cleaning chemicals** (organic solvents such as perchloroethylene, a chlorinated hydrocarbon)
k. **swimming pool chemicals** such as chlorine and bromine **SEE SECTION 3.3.4**.

More information on the raw materials used to make cleaning products together with their impacts can be found in **APPENDIX 4**.

8.4.4 Effective management of chemicals

a. OBJECTIVES:

The key to using any chemical product is **careful and informed selection, efficient use** and **safe disposal**. Basically, if you use 20 per cent more product than you need, you are adding 20 per cent to every other impact in the life cycle and 20 per cent to your costs. In order to use chemical cleaning products in the most environmentally responsible way you should ensure that:

- the product is **necessary and the right one for the job**
- it causes **minimal adverse environmental impacts**
- the **optimum doses** are used
- the products are **stored, labelled, used, handled and disposed** of in accordance with local and **international standards and regulations**.

b THE ACTION PLAN:

Identify and record where hazardous materials are being used, what they are being used for and the reasons for their use.

- **Assess the hazards associated with the product's use.** You may need to examine the product information sheet for each product and ensure that staff are using the appropriate concentration (this will vary according to local conditions such as the hardness of the water and soil conditions). **Materials Safety Data Sheets (MSDS)**, referred to in some countries as **Safety Data Sheets (SDS)**, are standardised documents that describe the known hazards associated with a material, indicating the safe handling procedures and recommended responses to accidents. The information is set out under 16 sections **SEE APPENDIX 1**. The sheets are prepared by the chemical supplier and in many countries they are required by law to send you an MSDS if you buy a chemical. They should also send one on request even if you are only considering purchase. If you already have the chemical but the MSDS is lost or the material is so old that none came with it, most manufacturers are happy to email or fax a relevant MSDS on request and should even make compilations of their data sheets available free of charge. When assessing an MSDS it is important not to confuse the risk statements associated with the raw materials and those of the final formulation, which may be a minute amount. (Sections 3 and 15 in the MSDS give the final classification of the product but people often give more attention to the raw material details in sections 2 and 16).
- Make sure you **understand the full package of requirements and support from your supplier** – e.g. technical advice, training, equipment and support materials. Some suppliers will conduct a complete review of your chemical usage and identify options for improvement.
- Identify opportunities for **reducing the number of different chemical cleaning products** and **replacing them** with simpler, cheaper and environmentally-preferable alternatives where possible.
- Review **handling, storage, labelling and disposal procedures**.
- Compile a **hazardous materials manual**.

c THE HAZARDOUS MATERIALS MANUAL

In some cases it may not be possible to use a less hazardous substance so it is important to ensure that the effects of its continued usage and disposal are minimised. One way to achieve this is to compile a hazardous materials manual, covering the use, handling, storage and disposal of hazardous chemicals and other hazardous substances used in your hotel. The manual needs to be in a format that can be readily and regularly updated.

- **Ask manufacturers and suppliers to provide details** for every substance that they supply to you. This information can be compiled into a manual for use by staff. Make sure that it is continually updated with new pages if new chemicals/hazardous materials are purchased. **APPENDIX 2** shows how you might set out your own hazardous materials sheets.
- It is particularly important that you **follow the correct disposal method**. Too often, chemicals are given the respect they deserve when they are being handled and used, but are then thoughtlessly disposed of into the normal waste-water system. It is imperative that the end-user is aware of correct disposal methods, and the implications of failing to follow them.
- Make sure that the necessary **information reaches the end-user** in his or her department.
- You should also ensure that any **hazardous chemicals are stored separately** or 'flagged' with a special method of identification in order to bring their hazardous nature to the attention of the person taking them from the stores.

d STORAGE

Storage of chemicals should be:

- **In a cool place**, to avoid chemical reaction through excessive heat or direct sunlight.
- **'Secure'**, i.e. on strong shelving, stacked in such a way so the containers will not fall over, and only accessible to those authorised to use them.
- In such a way as to facilitate **stock rotation**.
- So that they **do not block corridors, access or exit points**.
- With all appropriate **emergency equipment readily to hand**, i.e. correct fire-extinguishers, fire blankets, fire hose and a comprehensive first-aid box.
- Aimed at keeping all chemicals **securely isolated** from each other, as mixing products may cause a chemical reaction or even an explosion.
- With particularly **volatile chemicals** (such as chlorine) stored and **secured correctly outside the building**.
- Managed in a way that **avoids over-stocking** and hence waste and disposal problems.
- In **properly-labelled containers**.

e USE

- Always ensure that any new chemical products you purchase meet the basic **health and safety requirements** for your property.
- If possible **avoid products marked 'Danger', 'Poison', or 'Warning'**. When you must use a strong product to get the job done, protect yourself by wearing gloves and goggles, and be sure that your work area is well-ventilated.
- **Wear protective gloves** when using any cleaning products.
- **Never mix** different chemical products, and ensure that staff are trained not to do so under any circumstances. This could pose a serious health and safety risk.
- **Always add chemical products to water** and never water to the product.
- **Natural alternatives** may be appropriate for some cleaning applications (such as using vinegar and water to clean glass), but not where their use may compromise hygiene standards, such as in areas where food is prepared or displayed.

f LABELLING, ENVIRONMENTAL AND ETHICAL CLAIMS

- Many cleaning products carry some form of **environmental branding**. However some of the claims made on these labels may be unclear and cannot be verified so read them carefully and, if in doubt, consult the manufacturer.
- Be wary of the term **'natural'** when used to describe cleaning products. Although the chemical ingredients may be extracted from plants or the earth, they are likely to have been chemically converted or 'synthesised' in order to become useful in cleaning products.
- Beware of products that claim to be **biodegradable**. Only substances, not products, can be classified as biodegradable. In fact, over time all substances are biodegradable – it just depends how long it will take. Look for information on the substance's ultimate biodegradability, which involves its complete breakdown into simple salts, water and oxygen, which is the internationally recognised indicator.
- Some cleaning products or their chemical components are still **tested** by their manufacturers (or in some countries the authorities) **on animals**. If you want to source ethical as well as environmentally responsible products, you may wish to select a manufacturer that either does not currently test on animals or has established a date by which all animal testing will cease. Ask your supplier for their policy on this.

g QUANTITIES AND TIMING

- It is generally necessary to use more cleaning chemicals in hard water areas than in soft water areas. This is because chemicals are needed to soften the water for maximum cleaning efficiency. Investment in **water softening plant** will help to reduce the total volume of cleaning chemicals used. Such equipment may be particularly justified if your establishment has a restaurant or busy laundry.
- **Avoid manual dosing** if possible as it is not possible to be as exact on quantities. Many of the larger manufacturers of cleaning products provide **staff training** and **automated dispensers** (which measure out the precise quantity of concentrated products) to ensure that appropriate quantities and concentrations of a product are used. Take care, however, because concentrated chemical products can be more hazardous to handle than their diluted alternatives. In most cases your supplier will fit the equipment and advise you on appropriate handling and storage arrangements.
- It is important to leave the product in contact with what is being cleaned for **the necessary amount of time**. If the recommended contact time is not respected the cleaning result will be poor and a second cleaning will be required, doubling your chemical consumption.

h PACKAGING

- If possible, choose products that are packaged in recyclable containers or can be supplied through **refill systems**.
- The **'recyclability'** of containers will depend on the facilities available in your area. PVC containers (polyvinylchloride) are more difficult to recycle than high and low density polyethylene (HDPE and LDPE), polypropylene (PP), polyethylene (PE) and polyethylene tetraphthalate (PET).
- **Reuse** chemical containers only where they are to be filled with the same product, as cross-contamination can be dangerous. Thorough cleaning will require higher chemical and water consumption.

i DISPOSAL

- Some chemical products should be treated and disposed of as hazardous waste. When changing to alternative cleaning products consult the MSDS to ensure that **appropriate disposal routes** are chosen.
- If your hotel operates its own waste-water treatment plant or has to comply with discharge consents, **check the likely implications** of changing chemical cleaning products with your chief engineer or local authority prior to making a decision.

j TRAINING

- All relevant hotel **staff should be trained** in the handling, use, storage and disposal of chemicals. Many chemical companies incorporate a full training programme as part of their supply/maintenance package, and such facilities should be assessed and, where relevant, used as fully as possible.
- Contractors, vendors and suppliers using, handling and disposing of chemicals and other hazardous materials should be subjected to **pre-qualification assessments** to determine whether they can comply with the hotel's requirements. It should be noted that in many countries the hotel is liable for damages if the contractor improperly disposes of the hazardous wastes.

8.5 MERCURY IN CFLs

Mercury (Hg) is a naturally occurring heavy metal and is one of six elements that are liquid at or near room temperature and pressure. It occurs in deposits throughout the world and it is harmless in an insoluble form such as mercuric sulfide, but it is poisonous in soluble forms such as mercuric chloride or methylmercury.

8.5.1 The issues

The largest man-made source of mercury is coal-fired power stations as the mercury that naturally exists in coal is released into the atmosphere when it is burned. Mercury is used in a variety of industrial and scientific applications and in dentistry, although its use is being reduced and phased out where possible due to the negative health effects of mercury exposure. These include tremors, impaired cognitive skills, and sleep disturbance in workers with chronic exposure to mercury vapour even at low concentrations. The **World Health Organization**, the US **Occupational Safety & Health Administration (OSHA)**, and US **National Institute for Occupational Safety and Health (NIOSH)** all treat mercury as an occupational hazard, and have established specific occupational exposure limits.

Environmental releases and disposal of mercury are regulated in the US primarily by the **Environmental Protection Agency**. In the EU, the **Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment** bans mercury from certain electrical and electronic products, and limits the amount in other products to less than 1000 ppm. Its use in new non-electrical measuring devices, such as thermometers and barometers has also been banned since 2007, with certain exemptions for the healthcare sector and a two-year period of grace for manufacturers of barometers.

8.5.2 Mercury in CFLs

Mercury is essential to enabling a compact fluorescent lamp (CFL) to be an energy-efficient light source. CFLs contain a very small amount of mercury (around five milligrams) sealed inside the glass tubing. This is roughly equal to the amount that would cover the tip of a ballpoint pen. Older style thermometers, in comparison, contain about 500 milligrams of mercury, or 100 times more.

Many lighting manufacturers have taken significant steps to reduce mercury used in their fluorescent lighting products and there is no danger when the bulbs are in use. However, being made of glass, the lamps can break if dropped or roughly handled.

8.5.3 Safe handling of CFLs

PRECAUTIONS

- **Take care** when removing the bulb from its packaging, when installing it, or replacing it.
- Always screw and unscrew the lamp **by its base** (not using the glass).
- **Never use force** to twist the CFL into a light socket.

IF A CFL BREAKS

Open a window and **vacate the room** for 15 minutes or more

↓

Using **disposable gloves**, rather than bare hands, **carefully scoop up the fragments and powder** with stiff paper or cardboard and place them in a **plastic bag**

↓

ON HARD SURFACES:
Do not use a vacuum or broom to clean up the broken bulb. Wipe the area clean with damp paper towels or disposable wet wipes and place them in the plastic bag

ON CARPETS:
Remove all the materials you can without using a vacuum cleaner. Sticky tape (such as duct tape) can be used to pick up small pieces and powder. If vacuuming is needed after all visible materials are removed, vacuum the area where the bulb was broken, remove the vacuum bag (or empty and wipe the canister) and put the bag or vacuum debris into a plastic bag

↓

Place all the materials you have used to clear up the debris in **a second sealed plastic bag**

↓

Either take it to your **local recycling centre** or tell your waste contractor what is in the bag so that it does not go into the waste for general landfill

↓

Wash your hands after disposing of the bag.

DISPOSAL

- If the lamp has failed within its warranty period, the best thing to do is **return it to your supplier** and ask them to confirm it will be disposed of responsibly.
- Most landfill sites now have **separate recycling facilities** for CFL and other fluorescent lamps. Your waste contractor should advise you on how it will collect and dispose of spent CFLs. If there is no segregation in place at your local landfill site, you should **'double seal'** the bulb within two plastic bags in your area for waste collection. CFLs should not be disposed of in an incinerator.

8.6 PESTICIDES, HERBICIDES AND ALTERNATIVE CONTROL MEASURES

8.6.1 The issues

Hotels experience a variety of problems with unwanted pests, bugs and weeds. The specific methods used to combat them will depend on the location of the hotel and the problems being experienced. For example, hotels in the tropics are more likely to have a problem with cockroaches, ants and mosquitoes whereas hotels in urban locations may have trouble with rodents. The parts of the hotel which are most vulnerable are in kitchens, waste storage areas, guest rooms and hotel grounds.

Pesticides, insecticides, herbicides, bactericides and fungicides are terms used to describe the many chemical agents developed to kill unwanted life forms. They are widely used in hotel kitchens, waste storage areas, guest rooms and in hotel grounds.

- **Pesticides, rodenticides** and **insecticides** are used to control insect and other animal infestations.
- **Herbicides** are used to control 'weeds' and other unwanted plants.
- **Bactericides, sterilants, biocides** and **fungicides** are used to combat bacteria and moulds.

These substances range from simple to complex compounds, and have a correspondingly large range of environmental hazards associated with them. Some kill only the target organisms, others will kill a range of different life forms if used indiscriminately. Once employed, the chemicals may take considerable time to break down and become inactive. Additionally, they may become more concentrated as they pass up the food chain. Short term exposure to pesticides and herbicides can cause a range of health problems in humans and other animals, including eye, lung, throat and skin irritation, dermatitis and poisoning. They can also have long-term effects, including cancers and birth defects. Because they 'persist', meaning that residues may build up in our food and water supplies for considerable periods, environmental problems and damage to other life forms may occur long after the initial application.

There are many laws governing the use of substances used to control pests. In the UK for example they are subject to the **Control of Substances Hazardous to Health Regulations 2002 (COSHH), The Food and Environment Protection Act** and **The Control of Pesticides Regulations 1986**. Internationally, the **Stockholm Convention on Persitent Organic Pollutants** bans the use of certain pesticides and insecticides. SEE APPENDIX 3 AND ALSO SECTION 3.4.4

8.6.2 Your action plan

a OBJECTIVES

Good environmental practice in pest, weed, bacteria and fungal control involves maximising non-chemical methods to minimise the use of pesticides and herbicides. Insects and rodents have to be controlled, but the use of chemicals should be considered as a supplement to basic sanitation and other physical and biological measures aimed at the elimination or control of breeding areas.

In order to safeguard the health of employees and guests, and to protect the general environment, your objective in managing pest control chemicals should be to:

- **control and minimise the use** of pest and bacteriological control substances.
- **replace** hazardous substances with less hazardous (preferably naturally-occurring) alternatives.
- ensure that any substances you do use are **stored securely**.
- **supervise and control the preparation and use** of chemical applications.
- ensure that any residues and/or containers are **disposed of in an environmentally safe manner**.

b ACTIONS

This will involve:

- identifying **which pesticides and herbicides are being used** and the exact problems they are intended to resolve. The more that is known about the problem, the less chance there is of making a mistake. The words organic, natural and biodegradable in this context do not guarantee that they are safe
- determining whether their use **complies with local, international and company regulations**
- **assessing other methods of control** and substituting them for hazardous substances
- ensuring that pesticides and herbicides are **stored, used and disposed** of in a manner that protects human health and safeguards the environment
- ensuring that pesticide use **does not annihilate other life forms** that you wish to encourage
- **carrying out specific checks and actions** relating to the storage, preparation, application and disposal of chemicals.

8.6.3 Pesticide and herbicide management

Where the application of chemical pesticides and herbicides is unavoidable, proper management is absolutely essential.

Manufacturers and suppliers should provide full details of the hazards associated with the pesticides and herbicides they supply. They should also supply the appropriate information relating to storage, preparation and application. A review of the chemicals can then be undertaken to assess whether there are safer alternatives. For example, some insect sprays are based on **pyrethrum**, a natural insecticide obtained by extraction from chrysanthemum flowers. Pyrethrum-based insecticides are more readily broken down than some other types of pesticide.

Chrysanthemum cinerariifolium, from which potent natural **pyrethrum** insecticide is made

You can obtain information on available pesticides and on the proper application equipment direct from the manufacturers or general handbooks on current pesticides and herbicides and their use. Details of all pesticides and herbicides that you use should be recorded in a hazardous material sheet as shown in **APPENDIX 2**.

a HEALTH AND SAFETY OF PERSONNEL AND GUESTS:

- ### STAFF

  Where staff are employed in pest-management, they need to be properly trained in health and safety measures, in the causes and effects of misapplication of the pesticides and in the protection measures required for safe application. See the checklist in **APPENDIX 2**.

- ### CONSULTANTS

  In many instances it will be necessary to call on outside expertise to advise on pest-management problems, particularly in the creation of integrated pest-management programmes, which may require detailed knowledge of the biology and ecology of a particular species.

- ### CONTRACTORS

  In some instances a pest problem may only be solved by the application of special toxic pesticides. If this is the case, you should use specialised contractors. Ensure that all chemicals used by the contractor are approved by the local and national authorities and that their use is properly documented.

- ### VENDORS AND SUPPLIERS

  Vendors and suppliers should provide current data sheets for all chemicals and materials supplied. They should also either be able to take back unused or surplus pesticides or recommend a suitable agent through which they can be disposed.

- ### GUESTS

  Guests should be informed of any pest-control management systems. When application or spraying is in progress, they should be warned of this activity and kept away from the area in which it is taking place.

b SPECIFIC CHECKS AND ACTIONS:

SEE FIGURE 8.4 OVERLEAF

FIGURE 8.4

PESTICIDE AND HERBICIDE MANAGEMENT

SPECIFIC CHECKS AND ACTIONS

Storage

1. **Storage areas** must be dry, frost-free, well-ventilated and secure against theft and vandalism.
2. They should be situated **away from other buildings**, especially residential buildings or areas where food or flammable materials are stored.
3. Stores should be built to **resist foreseeable accidents**, including leakage and spillage, fires and the weather. Ensure there is no risk of any spillage entering the ground and polluting water sources. Floors should be impervious to liquids, anti-slip, chemical-resistant, washable and with a means of diverting spillages. Ideally they should be below surrounding ground level without the risk of flooding. Drainage should be into sumps or tanks large enough to contain any foreseeable leakage. Do not site them near watercourses, ponds, ditches or areas liable to flooding.
4. **Display warning signs** without attracting unwanted attention and in large areas, provide **emergency exits**.
5. **Shelving and stacking** facilities should be appropriate for the size of the containers stored in them. Flammable pesticides should be separated from other pesticides. Consideration should be given to possible reactions between chemicals coming in contact with each other. Proper emergency plans should be drawn up and made available.
6. Make sure all pest control chemicals are **clearly labelled** and that the manufacturer's instructions for use are kept with them.
7. **Effective first-aid provisions** should be available, together with data sheets on all the products in the store and the chemical safety precautions. Details of any statutory requirements and emergency telephone numbers should be available.
8. **Emergency telephone numbers** and other emergency facilities should be checked and if necessary updated at regular intervals. Make sure there is a first aid leaflet to hand and, ideally, display first aid information on the wall.

Preparation and handling

1. **Accurate measurements** should be made during both mixing and application phases. Use the most suitable chemical, in the minimum necessary amount, to achieve the desired results.
2. A **safe area** should be available for mixing pesticides. This should be done on a concrete pad, with a separate sump or tank to contain any leakage.
3. Operators should be provided with, and adequately trained in the use of the **necessary equipment** and **protective clothing**. Sufficient spares should be available.
4. **Proper health surveillance** should be available to all those working with pesticides and herbicides.
5. The **area of application** should be clearly marked, and **unnecessary access prevented** while spraying is in progress.
6. **Neighbours** and others in the area should be warned of the spraying programme.
7. Only the **appropriate quantity** of pesticide and herbicide should be removed from the pesticide store for immediate use.
8. Chemicals (especially pesticides and herbicides) must **never be put into unmarked containers**.
9. **Do not transport** chemicals in vehicles used for carrying people or food.

Application

1. **Time the treatment** to coincide with the presence of the pest.
2. Use a **selective chemical** that has the least effect on non-target species and treat only the area affected.
3. **Equipment** should be **frequently checked** and **properly maintained**, both for health and safety reasons and to minimise spray drift.
4. Spraying **should not be carried out in unsuitable weather**. Anyone operating sprayers should have access to a wind-speed meter and only spray when the wind speed is nil or negligible.
5. **Avoid inhalation of dusts** and **fumes** and **contact with the skin**. Users should wear protective clothing and headgear, and change clothing and wash thoroughly with soap and water after applying pest control chemicals.
6. **Hours of work** should be controlled so that people are exposed for the minimum time.
7. Ensure that anyone handling toxic chemicals **never works alone** and that the work area is **well-ventilated**. In confined areas, they should wear a safety-approved respirator.
8. **Wear a respirator** for outdoor spraying or dusting of organic phosphorus compounds.
9. Take care to **avoid the contamination of food and drinking water**.
10. **Eating, drinking and smoking** should be **prohibited** when using or handling chemicals.
11. Users should be **familiar with the effects** on the body of the chemicals they are likely to be using, and how the chemicals may enter the body.
12. Users should be **aware of the signs and symptoms** of acute poisoning related to chemicals they are using:
    - They should **stop work** if they are feeling ill.
    - They should **seek medical advice** and report the matter if they experience nausea, excessive sweating, are unusually thirsty or have unusual difficulties with their eyesight.
13. **Sprays should be turned off** before inspecting nozzles. Correct protective clothing should be worn for these inspections, and nozzles of pipes should not be blown through (using air from the lungs) or sucked on in order to clear blockages.
14. When using a **'rucksack'** type sprayer, be aware of the following hazards:
    - Liquid should **not be allowed to spill** on to the user's back or clothing.
    - **Shoulder straps** should be suitable and easily adjustable.
    - Sprays should **not be too heavy** to be lifted when full.
    - **Pump seals** should be regularly checked, and replaced as soon as there is any sign of deterioration.
    - **Hand lance triggers** and joints should be checked for seepage.
    - It should be possible to check from the outside how full the sprayer is **to avoid spillage** from overfilling.
15. **Control the re-entry** of people into the treated area.

Disposal of leftover chemicals

As most pesticides and herbicides are extremely toxic, due regard must be paid to **disposal** of unused chemicals. Disposal methods will depend on the:

- **quantity of waste** for disposal
- chemical and biological **degradability** of the active ingredients
- **toxic properties**
- **concentration**
- **physical form** of the waste
- **disposal options** available.

Always follow the **manufacturer's and/or supplier's instructions** even when disposing of empty containers. These details should he kept in the hazardous materials manual **SEE 8.4.4.c**. Landfilling pesticides and herbicides is not generally an environmentally sound option and in most cases incineration is advised, at temperatures in excess of 1000°C and at a residence time of at least two seconds.

The following general guidelines should also be adopted:

- **Never transfer pesticides** to **unlabelled** or **mislabelled** containers. Keep in clearly labelled containers even when disposing of them.
- **Do not reuse** pesticide/herbicide containers.
- **Rinse out containers** before disposal, and use the rinse water for pest and weed control.
- **Puncture containers** after they have been used, to prevent re-use.
- **Segregate pesticide/herbicide wastes** from general hotel wastes.
- Use an **authorised waste-disposal contractor**.
- Use an **authorised disposal site**.

8.6.4 Specific pests and how to deal with them

As a general rule, control methods must attack both adults and larvae or young, with the emphasis normally being on controlling the larvae and young in order to break the life cycle.

FIGURE 8.5

Common pests associated with hotels:

a: ants
b: aphids
c: bed bugs
d: caterpillars
e: cockroaches
f: dust mites
g: flies
h: mosquitoes
i: moths
j: rodents
k: snails
l: wasps

See text for full details

NOTE: IMAGES ARE NOT TO SCALE

a ANTS

Ants can become a problem during the summer, particularly when food is left on counters or crumbs and debris remain on the floor. **Pavement ants, larger yellow ants, thief ants** and **carpenter ants** are commonly found in hotels.

Ant control requires knowing their habits and where they enter from the outside. The ants establish colonies and send out scouts to find food and water. These scouts leave a scent trail which enables them to find their way back to the colony with news of found resources. Other colony members then follow the scent trails to retrieve the resources. Some ant varieties establish sub-colonies near resources or send out queens to establish new independent colonies.

The first thing to do is to kill any ants you see and to wipe down the area with soapy water in order to prevent major scent trails from being formed and to stop the scouts returning to the colony. If there is already an established trail, wipe backwards from the food source to the entrance of the trail. Then block the entry point to the building – the ants will give up trying to find a way through after a day or two. Temporary blockades can be made using sticky substances such as petroleum jelly or chili powder, cinnamon and boric acid. If you can find the entrance to the nest, pour boiling water into it.

To cut off the supply of food, keep opened foodstuffs in sealed containers or store them in the refrigerator or freezer. Wipe down worktops and sweep floors regularly. Clean out kitchen cabinets, drawers and shelves to remove crumbs and stains. Keep sinks and worktops dry and dry pans and dishes immediately after use.

Baits are best put in the path of an ant trail and then removed after the ant activity stops, before they lure ants from another colony to the area. You may need to try different baits if the first one doesn't work as they use different attractants. Use sticky barriers to stop ants traveling up trees and plants. Prune branches close to the building and remove fences or anything that might create a bridge for the ants to cross.

Low toxicity compounds to control ants include boric acid and diatomaceous earth (DE), a chalk-like powder consisting of the fossilised remains of diatoms, a type of hard-shelled algae. Make certain that any other compounds used in ant control products are safe and ensure that you follow the instructions carefully.

Pharaoh ants are tiny white insects that can come in with the delivery of clean laundry and are therefore not easily spotted. Once established they can spread throughout a building in a very short time. The treatment for infestations can only be administered by a licensed pest control contractor and involves feeding the ants liver dosed with a hormone that acts on the pests' reproductive cycle. This stops them breeding and eventually they die off. Treatment is expensive as it can take up to six months to eradicate an infestation.

b APHIDS

Before toxic insecticides were introduced in the 1940s it was standard practice to use beneficial insects for pest control in agriculture, but the availability of convenient, branded products combined with effective marketing rendered these techniques almost obsolete. Today, many garden pests have developed a tolerance of chemicals whilst the same chemicals are also killing off the beneficial insects that nature intended to control the pests. Cutting out the use of chemicals enables natural predators such as ladybirds (ladybugs) and green lacewings to return. As a result, butterflies and birds also become more plentiful.

Releasing predatory mites, ladybirds and lacewings into the grounds several times over a period of weeks will help to manage sap-sucking pest mites and whitefly. Parasitic wasps can also be used to control scales on trees, shrubs and flowers.

If it is difficult to obtain supplies of beneficial insects for release into the garden, then it is possible to purchase a branded 'lure' that simulates the scent of aphids and lures ladybirds and lacewings to the area.

c BED BUGS

Although bed bugs have been traditionally associated with backpackers' hostels and budget accommodation, the rise in international travel means they are on the increase and are particularly prevalent in some areas of Eastern Europe and the Far East. Sadly for some hotel guests, paying for a luxury room in a top hotel does not automatically guarantee immunity from bed bugs. Often they come in with hotel deliveries or in guests' luggage. Kitchens are a favourite location where they shelter behind wall tiles, equipment or in the crevices in walls and floors – any warm and damp locality near food. They also hide near beds in lampshades, behind fixed headboards and in upholstery. They are attracted to human hosts when they detect an increase in the level of carbon dioxide, exhaled during sleep.

Adult bed bugs are around four to six millimetres long and clearly visible to the naked eye, but colonies can build up without being spotted due to their nocturnal behaviour. However, if a guest has been bitten by a bedbug, they are likely to complain. Sores or bites on the body, often in a line, are fairly conclusive evidence, as are blood spots on sheets, skins that have been cast by bugs as they hatch, excrement that looks like mould on wallpaper, bedheads, fabrics and carpet close to the bed. If there is a serious infestation the room may also have a sweet, sickly smell.

Bedbugs only feed once a week, so they hide in wall cavities, ceilings and central heating ducts and reappear throughout the hotel at different times. Once established it is very difficult to eradicate an infestation as they are prolific breeders with a very short life cycle. Studies have shown that the average time taken for bed bugs to spread to adjacent rooms is seven weeks. For this reason, it is not sufficient merely to treat the room in which they are found as the problem is likely to have spread to other areas of the hotel. The most effective course of action is to enlist professional help so that other rooms can be checked for signs of secondary infestation and treated if necessary.

d CATERPILLARS

Proprietary-branded bacterial insecticides derived from natural ingredients are available to control caterpillars. Check that the insecticide does not remain in the environment for long – some are suitable for use even up to the day of harvest. The insecticide works by paralysing the digestive system of the caterpillars, making them unable to eat.

e COCKROACHES

Cockroaches have been around for more than 400 million years and are believed to share a common ancestor with termites. They contaminate food with their excrement and secrete an unpleasant odour that can permeate the indoor environment. Many individuals also develop allergies to them.

Cockroaches are broad, flattened insects with long antennae and are often confused with beetles. However adult cockroaches have membranous wings and lack the thick, hardened fore-wings of beetles. They are nocturnal and run rapidly when disturbed. Immature cockroaches (nymphs) look like adults, but are smaller and do not have wings. Females can carry an egg case with them for quite some time, dropping it wherever it may fall. Each egg case may contain hundreds of eggs which hatch into nymphs.

Cockroaches require high humidity, warmth, and a food source. They live and breed in moist dark places behind skirting boards, around plumbing, under refrigerators and in cupboards, pantries and kitchens. The holds of aircraft are notorious sources of cockroach infestation and the insects enter the hotel on customers' luggage or other items such as crates of food or drink. Outdoors they are found in piles of debris, rubbish and waste. They will readily feed on carbohydrates, paint, wallpaper paste, and book bindings.

Adult cockroaches can hide in a crack as narrow as 1.6 mm wide, while immature cockroaches tend to stay in even smaller cracks where they are well-protected. They tend to congregate in corners and generally travel along the edges of walls or other surfaces. Use a flashlight at night to inspect cracks, underneath counters, around water heaters, and in other dark locations and look for live and dead cockroaches, cast skins, egg capsules and droppings.

There are five main species and effective control depends on identifying them correctly. Measures to take include effective hygiene and exclusion practices, sticky traps lined with pheromones, boric acid, insect growth regulators and sprays.

Cleanliness should be your prime objective in the elimination of cockroaches. All food-handling areas should be cleaned frequently. In general, cockroach control is best done by a professional on a contract basis, through the application of pesticides to reduce the population to a reasonable level. Control is necessary on a regular basis because of the mobility, reproductivity, longevity and behaviour of these pests. Ensure that you know what pesticides are being used by the professional contractor and do not assume that they are using an environmentally appropriate chemical.

f DUST MITES

Fabrics, bedding (especially mattresses and pillows) and carpets all attract and generate dust – the perfect home for a dust mite. The problem is greater in Northern European countries and in North America where fabrics and carpets form such a major part of the room décor.

Dust mites are only 0.4mm long and so cannot be seen with the naked eye. Unfortunately, they are such a common problem that almost any bed examined under a microscope will be found to have dust mites.

There are several ways to keep dust mites at bay, including regular vacuuming of mattresses and pillows and the use of special mattress and pillow case covers. These need not be made of synthetic or rubber material as specially woven and treated cotton covers are also available that stop the mites getting through from the mattress. Improved ventilation and a low relative humidity will help in reducing numbers.

Thermal treatment of beds and furnishings on a periodic basis is also effective. The bed and furnishings are put into a very large plastic bag which is then sealed and heated up to 100°C, killing off any mites and bed bugs. It also denatures any other irritants that might affect allergy-sensitive guests. Although the process is energy-intensive, it avoids the use of chemicals or pesticides.

g FLIES

Flies of various descriptions, including bluebottles, house flies and fruit flies, are highly efficient carriers of a wide variety of diseases including dysentry, gastroenteritis, typhoid, cholera, meningitis and tuberculosis. For this reason they are highly undesirable visitors to your hotel – particularly the kitchen and restaurant. Once attracted in by food, they can very quickly cross-contaminate food if not dealt with immediately.

Flies reproduce most readily in waste and manure, which is where control should begin. Under warm weather conditions the reproduction cycle – from egg, to larva, to pupa, to adult winged fly – requires approximately one week. For this reason, collection of waste and residues should be carried out at least twice a week. It is also important to keep refuse areas in a clean condition to avoid providing flies with a breeding site. Ensure dustbin lids fit tightly and the interiors of bins are cleaned regularly to keep surfaces free of encrusted food material.

The use of fine mesh window and door screens is a good barrier against entry by any flying insect. Windows and doors can still be opened and, although both light and ventilation will be slightly impaired, it will not dramatically alter the general operating conditions in the work-place. Ultra-violet (UV) fly killing machines are very effective so long as they are sited correctly and should not just be reserved for kitchens. UV machines disguised as uplighters in dining and lobby areas are discreet and highly effective because they attract and eliminate flies quickly and silently. In food preparation areas they should only be used once all possible precautions have been taken to keep flying insects out. In many catering establishments, poorly-sited fly machines pose a greater food hygiene hazard than having no insect killers at all. This is because when placed next to the food preparation area they draw flies to the food which they are likely to contaminate before being killed. The best position is close to an entry point, at right angles to the nearest competing light source such as a window. If the UV bulb in the machine is working effectively, the insects should fly straight to it, keeping them well away from the food.

Avoid siting UV machines:

- near open doors and windows facing outwards as they will attract flying insects into the building
- where they may be obstructed by a fridge or other large piece of equipment
- near ceiling fans or air conditioning units where they will be prevented from getting to the machine by the air current
- too high up – flies normally fly below 2.5 metres so any higher means the machine will be above the flight path. It will also make it more difficult to service. The UV bulbs should be changed every 12 months to guarantee their effectiveness.

Chemical control of flies calls for treatment of the breeding sites using larvicides or residual sprays which are applied to surfaces where the adult flies land. The use of mist sprays quickly kills flying adults, as do baits containing substances to attract them, mixed with a poison. Some machines automatically spray a metered dose of natural pyrethrum extracted from the *Chrysanthemum cinerariaefolium* plant and can be used in kitchens and restaurants. A potential downside of such machines is that dying flying insects often fall into or on food so staff vigilance is paramount. 'Safe sprays' are available for food preparation areas, but you should check with your supplier to ensure you know exactly what chemical they contain and how they work.

h MOSQUITOES

Mosquitoes pose a real problem in some tourist areas, carrying with them the threat of malaria, yellow fever, dengue fever and encephalitis. Secondary infections can occur when mosquito bites are scratched, even when no disease agent was transmitted. Some mosquito strains have evolved immunity to several of the known safe preventative medicines.

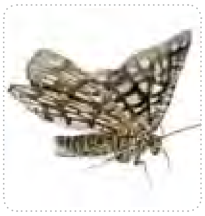
Most types of mosquito lay their eggs in stagnant water, forming 'rafts' of eggs that are around a quarter of an inch long and an eighth of an inch wide. The best control method is to eradicate their habitat and make their environment an unfavourable one.

- Because they like moisture and lay their eggs in standing water, it is important not to leave flower pot saucers, buckets, plastic sheeting or other open containers outside collecting water. Ensure that any water butts you use for collecting rainwater for irrigation are fitted with a lid.
- Clear debris from gutters and drains to ensure that there is no standing water after rain and drain unused pools or fountains so that the water cannot become stagnant.
- Eliminate depressions, mud flats and other areas that might hold water by draining or filling them.
- Repair leaking taps and air-conditioning units so that puddles cannot form and ensure that septic tanks, cesspools and sewage systems are properly maintained and in good working order.

- Avoid over-irrigating lawns and gardens, and keep weeds and grass (where the insects rest) well clipped.
- If you have a pond or lake in the hotel grounds or golf course, fill it with mosquito-eating fish such as top-feeding minnows or goldfish – they will eat the floating rafts before they mature into mosquitos.
- Keep water shorelines clear of vegetation that is likely to harbour larvae, and if possible allow water levels to fluctuate to reduce the production of larvae.
- Some hotels have successfully reduced the number of mosquitoes and other insects by attracting bats to their property. Bats are perfect mosquito catchers as they too are active after dark, and one bat can catch as many as 600–1000 mosquitoes in an hour. Many bats in tropical climates are fruit-eaters so planting banana, fig, date, avocado and mango trees in the hotel gardens will help to encourage them and provide fruit for the restaurant. A simply-built bat house will usually accommodate up to 100 bats.
- To prevent mosquitoes from coming indoors, fit fine-mesh screens to porches, doors and windows. Also, encourage your guests to switch off lights and close their doors and windows before leaving their rooms for cocktails or dinner.

If these measures are insufficient, the use of area repellents such as citronella candles, coils or sprays will repel mosquitoes from porches, patios and other unscreened outdoor areas, although they only work well when the air is still. To kill the mosquito larvae and break the life cycle, mosquito 'dunks' can be placed in still water such as bird baths, water butts, ponds, lakes and other breeding places. In areas with a severe mosquito problem, repellents can be used directly in gardens and on lawns to form an invisible barrier and deter mosquitoes from landing in shrubs and bushes. You may also need to treat areas of water with an insecticide to kill the larvae.

MOTHS



Moth larvae feed on a wide variety of natural and even synthetic materials. They can be found in kitchens and food storage areas, and clothing, carpets, blankets and upholstery are particularly vulnerable. Holes around the hems of wool blankets are often the first sign of moth attack.

Cleanliness is the key to eradication as the larvae cannot complete their normal life cycle without the necessary nutritional supplement such as food, beverage, sweat or urine stains to provide them with the proteins, mineral salts and vitamin B complex on which they depend. A single egg or caterpillar can start the cycle over again so it is important to be thorough when getting rid of them.

Pantry moths thrive on grain-based foodstuffs in kitchen storage areas. They can be identified by tiny holes in food containers and webs in corners, stickiness in otherwise dry foodstuffs or by an unusual odour. Occasionally the larvae or moths themselves can be seen. The life cycle for these moths is six to eight weeks so it can take some time to eradicate them.

Clean the affected area by vacuuming all surfaces, walls, shelves, cabinets and floors, then scrub hard surfaces rigorously with hot water and detergent, especially in corners and all round the edges of removable shelves. Clean every surface that comes into contact with food. Next rinse the area with white vinegar, either in a spray or by wiping down with a cloth.

Throw away all grain-based food items as well as nuts, raisins, flour, and tea, even if it is in sealed containers. The remaining food items and containers should be thoroughly cleaned with a detergent and water solution and wiped down with a vinegar rinse before being put back. Use air-tight containers made of hard plastic, glass or metal and not plastic bags.

Kill any moths left flying around in the air with a fly swatter or moth traps. There are many commercial traps available.

After a severe infestation, it may be wise to freeze any new grain products you buy in before putting them into store cupboards and consider storing all of your grain based products in this way.

Peppermint gum, bay leaves, peppercorns and cloves are all said to help deter pantry moths.

Moths in clothing or fabrics need to be treated in much the same way – by killing the eggs and larvae to interrupt the life cycle. Fabrics should be washed or dry cleaned and then put in bags and placed in a freezer. When you take them out to thaw, shake them vigorously to remove the dead larvae.

Clean the areas where the fabrics have been stored using a vinegar and water solution as described earlier. If you are storing blankets and bedding away for any length of time, ensure that they are clean. Ideally they should be stored in a chest made from cedarwood. Alternatively, put chips or blocks containing cedarwood oil into the drawers. Lavender sachets are also a useful deterrent. Air rooms well, allow in plenty of sunlight, vacuum regularly and empty vacuum cleaner bags frequently as they can harbour moths, which can eat through the bags.

You will need to follow these control procedures on a continuous basis if your hotel is in an area where moths are a persistent problem. For acute moth problems, re-usable traps are available that can be baited with a controlled-release pheromone system to lure moths into the trap and disrupt their mating cycle.

Mothballs not only have an unpleasant odour, but they are also poisonous so should be avoided if possible. Insect foggers are not recommended as they can pose a health threat and are not always effective.

j RODENTS

Rodents, such as rats and mice, are attracted to hotel and restaurant premises when litter and food are left lying around. They live in close proximity to us and are found in living quarters, kitchens, storage rooms and outbuildings.

In addition to the fact that rats transmit disease, they can cause substantial structural damage and consume and contaminate large amounts of foodstuffs. A rat will consume 8kg (17 lb) of food (including your waste food) yearly and can produce four to five litters a year. Mice often enter a building looking for food and shelter when the weather begins to get colder. Since mice are deterred by the smell of a rat, the problem is often one or the other rather than both together. Mice can squeeze through holes as small as a quarter of an inch in diameter, so eliminating any gaps in masonry where they can gain access from outside is very important.

Rodent control should start with a survey to determine the source of the problem and the conditions that encourage the infestation. This should be followed up with a programme to kill the rodents, removing their sources of food and water, eliminating their place of refuge and making it rodent-proof, and educating and obtaining the co-operation of employees. If the food supply is removed before you kill them, the rodents will migrate to other areas, making elimination more difficult.

The construction of rodent-proof buildings and the elimination of refuges are key preventive measures. Openings in building foundations and walls should be closed or screened with wire mesh that has holes not more than 1.25 cm (0.5 in) wide. Where pipes enter masonry, force heavy hardware cloth or steel wool into the opening, then fill it with concrete. Continual surveillance is necessary, and places where rodents have been gnawing to gain entry to a building should be sealed with metal flashing. Doors are particularly vulnerable to rodent attack so ensure that external doors and windows (especially basement windows and those near ground level) close tightly with no gaps at the bottom. Materials stored in the open, in sheds or in buildings should be stacked at least 30 cm (1 ft) above the ground.

Stringent waste disposal practices should be observed – make sure that any food being collected for disposal is in a secure vermin-proof container with a lid and not just in plastic bags. Wash down dustbin areas regularly. Make sure composting bins are designed so that rodents cannot get in.

Traditional mouse and rat traps, or 'snap' traps, kill instantly. If trapping efforts fail it is usually due to too few traps being used and ideally you should use two traps every two to three feet along the wall. Bait should be sticky to ensure that the mouse triggers the trap mechanism even if it only lightly touches the bait. Mice prefer peanut butter or chocolate to cheese, or you can use bacon, oatmeal or apples as bait. An alternative is a battery-operated trap that generates a high-voltage once the rat or mouse is inside. The design is such that it is relatively safe to use in areas where there may also be children, other wildlife or pets. Because the rat or mouse stays in the trap, there is not the problem of having to locate where the animal has died.

Poison bait should ideally only be used by a specialist contractor. Anti-coagulant poisons are preferred because of their low level of toxicity for human and other life, but some rat populations have become immune. Whilst the hazard to humans varies according to the poison employed, extreme care should still be taken in distributing and placing all poison bait. Every possible precaution should be taken to prevent risk to humans and the contamination of food and water.

k SLUGS AND SNAILS

Slugs and snails can ruin the appearance of the best kept grounds and gardens and are a particular problem for hotels that grow their own organic vegetables. There are various non-chemical solutions including putting salt or sharp shingle around vulnerable plants, drowning them in beer or simply throwing them over a neighbouring fence. Another is the use of an elemental copper band on adhesive tape – the natural electric charge in the copper repels snails and slugs.

l WASPS

Wasps are generally a problem where food and drink is being served outside during warmer months of the year. It is important to control them as some people are allergic to the venom in wasp stings and can develop an allergic reaction, ranging from mild to life-threatening. Each year, around four anaphylaxis deaths caused by severe allergic reactions to bee or wasp stings are reported in the UK alone.

A simple trap can be made by putting beer or a solution of jam or honey with water in a jam jar. If this does not work, there are branded traps available containing specially formulated attractant baits.

8.6.5 Natural control methods for hotel gardens

If you can create a healthy, balanced environment for plants, you will reduce the need to use expensive chemicals in the grounds and gardens. There are many naturally-occurring predators to control pests, and organic solutions to disease, weeds and fungi. Also, if you look after your soil by feeding it with organic compost (including kitchen and garden waste SEE SECTIONS 4.4.7 AND 4.4.8), leaf mould and other soil improvers such as horse manure, or fish, blood and bone fertiliser, you will minimise the need for synthetic chemicals of all kinds.

a PREVENTATIVE MEASURES

There are several steps that hotels can take to reduce the risk of problems requiring chemical control:

- Plant at the **right time**, in the **right place**. Seedlings should not be planted too early, nor located in unsuitable conditions. Young plants should not be deprived of their peak growing potential – as it is often their best defence against attack. Putting plants which need a lot of water close to buildings will make them more vulnerable to mildew.
- Select **disease-resistant varieties**. It is often possible to find varieties that are resistant to particular pests or diseases, so if you are aware of a particular local problem, choose plants that will be unaffected.
- **Traditional methods** of planting and maintaining grounds can often reduce the need for biocide use. In particular, mixing plants and avoiding 'monocultures' have long proved to be effective in reducing the numbers of certain pests.

b ATTRACTING NATURAL PREDATORS

Birds, insects, worms and other creatures all help to maintain a **natural balance** in the garden, controlling unwanted visitors such as slugs, snails, aphids and unwanted insects. Aim to provide habitats for creatures that prey on pests, such as nesting sites and supplies of food for birds during winter months, or a pond for frogs and toads.

c BIOLOGICAL CONTROL

Biological control is where natural predators or 'competitors' are **introduced** into an environment to control animal or plant infestations. They can include animals, insects, viruses or fungi. Predatory mites, for example, can counter red spider mites; parasitic wasps will resolve whitefly problems, ladybirds will control aphids. *Bacillus thuringiensis* will put an end to pest caterpillars, by giving them a natural bacterial disease. The use of such natural biological control can be very cost-effective, but needs careful planning. Some experiments in introducing species to new environments (such as cane toads in Australia) have been disastrous. Careful and expert review is essential before taking action as a biological introduction may not be applicable to your hotel environment.

d PHYSICAL CONTROL

Physical control refers to the **blocking or trapping** of insects or other animal pests. Examples include using Ultra Violet (UV) light to attract insects to electrical exterminators and using flame guns to control weeds. You can also provide effective protection to seedlings from insects through the use of plastic bottles cut in half and inverted over the seedlings. Basic sanitation measures will also help such as:

- proper **storage, collection and disposal** of refuse, including manure
- eliminating or reducing **breeding areas** by keeping water collection areas clean, clearing out bushes and ensuring hotel buildings and other structures are rodent-proof
- fitting **screens** on doors and windows to stop the ingress of pests
- effective **food safety and hygiene** precautions for all food storage, preparation and service areas
- **pest-control** operations at regular intervals.

e WEEDS AND UNWANTED VEGETATION

Weeds are plants that grow where they are not wanted. Even cultivated plants that grow larger than intended and begin to spread out of control become weeds. They can be very persistent and may grow in cracks in paving and walls, gutters, or in soil where no other plants can compete for example. Many species of weeds are not readily killed by mechanical cutting; they quickly recover and continue to grow. Some weeds grow rapidly during times when desirable plants are dormant, and will spread and shade out the species you want. Other weeds may be toxic to livestock or have noxious properties. All these factors need to be taken into account both when planting and when planning vegetation control.

To reduce or avoid the use of herbicides you should:

- Strive to keep the exterior grounds of the hotel **well-maintained** at all times.
- **Remove plants that are out of control.** Common sense and alertness will help you recognise incipient weed problems.
- Consult with a professional weed expert who is knowledgeable about the proper maintenance of desired vegetation. Having a contract with a reputable firm for certain phases of grounds maintenance (fertilising, chemical weed control, etc.) can be more economical than stop-gap attempts by personnel who have to divide their time between various maintenance jobs.

8.7 ASBESTOS

8.7.1 The issues

Asbestos is a naturally occurring, chemically inert mineral which is immune to rot and bacteriological attack. It is mined in much the same way as copper, iron and lead and the main producers are the US Canada, South Africa and former Soviet Union states.

With its many useful properties, asbestos was a very popular product in the 20th Century until the 1970s. Its primary use was as a construction material because of its high resistance to alkalis, corrosion and high temperatures, its high tensile strength, and its properties as a sound attenuator and electric, heat and cold insulator. However, its one serious drawback is the known adverse effects of asbestos on human health. Although asbestos use is banned in the European Union, the US, Japan, Australia and other countries, it is still used in some countries owing to the lack of equivalent replacement materials for many applications.

Asbestos comprises a group of minerals with a crystalline structure, occurring as parallel bundles of fibres. When disturbed, these bundles separate into smaller individual fibres called 'fibrils'. Once inhaled or ingested, the fibrils are not readily broken down or expelled and remain like needles in the body. Asbestosis is a disease is caused by exposure to high levels of airborne asbestos fibres over a long period of time and Mesothelioma is a rare and virulent form of cancer which occurs in those who have been exposed to asbestos fibres as long as 50 years ago. Mesothelioma affects the lining of the lung, lining of the abdominal cavity or the lining around the heart. Some sufferers were exposed at work and others were exposed secondarily through family members who without their knowledge, brought fibre home on their work clothes or on their hair or skin. Mesothelioma International[4] estimates that 250,000 workers in Western Europe alone will have died from the disease by 2029.

When used as a component of other materials, it is not always easy to tell if asbestos is present. The only conclusive way to find out is to take a sample and examine it under a microscope by polarised light or by X-ray diffraction, or both. This should be carried out by a competent laboratory.

[4] See www.mesotheliomainternational.org

8.7.2 Types of asbestos and where it is found

There are **three basic types** of asbestos: **Chrysolite** (white asbestos), **Crocidolite** (blue asbestos) and **amosite** (brown asbestos). Other varieties include **anthophyllite**, **actinolite** and **tremolite**. They fall into two groups:

SERPENTINE GROUP

Serpentine minerals have a **sheet or layered structure**. Chrysolite or 'white' asbestos is the only asbestos mineral in the serpentine group and is commonly found in buildings or materials that date from the early 20th century to the mid 1970s. Some of the materials in which it is contained include:

- joint compound
- mud and texture coats
- vinyl floor tiles, sheeting, adhesives
- roofing tars, felts, siding, and shingles
- transite panels, siding, countertops, and pipes
- fireproofing, fire blankets, interior fire doors and fireproof clothing for firefighters
- caulking putties
- gaskets
- brake pads and shoes and clutch plates
- thermal pipe insulation

AMPHIBOLE GROUP

Five types of asbestos are found in the amphibole group: **amosite, crocidolite, anthophyllite, tremolite**, and **actinolite**. Amosite, the second most likely type to be found in buildings, is the 'brown' asbestos.

Amosite and crocidolite were used in many products until the early 1980s. The use of all types of asbestos in the amphibole group was banned (in much of the Western world) by the mid-1980s, and by Japan in 1995. These products were mainly:

- low density insulation board and ceiling tiles
- asbestos-cement sheets and pipes for construction, casing for water and electrical/telecommunication services
- thermal and chemical insulation (such as fire doors, limpet spray, lagging and gaskets)

Asbestos can be found in cement, rubbers, plaster, paint, bitumen, mastic, resins or plastics where the fibres are bound into the mix. When it hardens, the fibres are securely sealed, so that they cannot escape into the atmosphere. The end product, whether it is floor tiles, fire blankets, gloves, roofing sheets, pipes or fire partitions, poses no threat to health as long as it remains intact.

The most widespread use of asbestos is in ceiling, floor and wall coverings. It is sprayed together with cement to form a coating on structural steel members for fire protection. It has been used extensively for insulating boilers and tanks and for pipes carrying steam, condensate and hot water, for ventilation ducts and kitchen exhausts.

Vermiculite is a naturally occurring mineral that may contain asbestos. Vermiculite expands into worm-like accordion shaped pieces when heated. The expanded vermiculite is a light-weight, fire-resistant, absorbent and odourless material. These properties allow vermiculite to be used to make numerous products, including attic insulation, packing material and garden products.

More information on asbestos-containing materials can be found in **APPENDIX 7** of this section.

8.7.3 Hazards of asbestos dust

Today we are aware that breathing in sufficient amounts of asbestos dust for long enough periods can cause serious illness. Legislation concerning air emissions recognises the risk category of asbestos fibres as being of the highest order. However, the mere presence of asbestos-containing materials (ACM) in a building does not automatically constitute a health risk to the occupants.

To pose a risk to health, the ACM must be 'friable' and capable of becoming airborne when disturbed. Friable means that the asbestos can be crumbled or pulverised to a powder by normal hand pressure. It is the airborne particles that are dangerous as only these 'fibrils' can be breathed into the lungs. The effect, in the form of cancer, may not appear until many years later.

Because of its widespread use and application, the atmosphere surrounding us contains asbestos particles – more so in cities than in the countryside. The average particle count for cities is 100–200 per m^3 of air. However, near emission sources, concentrations can be up to 1000 particles per m^3 of air. Within contaminated buildings they well exceed 1,000,000 particles. If frayed asbestos is present in your building, you are potentially exposed to a considerable health risk.

As more has become known about the hazards that asbestos presents, strict controls have been imposed upon its use and management and its use is being phased out. In the UK, owners and occupiers of non-domestic properties (including hotels) have a duty to manage asbestos, which is contained in regulation 4 of the **Control of Asbestos Regulations (CAR) 2006 – The Duty to Manage Asbestos in Non Domestic Premises**.

8.7.4 Asbestos management

a YOUR RESPONSIBILITIES

Most asbestos legislation requires the 'dutyholder' (the person or organisation with clear responsibility for the maintenance or repair of non-domestic premises through an explicit agreement such as a tenancy agreement or contract) to:

- **Find out if there are materials containing asbestos** in non-domestic premises, and if so, the amount, where it is and what condition it is in.
- **Presume** that materials contain asbestos **unless there is strong evidence that they do not**.
- **Maintain an up-to-date record** of the location and condition of the ACMs or materials presumed to contain asbestos.
- **Assess the risk** of anyone being exposed to fibres from the materials identified.
- **Prepare a plan** that sets out in detail how the risks from these materials will be managed.
- **Take the necessary steps** to put the plan into action.
- **Periodically review** and monitor the plan and the arrangements to act on it so that the plan remains relevant and up-to-date.
- **Provide information on the location and condition of the materials** to anyone who is liable to work on or disturb them.

Your **staff also have a duty to co-operate** as necessary to allow the dutyholder to comply with the above requirements.

b IDENTIFICATION

Both the identification of ACMs and the follow-up required can be extremely complicated and require an expert. Later in this section we focus on how to select expert assistance and what the main steps are that an asbestos consultant will take on your behalf.

INSPECTION

The purpose of an asbestos inspection is twofold: to **identify** any ACM within a building and to **assess** the condition of the asbestos with regard to any potential health hazards it might pose.

A comprehensive asbestos inspection should begin with a **thorough review** of a complete set of building plans. Any building more than 25 years old is very likely to contain asbestos, although it may not necessarily present a hazard

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Once the plans have been reviewed and the functional areas plotted, an **inspector** then makes a **physical walk-through** of every accessible area within the building. This survey should include spaces above false ceilings and shafts which are inspected as far as possible. Note that there may be dust accumulations from frayed asbestos on top of false ceilings, ducts or within mechanical shafts. The potential health hazard generated by a specific ACM depends on the condition of the material, concentrations of asbestos and friability. The physical condition of the material can be assessed once all the ACMs within the building have been positively identified

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Photographs are taken

↓

Materials suspected of containing asbestos will be **sampled** and taken away for **laboratory testing**

THE INSPECTION REPORT

After the inspection, the consultant should provide an inspection report and management plan for proper handling of any asbestos identified. At the minimum, the report and plan should include the following information:

Written documentation explaining the methodology used to determine the presence of ACM

↓

A copy of the **laboratory analysis**

↓

An **explanation of the types of ACM found**

↓

Recommendations for handling each type of ACM

↓

Drawings of the facilities inspected

↓

When ACMs are found to be present, **a specific plan of action**, referred to as an **asbestos management plan**, should be developed

8.7.5 The asbestos management plan

The consultant's inspection report may offer one or a combination of recommendations for managing ACMs within the building.

a REMOVAL

This means physically removing the ACM from the building. Removal is usually recommended for severely damaged materials that cannot be repaired, should not bear further weight or which are present in areas of high-occupancy. The procedure is conducted under strict supervision, generally by trained and experienced asbestos-abatement personnel, following a detailed set of specifications. These will be set out in the contract documents. During removal, all occupants are temporarily relocated and the area is isolated and heavily controlled.

b LEAVING THE ASBESTOS IN PLACE

This option is no longer permitted if the asbestos is not completely intact unless the risk of removing it is perceived to be a greater risk to health than leaving it in place. Once you have identified ACMs within the building, you will be required to implement a continuous surveillance and maintenance programme throughout the life of the building. Since a limited risk is still there, it may also be difficult to get adequate insurance coverage – if at all. However this needs to be balanced against the fact that removing asbestos that is in good condition is not only creating an unnecessary dust hazard, but also will be expensive. SEE FIGURE 8.6

ENCAPSULATION

This is carried out by applying material to penetrate and bind the asbestos fibres to prevent release. Encapsulation is recommended when the ACM is in good condition and is intact to its substrata, but not for heavily damaged and friable materials.

The application must be conducted under supervised and controlled conditions, including containment of work areas to prevent the release of fibres into the environment. A consultant should also determine if the encapsulating materials are compatible with the ACM.

ENCLOSURE

This is done by building an airtight environment around the ACM and is used for materials with localised damage or those that are inaccessible.

The enclosure material should be labelled to alert workers to the presence of ACM if work is ever required behind the enclosure.

ACM OPERATIONS AND MAINTENANCE (O&M) PROGRAMME

After completing encapsulation or enclosure, an operations and maintenance (O&M) programme is initiated with the help of a qualified asbestos consultant to provide a system for periodic surveillance, training maintenance staff and repair of any damage that occurs in the future. The programme must remain in effect throughout the life of the building, and is designed to help keep ACMs under control without posing a threat to the building's occupants.

The O&M programme provides procedures for emergency releases, how to clean areas properly, the do's and don'ts of dealing with the material and the personal protective equipment to be used should a fibre-release incident occur. In this way, all remaining ACMs can be dealt with in a practical and safe manner.

FIGURE 8.6

Techniques for controlling asbestos that must be left in place

c COSTS ASSOCIATED WITH ASBESTOS REMOVAL

The asbestos consultant will need to prepare professional cost estimates in order to establish a budget. The following considerations have an influence on the total cost of the project:

- whether the removal is to be conducted when piping systems are hot, which will increase the cost
- inaccessibility due to the height or location of the ACM
- whether removal will restrict or limit the operation of the hotel, resulting in revenue loss
- requirements of asbestos-removal contract specifications with regard to bonding, insurance and licensing, and management of removal operations
- work required by other contractors before, during and after the abatement work
- future abatement regulations mandated by state or local legislation
- other abatement alternatives
- future operations and maintenance (O&M) costs.

Once the decision as been taken as to how to remove the ACM, the abatement process must be planned and an abatement contractor retained. Both actions require detailed planning.

d UNDERSTAND AND DEFINE RESPONSIBILITIES

Specific guidelines and regulations have been established by state and local authorities for the proper removal and disposal of asbestos. The use of a qualified contractor is essential – in the past abatement work in some locations in the US was incorrectly carried out, increasing rather than minimising the dangers. Incompetent abatement creates a considerable financial risk for the building owner and operator including the potential liabilities of exposing building occupants to contamination and improper waste disposal, project delays and other schedule problems that keep facilities out of service, creating loss in revenue and cost overruns.

Define the exact responsibility of your consultant versus that of the contractor. The consultant will generally develop the specifications that identify the correct procedures and requirements necessary to remove the ACM. In addition, they will define any substitute materials that may be necessary. The consultant's advice is also valuable in the selection of the contractor. During the execution process they will monitor all actions undertaken by the contractor to ensure that the specifications are met and exposure of building occupants and possible liability are kept to a minimum. This includes regular measurements of the air, where specified concentration levels of asbestos shall not be exceeded.

When you have appointed a consultant, they will be able to help you to establish the asbestos management plan with your team. If the building is to remain in service, the project will need to be divided into several separate phases, calling for specific logistical considerations such as:

- maintaining access
- sequencing and accessing lifts
- providing uninterrupted access to utility vaults in the basement
- maintaining equipment operation and essential services.

8.7.6 Guidelines for selecting an asbestos removal contractor

The first step is to obtain the services of a qualified consultant or asbestos industry professional to help you seek the right contractor. It is not essential to employ a large firm but it must be a well-qualified firm that can manage, fund and complete your job safely.

How you evaluate contractors will be influenced by the size and complexity of your project. If it is difficult or very large, it will demand more detailed contractor evaluation than if it is small or straightforward.

STEP 1 INITIAL SCREENING

- Establish the **scope of and specifications** for the work that needs to be done
- Draw up a list of **potential candidates** using referrals from the consultant, information from trade associations and from state and local environmental agencies.
- Seek to **answer the following questions**:
  - Does the company have the **necessary accreditation**? In the UK you can check that the organisation is approved by a recognised accreditation body that complies with the International Standard **ISO 17020**. In the case of individual surveyors, he or she should have personnel certification for asbestos surveys from a certification body approved by a recognised accreditation body under **ISO 17024**. You will also need to check which of the three types of survey they are qualified to carry out. Further information can be obtained from the **United Kingdom Accreditation Service (UKAS)**.
  - Individuals undertaking asbestos surveys in the UK should be certified either by the **ABICS (Asbestos Building Inspectors Certification Scheme)** which is operated by the **British Occupational Hygiene Society (BOHS)** or the **National Individual Asbestos Certification Scheme (NIACS)**, a joint venture comprising a specialist division of the **Asbestos Removal Contractors Association (ARCA)** and the **Royal Institute of Chartered Surveyors (RICS)**.
  - Is it a good company in a **sound financial state**, with the necessary **technical competence, experience, responsible practices, good management and responsive administration**?
  - Do they have sufficient **qualified manpower** to carry out the job at the time you want them and to complete it within the specified time frame?
  - Can they respond to and comply with **complex and changing laws** and regulations?
  - Do they have **asbestos-specific insurance** and bonding capability?
  - Can they offer **long-term protection** against claims that may not be filed for 20 years or more?

From this you should be able to draw up a shortlist of two to four bidders. A large bid list may not necessarily produce more price value, but may increase your workload and drive away responsible contractors.

STEP 2 CONTRACTOR EVALUATION

- **Involve** your risk managers, legal advisers, financial experts, engineers and asbestos consultant in the process of understanding and verifying the information received.
- **Check references** from both owners and consultants.
- Review the amount, size and success of contractors' **past abatement projects** and construction management efforts, paying particular attention to projects similar to your own in size, complexity and arrangement.
- **Review the quality and experience** of their project managers, supervisors and workers. Are all the contractor personnel properly trained and licensed and able to handle specific areas of responsibility?
- Can they meet your **scheduled deadline**?

- Obtain a copy of their **proof of insurance** (a certified copy of the insurance certificate) and bonding capability. Some contractors are insured with occurrence-type policies, under which the insurer pays claims for all covered injuries and property damage occurring during the policy period. The major advantage to the policyholder (and additional persons insured under the policy) is that once the policy is written, claims can be made at any time afterwards. The insurer is responsible for paying claims even after the policy is no longer in force. This is in contrast to a 'claims-made' policy which does not cover claims, injuries or damages filed after the policy has expired, even if the injury or damage took place during the policy period. Extended claims coverages (known as 'tails') can be purchased, but these can be very expensive and are not necessarily available.
- Do the insurance and bonding carriers have the **quality, reserves and financial soundness** to back up the coverage they write? Check how long they have been in business and their financial statements. The insurance and bonding carriers are two very important third-party entities which are also making a critical evaluation of the contractor. The involvement of high-quality firms with sound coverages is a good indicator of contractor performance.
- Does the contractor have comprehensive **employee training, medical, respiratory protection and industrial safety programmes** in place? Do they respond to the latest regulations, specifications and standards of care? Your consultant's assistance will be invaluable here.
- **Review** the documentation and quality assurance programmes that the contractor will provide. The records generated during your job must be maintained for 30 years or longer. Is the contractor reasonably likely to accomplish this?
- **Review the credentials** of the contractors' proposed hygiene, waste-hauling and disposal providers. Since you 'own' your asbestos waste forever, it is essential to be insured that this hazardous material is properly handled and buried in approved disposal facilities.

STEP 3 CONTRACTOR SELECTION

- Is the contractor's proposed work plan and schedule **well thought out** and **realistic**?
- Does it correspond to your **concerns and expectations**?
- Arrange for a **pre-bid meeting** with proposed contractors to answer any questions about the scope of work and to visit the project site.
- Use an **evaluation sheet** to weight the selection criteria and decide which contractor can produce the results most important to you. A full committee review, with all your participating advisers, may be appropriate.
- **Avoid using price as the primary criterion**. Failure to perform adequately on an abatement project can result in widespread asbestos contamination and its associated health hazards and liability implications. Consider negotiating on the price if one firm is clearly the most capable and desirable for your project but is much more expensive.
- Sit down with the contractor's representatives and your advisers to arrive at a **mutually agreeable contract** with fair financial terms.

8.7.7 Safety of personnel

a. Where ACMs are present, ensure that you are complying with relevant **Health and Safety regulations** regarding asbestos in the workplace. Most legislation requires the duty holder to ensure that the hazards relating to asbestos are effectively communicated to anyone likely to come into contact with it.

b. **Under no circumstances** should **hotel employees** be allowed to remove asbestos or carry out any other work associated with it. They should be told about the project and any hazards it presents, the purpose of sealing off the asbestos area and why they must keep out.

c. **Time spent** by the hotel's environmental and/or safety committee discussing plans with the contractor and briefing employees to explain what is to be done will be well worthwhile. The precautions that will be taken during the removal process, in order to protect any building occupant against hazardous dust, should be described. Any hotel employee who will be affected in any way by the asbestos work should attend training sessions and be given written information and guidance as to the do's and don'ts during the removal process.

d. **Tenants, guests** and **other occupiers** of the building should also be notified in accordance with regulations.

All parties need to understand what will happen during the asbestos removal process in order to prevent the release of hazardous airborne fibres

8.7.8 The removal process

It is important for **everyone to understand** what will happen during the asbestos removal process, both for the preparation and execution of the risk-management plan. This will enable you to prevent hazardous airborne fibre release and possible liability suits and will involve:

a. ISOLATION TECHNIQUES

In order to keep the services of the building operating, several **isolating techniques** may be employed:

- **Erecting walls or partitions** which separate the asbestos work area from the public and service areas. Health regulations require the creation of a 'regulated area' to prevent employees adjacent to the abatement work from being exposed to asbestos fibres. Additionally, there are concerns about dust, debris and noise generation from the removal activities. Typical walls are constructed with stud framing and plywood sheathing. Often sound insulation and gypsum board are also used to minimise noise and vibration, or to add a fire barrier to further separate the construction from the occupied areas.

- **Erecting isolation barriers.** Since some demolition activities do not necessarily involve asbestos, the 'regulated' area must be further separated from the general demolition and construction activities. These partitions, again often constructed of wood framing and sheathed, are then covered with one or two layers of impermeable 6 ml thick plastic sheeting.
- **Building tunnels** using construction techniques similar to those described above. Once the active work areas are appropriately partitioned and isolated, each 'regulated area' is fully established by providing a **containment**. Containment is a means of isolating and controlling a work area to affect the behaviour and migration of contaminants and hazardous materials.
- The work area will then be **isolated** to prevent entry by unauthorized personnel by locking all relevant doors in agreement with the operator. Rerouting of emergency exits may be necessary. Locked access to the work area will only be provided for the contractor's personnel and the doors must have 'panic' release systems from the inside.
- **Warning signs** will then be installed at each locked door leading to the work area. Critical doors opening into the work area must be marked in accordance with regulations, along the lines of the examples shown below:

b EQUIPMENT ROOMS

If asbestos is sprayed on the building structure within a **plant room**, another key logistical consideration is the HVAC equipment itself. The chiller, boiler and most of the air-handling equipment stay in operation during the removal activities in the plant-room. Their very presence and location often mean they make accessing the asbestos fireproofing difficult.

To overcome this, a specialised scaffolding company may be called in to erect tube-and-clamp scaffolding around the equipment and overhead to provide access to the material. The scaffolding is arranged so that the framework ban he used as a 'reverse containment', i.e. plastic sheeting is applied over the scaffold framing and sealed. Airflow ducts are then used to discharge air via-high efficiency particulate air filters into this enclosure to pressurise it positively against inward asbestos leakage and also to ventilate the enclosure to prevent equipment overheating.

Asbestos removal activities can then proceed around the equipment without it being directly in the work area or subjecting it to contamination. This technique is also frequently used with active switchgear, control panels or any stationary items within a work area that cannot be moved, must stay in service or must not be subjected to asbestos contamination.

Asbestos removal may also be required on the HVAC equipment itself, where ACMs have been used. The abatement of this equipment is usually scheduled over a weekend or at a time when the equipment can be shut down. It is important to discuss this scheduling carefully with the contractor to ensure on-time completion. Time must be allowed for decontaminating the area, clearance testing and reapplication of enough insulation materials to permit restarting all the pieces of equipment.

c DECONTAMINATION

Decontamination units must be installed to enable asbestos removal from persons and materials as they leave the work area.

d WET REMOVAL

Asbestos-containing materials are **thoroughly wetted** before stripping and/or tooling to reduce fibre dispersal into the air. Wetting is accomplished by a fine mist spray.

The material is sufficiently saturated to the substrate without causing excess dripping. Material that has been painted over is perforated and clean water injected. Where necessary, the ACM is stripped away while simultaneously spraying water.

e AIR-MONITORING

Air-monitoring should be carried out **continuously and under the supervision of the consultant**, who is independent of the contractor. If there is no appropriate laboratory nearby, portable equipment will be brought and an analytical laboratory set up on site. This permits continuous air-sample analysis, and will identify a high-fibre release incidence so that it can be promptly remedied.

f DISPOSAL

All removed asbestos is **packed into marked disposal bags while still in wet condition**, and not allowed to dry out. Air is removed from the disposal bags with a High Efficiency Particulate Air (HEPA) vacuum cleaner before sealing. All bags are then sealed in leak-tight fibreboard drums. They should not be stored outside the work area.

They are then removed by a **licensed waste haulier** in fully enclosed skips or trucks to an approved site. Receipts and full documentation must be obtained from waste haulier and the final disposal area.

8.8 POLYCHLORINATED BIPHENYLS (PCBs)

8.8.1 The issues

Polychlorinated biphenyls (PCBs) belong to a family of organic chemicals known as chlorinated hydrocarbons.

PCBs are man-made and are stable against heat, excellent insulators, colourless and do not dissolve in water. They are relatively inert, being difficult to break down or to make react with other chemicals. They range in consistency from heavy oily liquids to waxy solids. In cooling applications they are frequently mixed with solvents such as dichlorobenzene to decrease viscosity. These solvents frequently emit a characteristic odour.

PCBs were used from the 1930s until the 1970s as coolants and insulating fluids for transformers and capacitors because they do not readily burn or conduct electricity. They were also used as stabilising additives in flexible PVC coatings of electrical wiring and electronic components, pesticide extenders, cutting oils, flame retardants, hydraulic fluids, sealants, adhesives, paints, de-dusting agents, and in carbonless copy paper.

Two catastrophes, in Japan and Northern Italy revealed the considerable hazard posed by PCBs, and since then governments have phased out their production and use and research has focused on finding replacements. Around the world, PCBs are gradually disappearing from the market and from use.

8.8.2 Hazards of PCBs

PCBs are classified as **persistent organic pollutants (POPs)** **(SEE APPENDIX 3)** because when they are released into the environment they do not easily biodegrade. As they have a strong tendency to persist and build up in living tissue, they easily make the leap between predator and prey in the food chain. Their half-life value (period of decay to 50 per cent of original strength) is 20–100 years.

Laboratory data show that PCBs cause cancer in animals, and despite the absence of statistical proof that they cause cancer in humans, it is prudent to consider any animal carcinogen a possible human carcinogen.

Animal studies show adverse reproductive and development effects from repeated exposure to PCBs. In addition, it has been shown that PCBs are toxic to fish at very low levels of exposure. Their bioconcentration factor is 85,000–100,000, meaning that very low concentrations in the ocean gradually build up to over 85,000 times this amount in the body of fish up the food chain. The survival rate and the reproductive success of fish can be adversely affected. It is believed that there may be similar cause for concern when humans are exposed to large doses of PCBs.

The 'Yusho' accident in Japan in 1968 affected the health of 1,600 people after they had consumed rice oil contaminated with Kanechlor 400, a 48% chlorinated biphenyl, at 2,000–3,000 mg/kg, which entered the oil through a leak in the heat exchanger. Their complaints ranged from dizziness, nausea, eye irritation, bronchitis and digestive problems to more serious ones such as liver damage and chloracne, a painful disfiguring skin illness and a weakened immune system.

The worst accident occurred in 1976 in Seveso with the accidental release of a highly toxic gas – TCDD. The amount was estimated at only 2–3 kg distributed over an 18 km^2 area. Nevertheless, a large number of animals died as a result. Humans had the same problems as observed in the Japanese incident, but on a larger scale. The polluted soil had to be disposed of over many years.

TCDD is a gas of the chlorinated dioxin family, frequently referred to simply as dioxin. The same gas can be formed when PCB is exposed to heat. Accidents such as a transformer explosion or fire have made the buildings in which they were housed uninhabitable.

Similar to PCBs, TCDD is non-biodegradable, and therefore finds its way into the food chain. TCDD is considered to be one of the most toxic substances in the world.

8.8.3 Legislation

The **US Environmental Protection Agency** banned PCB production in 1979 and they are subject to the **Toxic Substances Control Act (TSCA)**. A number of countries have set regulations for the use, marking, storage, recording and disposal of PCBs. Both the owning company and operator are legally responsible. The responsibility for investigation, notification and corrective action rests with the hotel.

Because of the millions of items of equipment containing PCBs, complete phase out will take a long time. Disposal has also been handled differently from country to country.

8.8.4 Dealing with PCBs

	START WITH AN INSPECTION	RESPONSES

TRANSFORMERS (OIL-COOLED) AND VOLTAGE REGULATORS	• **Check the nameplate data** and **technical service manual** to verify if your transformers contain PCBs. If verification is not possible, check with the manufacturer or your local electricity company
	• If a PCB is present, **check the transformer** and its **vault for oil leaks.**
		• If PCBs are present, the **transformers should be replaced and disposed of** by a licensed company at a state-approved disposal plant. The oil is removed there and burnt at temperatures exceeding 1,200°C. Only at this high temperature can PCBs be destroyed as at lower temperatures, highly toxic dioxin gases will form
		• **Replacement transformers** should be air-cooled, if adequate ventilation can be provided
		• Review your **future renovation and construction plans** to evaluate if a change in capacity is appropriate
		• **If leakage has occurred** or is still occurring, proceed as follows:
		  – **Place a pan underneath** the leaking equipment
		  – Call in a **qualified and licensed consultant** to evaluate the extent of leakage and migration
		  – As a first-aid measure, carry out **required repairs** to the transformer to **stop leakage** until replacement takes place
		  – Depending on the extent of contamination of the concrete basin, **removal** and **disposal** of all affected material to an approved plant must be carried out by a licensed contractor.

CAPACITORS	Capacitors may be installed in **different sizes**: larger ones are for power factor correction near the main distribution panel or at major equipment such as chillers. Smaller ones are often used as ballasts within fluorescent light fixtures • **Check the nameplate data and service manuals** to verify whether the capacitors contain PCBs.	• Capacitors found to be defective and/or leaking should be **treated in the same way as transformers** • Capacitors installed in **fluorescent tube lights** can remain there as long as they are intact. Fluorescent light ballasts manufactured prior to 1980 may contain about 17 millilitres of PCB sealed inside the capacitor of the ballast. The capacitor is wrapped in paper and sealed in asphalt inside the ballast case. High temperatures may cause the asphalt to soften and leak out of the ballast case. Often this leakage of asphalt is mistakenly believed to be PCB. Asphalt, when cooled to room temperature, will re-harden, whereas PCB dielectric from a leaking capacitor would remain as a heavy oil. Sometimes the ballast has the date of manufacture on it, and sometimes it is marked 'No PCBs' by the manufacturer. If the light fixture has no manufacture date and is not marked to say it does not contain PCBs, assume that it does.

8.9 MORE INFORMATION

8.9.1 Contacts

1. Agency for Toxic Substances and Disease Registry (ATSDR)
   www.atsdr.cdc.gov
2. American Conference of Governmental Industrial Hygienists (ACIGH)
   www.acgih.org
3. The Asbestos Institute
   http://theasbestosinstitute.com
4. Asbestos Testing and Consultancy
   www.atac.org.uk
5. International Association for Soaps, Detergents and Maintenance Products
   www.aise.eu
6. British Occupational Hygiene Society (BOHS)
   www.bohs.org
7. Chemical Abstract Service (CAS)
   www.cas.org
8. European LPG Association
   www.aegpl.com
9. Royal Institute of Chartered Surveyors (RICS).
   www.rics.org
10. UK Accreditation Service (UKAS)
    www.ukas.com
11. UK Department for Environment, Food and Rural Affairs
    www.defra.gov.uk
12. UK Health and Safety Executive
    www.hse.gov.uk
13. US Occupational Safety & Health Administration (OSHA)
    www.osha.gov
14. US Environmental Protection Agency
    www.epa.gov
15. US National Institute for Occupational Safety and Health (NIOSH)
    www.cdc.gov/niosh
16. US National Toxicology Program
    http://ntp.niehs.nih.gov
17. US Office of Pollution Prevention and Toxics, TSCA Hotline
    tsca-hotline@epa.gov
18. REACH (the registration, evaluation and authorisation of chemicals)
    www.hse.gov.uk/reach/
19. World Health Organization
    www.who.org

8.9.2 Resources

1. **Asbestos and Man-Made Mineral Fibres in Buildings: Practical Guidance**
   http://products.ihs.com/Ohsis-SEO/310734.html
2. **Asbestos Hazard Emergency Response Act (AHERA)**
   www2.epa.gov/asbestos/asbestos-laws-and-regulations
3. **Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations 2005**
   www.hse.gov.uk/cdg/pressure.htm
4. **Chemicals in Products - Safeguarding the Environment and Human Health**
   www.iupac.org/publications/ci/2004/2601/bw3_duffus.html
5. **Control of Asbestos Regulations 2006**
   www.opsi.gov.uk/si/si2006/20062739.htm
6. **Control of Pesticides Regulations 1986 (amended 1997)**
   www.opsi.gov.uk/si/si1997/19970188.htm
7. **Control of Substances Hazardous to Health Regulations 2002 (COSHH)**
   www.hse.gov.uk/coshh/
8. **Easy steps to control health risks from chemicals**
   www.coshh-essentials.org.uk
9. **EU Directive 2002/95/EC on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment**
   http://ec.europa.eu/environment/waste/weee/legis_en.htm
10. **Directive 2012/19/EU of the European Parliament on waste electrical and electronic equipment (WEEE)**
    http://ec.europa.eu/environment/waste/weee/legis_en.htm
11. **Globally Harmonised System of Classification and Labelling of Chemicals (GHS)**
    www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html
12. **Guidance note for the Control of Pollution (Oil Storage) (England) Regulations 2001**
    www.gov.uk/government/uploads/system/uploads/attachment_data/file/69255/pb5765-oil-storage-011101.pdf
13. **Guide to Occupational Exposure Values, 2007**
    www.acgih.org/Store/ProductDetail.cfm?id=1911
14. **ISO 17020**
    www.iso.org/iso/catalogue_detail?csnumber=29342
15. **ISO 17024**
    www.iso.org/iso/catalogue_detail?csnumber=29346
16. **Methods for the Determination of Hazardous Substances**
    www.hse.gov.uk/pubns/mdhs
17. **NIOSH Asbestos Bibliography**
    www.cdc.gov/niosh/docs/97-162/
18. **OSHA Hazard Communication Standard (HCS)**
    www.osha.gov/dsg/hazcom/
19. **UK Health and Safety at Work Act (HASAW or HSW)**
    www.hse.gov.uk/legislation/hswa.pdf
20. **Managing Above Ground Storage Tanks to Prevent Contamination of Drinking Water**
    www.epa.gov/safewater/sourcewater/pubs/ast.pdf
21. **NetRegs**
    www.netregs.gov.uk
22. **Pesticides - Use them Safely**
    www.hse.gov.uk/pubns/indg257.pdf
23. **Plant Protection Products Directive (PPPR) (91/414/EEC)**
    https://osha.europa.eu/en/legislation/directives/exposure-to-chemical-agents-and-chemical-safety/osh-related-aspects/council-directive-91-414-eec
24. **Restriction of Hazardous Substances Directive (RoHS)**
    www.rohs.gov.uk
25. **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) - EC Regulation 1907/2006**
    http://ec.europa.eu/enterprise/reach/index_en.htm
26. **Gas Safety**
    www.hse.gov.uk/pubns/gasindex.htm
27. **Stockholm Convention on Persistent Organic Pollutants (POPs)**
    www.pops.int/documents/pops/default.htm
28. **Sustainable Cleaning – A guide for users of professional cleaning products**
    http://www.ukcpi.org/pdfs/sustainable_cleaning.pdf
29. **UK Health and Safety Executive - Asbestos management**
    www.hse.gov.uk/asbestos/campaign/duty.htm
30. **US Environmental Protection Agency (Asbestos)**
    www.epa.gov/asbestos

APPENDIX 1 Materials Safety Data Sheets (MSDS)

The **US Occupational Safety & Health Administration's (OSHA) Hazard Communication Standard (HCS)** requires chemical manufacturers and importers to evaluate the hazards of the chemicals they produce or import. This involves the preparation of **labels** and **material safety data sheets (MSDS)** to convey the hazard information to their customers. All employers with hazardous chemicals in their workplace must have labels and MSDSs for their exposed workers and train them to handle the chemicals appropriately. The requirements do not apply to materials packaged for consumer use.

The MSDS should include precautions for normal use, handling, storage, disposal, and spill cleanup for each material. The hazards identified need to be reasonably foreseeable health and toxicity concerns arising from the product's use and the MSDS should not include recommendations for protective measures that are more strict than needed.

CONTENT

Chemical manufacturers and importers must obtain or develop a MSDS for each hazardous chemical they produce or import. Employers must also have a MSDS, in English, in the workplace for each hazardous chemical they use. OSHA's HCS specifies what a MSDS must contain:

1. The product name used on the label, and the chemical and common name(s) of ingredients which have been determined to be health hazards, and which comprise one per cent or more of the composition. Carcinogens shall be listed if the concentrations are 0.1 per cent or greater.
2. The chemical and common name(s) of all ingredients which have been determined to present a physical hazard when present in the mixture.
3. Relevant physical and chemical characteristics of the hazardous chemical (such as vapour pressure, flash point).
4. Relevant physical hazards, including the potential for fire, explosion, and reactivity.
5. Relevant health hazards, including signs and symptoms of exposure, and any medical conditions generally recognised as being aggravated by exposure to the chemical.
6. The primary route(s) of entry into the body.
7. The OSHA permissible exposure limit and **American Conference of Governmental Industrial Hygienists (ACIGH) Threshold Limit Value (TLV)**. Additional applicable exposure limits may be listed.
8. Whether the hazardous chemical is listed in the **National Toxicology Program (NTP)** Annual Report on Carcinogens (latest edition) or has been found to be a potential carcinogen.
9. Precautions for safe handling and use, including appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for clean-up of spills and leaks.
10. Appropriate control measures, such as engineering controls, work practices, or personal protective equipment.
11. Emergency and first aid procedures.
12. The date of preparation of the MSDS or the latest change to it, together with the name, address and telephone number of the chemical manufacturer, importer, employer or other responsible party preparing or distributing the MSDS, who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.
13. If no relevant information is found for any given category, it should be marked to indicate that no applicable information was found.
14. If significant new information becomes available regarding the hazards of a chemical, or ways to protect against the hazards, it must be added to the MSDS within three months.
15. A MSDS must be provided with the initial shipment of a hazardous chemical, and with the first shipment after a MSDS is updated.

APPENDIX 1

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STANDARDISATION

Since the HCS does not impose a specific format on MSDSs, the information varies widely in presentation and amount, which can range from two to eight or more pages. Some companies have transferred the information on vendor MSDSs into their own format, with the result that they then become the 'responsible party' for the content of the MSDS.

In an effort to improve completeness, accuracy, and consistency, the **Chemical Manufacturers Association (CMA)** developed a 16-part voluntary standard for MSDS preparation, which was published in 1993 as **ANSI Z400.1-1993, American National Standard for Hazardous Industrial Chemicals, Material Safety Data Sheets, Preparation**. Its sections can be summarised as follows:[5]

SECTION 1: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Names the material and relates the MSDS with the label and shipping documents. Must include a mailing address and telephone number for the manufacturer or distributor.

SECTION 2: COMPOSITION, INFORMATION ON INGREDIENTS

Identifies the hazardous components of the material. If non-hazardous ingredients are listed, they should be listed separately. Chemical Abstract Service (CAS) numbers should be included, as well as **OSHA Permissible Exposure Limits** and American Conference of Government Industrial Hygienists (ACGIH) TLVs. If the identity of any ingredient is claimed to be a trade secret, it should be indicated.

SECTION 3: HAZARDS IDENTIFICATION

Describes the material's appearance, odour, and health, physical, and environmental hazards that may be of concern for emergency response personnel.

SECTION 4: FIRST AID MEASURES

Should include emergency and first aid procedures in easy to understand language. Procedures for each potential route of exposure should be included. A 'Notes to Physicians' sub-section should be included if the information is available.

SECTION 5: FIRE-FIGHTING MEASURES

Should describe fire and explosive properties of the material, the extinguishing media to be used and fire-fighting instructions. It applies to anyone who may be in the area of the fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Information needed to prevent or minimise adverse effects on employees, neighbours, property, and the environment, including waterways. It is intended for emergency response personnel.

SECTION 7: HANDLING AND STORAGE

Provides guidelines for minimising any potential hazards from storing the material, information to minimise handling when appropriate, temperature, inert atmosphere, and conditions to avoid.

[5] **Source:** Reference Data Sheet on Material Safety Data Sheets by Richard Gullickson, CIH, May 1996. See **www.msdssearch.com/msdshistory.htm**

APPENDIX 1
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SECTION 8: EXPOSURE CONTROLS, PERSONAL PROTECTION

Discusses the degree of engineering control that may be needed when handling the material, and the personal protective equipment that should be used if there is a potential for exposure above the regulatory or suggested limits. Exposure guidelines should be included.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

These should be included to assist users to determine proper handling and storage. Appearance, odour, physical state (liquid, solid, gas), pH, vapour pressure and density, melting and freezing point, solubility, and specific gravity should be included. Additional properties may be included if they are useful.

SECTION 10: STABILITY AND REACTIVITY

Should describe conditions that may result in a potentially hazardous reaction, such as evolution of hazardous gases, production of heat, or other hazardous conditions.

SECTION 11: TOXICOLOGICAL INFORMATION

Should include any known information resulting from animal testing or human experience on the toxicity of the material, information on its potential for causing cancer and data for acute, sub-chronic, and chronic exposures, if available.

SECTION 12: ECOLOGICAL INFORMATION

Should list impacts to the environment that may occur if the material is released to the environment, or in evaluating waste treatment practices.

SECTION 13: DISPOSAL CONSIDERATIONS

Should provide guidance to environmental and other technical people responsible for waste management for the product.

SECTION 14: TRANSPORT INFORMATION

Information concerning classification for shipping the material. It should include **US Department of Transportation (DOT)** classifications, or an indication that it is not regulated. It may include information for shipment into other countries.

SECTION 15: REGULATORY INFORMATION

Should contain information regarding the regulatory status of the material. It should include OSHA and **EPA** regulations. It may also include other regulatory agencies, and state agencies, if appropriate.

SECTION 16: OTHER INFORMATION

For other material the preparer feels is pertinent, that should not be included in the other 15 sections, such as label information, hazard ratings, revision dates, and references to other related information.

APPENDIX 2 Hazardous materials sheet

NAME(S):

GENERIC NAME / TRADE NAME:

CHEMICAL NAME:

SUPPLIER:

COMPOSITION:

APPEARANCE AND ODOUR:

USAGE:

PHYSICAL PROPERTIES (at 20°C, 1,013 mbar):

Density (kg/m^3):		Vapour density (air = 1):	
Boiling point (°C):		Vapour pressure (mbar):	
Melting point (°C):		Kinematic viscosity (mm^2/s):	
Flashpoint (°C):		Solubility (kg/m^3):	
Auto-ignition temp. (°C):		Particle size (micron):	
Flammability limits (% v/v):		pH:	

IMPORTANT CHARACTERISTICS:

ACIGH Threshold Limit Value (TLV):

Incompatibilities:

OCCUPATIONAL EXPOSURE LIMIT:

OSHA permissible exposure limit:

SAFETY HAZARDS:

Fire:

Stability:

PRECAUTIONS:

Fire:

Stability:

FIRE-EXTINGUISHING AGENTS:

FIRE PRECAUTIONS:

APPENDIX 2
.../continued

HEALTH HAZARDS:
Inhalation:

Skin:

Eyes:

Ingestion:

FIRST AID:
Inhalation:

Skin:

Eyes:

Ingestion:

PERSONAL PROTECTION:

ENVIRONMENTAL HAZARDS:

PRECAUTIONS:

SPILLAGE MITIGATION (SEE ALSO PERSONAL PROTECTION):

DISPOSAL OPTIONS:
Preferred:

Acceptable:

NOTE: Disposal should be acceptable within requirements of operative legislation.

STORAGE:

PACKING AND LABELLING:

SUPPLEMENTARY INFORMATION:

na = data not available, **n/a** = not applicable, **ne** = not established

DATE OF ISSUE:

DATE REVISED:

APPENDIX 3 The 12 Persistent Organic Pollutants (POPs) listed under the Stockholm Convention[6]

1. Aldrin	A pesticide applied to soils to kill termites, grasshoppers, corn rootworm, and other insect pests.
2. Chlordane	Used extensively to control termites and as a broad-spectrum insecticide on a range of agricultural crops.
3. DDT	Perhaps the best known of the POPs, DDT was widely used during World War II to protect soldiers and civilians from malaria, typhus, and other diseases spread by insects. It continues to be applied against mosquitoes in several countries to control malaria.
4. Dieldrin	Used principally to control termites and textile pests, dieldrin has also been used to control insect-borne diseases and insects living in agricultural soils.
5. Dioxins	These chemicals are produced unintentionally due to incomplete combustion, as well as during the manufacture of certain pesticides and other chemicals. In addition, certain kinds of metal recycling and pulp and paper bleaching can release dioxins. Dioxins have also been found in automobile exhaust, tobacco smoke and wood and coal smoke.
6. Endrin	This insecticide is sprayed on the leaves of crops such as cotton and grains. It is also used to control mice, voles and other rodents.
7. Furans	These compounds are produced unintentionally from the same processes that release dioxins, and they are also found in commercial mixtures of PCBs.
8. Heptachlor	Primarily employed to kill soil insects and termites, heptachlor has also been used more widely to kill cotton insects, grasshoppers, other crop pests, and malaria-carrying mosquitoes.
9. Hexachlorobenzene (HCB)	HCB kills fungi that affect food crops. It is also released as a byproduct during the manufacture of certain chemicals and as a result of the processes that give rise to dioxins and furans.
10. Mirex	This insecticide is applied mainly to combat fire ants and other types of ants and termites. It has also been used as a fire retardant in plastics, rubber, and electrical goods.
11. Polychlorinated Biphenyls (PCBs)	These compounds are employed in industry as heat exchange fluids, in electric transformers and capacitors, and as additives in paint, carbonless copy paper, sealants and plastics.
12. Toxaphene	This insecticide, also called camphechlor, is applied to cotton, cereal grains, fruits, nuts, and vegetables. It has also been used to control ticks and mites in livestock.

[6] **Source:** The Stockholm Convention **www.pops.int/documents/pops/default.htm**

APPENDIX 4 Common ingredients in cleaning products and their impacts

This table provides a guide to some of the raw materials commonly found in cleaning products. The subject is complex and there will always be differences in scientific opinion. It is not possible to be definitive, particularly when it comes to certain chemical categories. Within each chemical family group there are numerous different environmental classifications and great variation in performance for each.

It should be noted that the classification of raw materials is not always the final classification of a finished product. For example, a raw material classified as harmful, when added to a formulation in a very small percentage (e.g. 0.2 per cent), would not make the final formulation harmful.

More detailed information on ingredients, functions and issues relating to professional cleaning products can be found in **Sustainable Cleaning – A guide for users of proffesional cleaning products** which is listed under Resources in **8.9.2**.

Substance	What it does	Examples	Impact on humans	Impact on environment
Abrasive	Insoluble materials that provide a mechanical action to the cleaning function	Calcium carbonate	Non-hazardous	
Acid	Used for the removal of mineral soils	Phosphoric acid, citric acid	Corrosive or irritant depending on substance	Non-hazardous
Alcohol	See solvent	Isopropanol	Irritant, highly flammable	Non-hazardous
Alkalis	Help to break down fats, oils, and other organic soils	Sodium hydroxide, sodium carbonate	Corrosive or irritant depending on substance	Non-hazardous
Bacteria	Micro-organisms for drain cleaning are responsible for resolving the fatty deposits and for building a protective film inside the drain system	Bacillus type micro-organisms	Non-hazardous	
Chlorine	Can be used either as bleaching agent or disinfectant/sanitiser. Chlorine helps to break down organic soils	Sodium hypochlorite	Corrosive	Hazardous
Enzyme	Complement the detergent activity by digesting certain soil types	Protease	Harmful	Non-hazardous
Perfume	Mask bad odours or provide a pleasant smell to the detergent	Natural (lemon, lavender, pine) Artificial (limonene, musks)	Non-hazardous	
Peroxygen	Can be used either as bleaching agent or disinfectant/sanitiser	Hydrogen peroxide	Corrosive, oxidising	Non-hazardous
Phosphate	Provides a source of moderate alkalinity and supports the cleaning process whilst tying up water hardness minerals	Sodium tripolyphosphate	Non-hazardous	
Quaternary Ammonium Compound (QAC)	The quaternaries are cationic surfactants with germicidal (disinfectant) properties	QAC	This is a family of substances and both hazardous and non-hazardous types exist	
Sequestering agents	Series of organic chemical compounds that have the ability to tie up water hardness and other metallic salts	NTA, polyacrylate	Can be harmful or non-hazardous depending on substance	Non-hazardous
Solubiliser	Improve the solubility of some constituents of cleaners and disinfectants in an aqueous solution	Sulfonates, glycols	Non-hazardous or irritant depending on the substance	Non-hazardous
Solvent	Used in detergent formulas to complement the cleaning efficiency	Isopropanol	Irritant, highly flammable	Non-hazardous
Surfactant	Reduces the surface tension of water so it can quickly wet a surface to enable dirt to be loosened and removed. Provide foaming and emulsification. Made from petrochemicals or oleochemicals	Anionic, cationic, non-ionic, amphoteric	Depends on which surfactant	Varies greatly

FIGURE 8.7
Common ingredients in cleaning products and their impacts

APPENDIX 5 Hazardous materials: terminology

B

BEI
Biological Exposure Indices covering more than 80 chemical substances.

BIO-ACCUMULATION
The ecological process through which chemical products accumulate throughout the food chain.

BIODEGRADATION
Biodegradable material is susceptible to degradation, usually by micro-organisms, leading to the release of heat, carbon dioxide, organic residues and methane. This term usually refers to surfactants and most commonly defines a level of biodegradability specified by legislation. This is a complex area but there are basically two forms: **primary biodegradability**, which deals with a first cleavage of the molecule and **ultimate biodegradability**, which involves complete breakdown into simple salts, water and oxygen.

C

CARCINOGENIC
A substance thought to cause cancer.

CONCENTRATE
A liquid product that contains less than 20 per cent water by weight.

CORROSIVE
Can destroy living tissues such as skin, eyes, the lungs and stomach. Oven cleaners, for example, may be corrosive.

COSHH
The Control of Substances Hazardous to Health Regulations 2002 which require employers to control exposure to hazardous substances to prevent ill health.

D

DIRTY DOZEN
Twelve of the most toxic chemical substances such as polychlorinated biphenyls (PCBs), outlawed under the Stockholm Convention.

F

FLAMMABLE
Can be easily ignited by sparks or flames. Of particular concern are liquids with low flashpoints e.g. solvents and fuels.

H

HARMFUL
A substance which if inhaled, ingested or penetrates the skin may incur limited health risks.

I

IRRITANT
A non-corrosive substance which can cause inflammation through immediate, prolonged or repeated contact with the skin or mucous membranes.

M

MONTREAL PROTOCOL
International agreement to which nearly all countries in the world are signatories. Covers the phase-out of ozone depleting substances (ODS) such as halons and certain refrigerants that damage the earth's protective ozone layer.
SEE SECTION 5

MSDS
Under an internationally established system, all manufacturers of chemical products have to provide materials safety data sheets (MSDS). Issued by the manufacturer or supplier they contain comprehensive technical information on storage, handling, use and disposal of the product.

O

OLEOCHEMICALS
Derived from fats and oils from plants or animals.

OXIDISING
Destroys organic matter by breaking down the cell walls.

P

PETROCHEMICALS
Derived from crude oil or natural gas – often termed synthetic chemicals even though oil and gas are natural resources.

POISONOUS
Toxic to humans and/or hazardous during transportation.

S

STOCKHOLM CONVENTION
Global treaty ratified in May 2004 to protect human health and the environment from persistent organic pollutants.

SDS
Safety Data Sheets (see MSDS) the more common term for MSDS in Europe.

T

TLV
Threshold Limit Value for occupational exposure.

TOXIC/TOXICITY
Can cause physical or mental impairment or even death when inhaled, ingested or absorbed in very small, specified concentrations. Classified as either acute or chronic. Tests for **acute toxicity** (typically carried out on three different water-living organisms: fish, *Daphnia* and algae) reveal the diminished survival (lethal) effects, or sub-lethal physiological effects on reproduction, growth etc. The result is expressed as LC50, which means Lethal Concentration (mg/l) at which 50 per cent of the tested organisms died. The higher the figure the higher the toxicity. **Chronic toxicity** testing provides a more comprehensive understanding of the toxicity of the defined substance and encompasses assessments on the organism's entire life cycle to determine its long term effects.

V

VOCS
Volatile Organic Compounds. Typically emitted from fuels, solvent and aerosol cans, when released to atmosphere they contribute to the formation of photochemical smog which is believed to be a contributory factor in respiratory diseases.

APPENDIX 6 Pest control chemicals: checklist for staff

BEFORE APPLYING

1. What is the pest problem? ....
2. What are the best methods or products to control the pests? ....
3. What is the least toxic and the least persistent pesticide/herbicide available? ....
4. What health surveillance is in place for those mixing and applying pesticides/herbicides? ....
5. Quantity of pesticide to be used:

   Area: .... Department: ....
6. Protective clothing to be worn: ....

   NOTE: Do you know the symptoms of acute pesticide poisoning related to the chemicals that you are using? If you feel ill, even with a headache or cold-like symptoms, stop work.

DURING THE APPLICATION

7. Equipment being used: ....
8. Has all equipment been checked for the health and safety of the operator? ....
9. Are you using the best and safest equipment available? ....
10. Have you checked that sprayers are not too heavy to be lifted when full? ....
11. Is the correct protective clothing being worn? ....
12. Have you notified others and cordoned off the area? ....
13. Time control:

    Time: .... Duration: ....
14. How many persons are working in the spraying area? ....

    NOTES:
    - Never work alone when handling toxic pesticides.
    - Never eat, drink or smoke when applying or mixing pesticides.
    - Do not breathe in pesticide spray, dust or fumes.

AFTER APPLICATION

15. Have all unused pesticides/herbicides been returned to the store?

    Yes .... No .... Why not? ....
16. Have you ensured that no pest control chemicals are left in sprayers/other containers? ....
17. Have you disposed of the empty containers safely and according to the best possible practice laid down nationally/internationally? ....

    NOTE: All recommended protective clothing must be worn and replaced at regular intervals. Soap and water should be used to wash skin and clothing where necessary. Never use empty pesticide containers for the storage of food or water.

APPENDIX 7 Asbestos-containing materials in buildings

FIGURE 8.8
Asbestos-containing materials in buildings

Generic name	% asbestos content	Dates when used
SURFACING MATERIAL		
Sprayed or trowelled on	1–95	1935–1970
PRE-FORMED THERMAL INSULATING MATERIALS		
Batts, blocks, pipe covering:		
85% magnesia	15	1926–1949
Calcium silicate	6–8	1949–1971
TEXTILES (CLOTH)		
blankets (fire)	100	from 1910
felts	90–95	from 1920
blue stripe	80	from 1920
red stripe	90	from 1920
green stripe	95	from 1920
Sheets	50–95	from 1920
Cord/rope/yarn	80–100	from 1920
Tubing	80–85	from 1920
Tape/strip	90	from 1920
Curtains (theatre safety; welding)	60–65	from 1945
CEMENTITIOUS CONCRETE-LIKE PRODUCTS		
Extrusion panels	8	1965–1977
corrugated	20–45	from 1930
flat	40–50	from 1930
flexible	30–50	from 1930
flexible perforated	30–50	from 1930
laminated (outer surface) roof tiles	20–30	from 1930
Clapboard and shingles		
clapboard	12–15	1944–1945
siding shingles	12–14	?–onwards
roofing shingles	20–32	?–onwards
Pipe	15–20	from 1935
PAPER PRODUCTS		
High temperature	90	from 1935
Moderate temperature	35–70	from 1920
Indented	98	from 1935
Millboard	80–85	from 1925
ROOFING FELTS		
Smooth surface	10–15	from 1910
Mineral surface	10–15	from 1910
Shingles	1	from 1971
Pipeline	10	from 1920
ASBESTOS CONTAINING COMPOUNDS		
Caulking putties	30	from 1930
Adhesive (cold applied)	5–25	from 1945
Joint compound roofing asphalt	5	?–onwards
Mastics	5–25	from 1920
Asphalt tile cement	13–25	from 1959
Roof putty	10–25	?–onwards
Plasters/stucco	2–10	?–onwards
Spackles	3–5	1930–1975
Sealants, fire/water	50–55	from 1935
Cement, insulation	20–100	1900–1973
Cement, finishing	55	1920–1973
Cement, magnesia	15	1926–1950
FLOORING TILE AND SHEET GOODS		
Vinyl/asbestos tile	21	from 1950
Asbestos/asbestos tile	26–33	from 1920
Sheet goods/resilient	30	from 1950
WALL COVERING		
Vinyl wallpaper	6–8	?–onwards
PAINTS AND COATINGS		
Roof coating	4–7	from 1900
Air-tight	15	from 1940

Appendix 10 – Asbestos Bulk Sample Analysis Report

The Jolly Beach Resort/ Tranquility Bay Resort
Bulk Sample Analysis Report

May 2024

PREPARED BY:
Green Engineering

FOR
BCQS International

1.0 Project Description and Scope ____ 1
2.0 Methodology and Procedure ____ 1
3.0 Data Assessment ____ 2
4.0 Recommendations: Asbestos Management Option ____ 4

Figure 1: Schematic of Resort Layout ____ 3

Table 1: Laboratory PLM Test Results ____ 3
Table 2: Condition Assessment ____ 4

Appendix A- PLM Laboratory Results

Appendix B- Laboratory Accreditation (EMSL)

Appendix C- Site Survey Records

Glossary

ACM	Asbestos containing material. It refers to materials that contain >1% asbestos
ASTM	American Society for Testing & Materials
CFR	Code of Federal Regulations (US)
OSHA	Occupational Safety and Health Administration (United States)
PACM	Presumed asbestos containing material
PLM	Polarized Light Microscopy
USEPA	United States Environmental Protection Agency

1.0 Project Description and Scope

Green Engineering Limited (GE) was contracted by BCQS International (BCQS) to conduct presumptive asbestos sampling and analysis at the Jolly Beach Resort / Tranquility Bay Resort located in Jolly Beach, Antigua.

The Jolly Beach Resort/ Tranquility Bay Resort has been identified for demolition therefore, this survey was meant to provide the necessary technical information regarding the presence of asbestos containing materials at the resort. An assessment of the physical condition of these materials also formed part of this activity.

The Scope of Works included the following:

- Bulk sample collection of all materials presumed to be ACM
- To conduct laboratory Polarized Light Microscopy (PLM) analysis on the bulk samples.
- Provide a report on the findings and include an objective assessment of any confirmed asbestos containing materials.

2.0 Methodology and Procedure

The on-site asbestos materials survey was conducted in accordance with the following asbestos standards:

- ASTM E2356 – Standard Practice for Comprehensive Building Asbestos Surveys
- OSHA Construction Industry Standard 29CFR 1926.1101

Laboratory PLM analysis was conducted by an accredited laboratory (EMSL Analytical Inc.). (See Appendix B for Laboratory Accreditation certificates).

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The test procedure was in accordance with USEPA's method 40CFR 763, Subpart F, Appendix EPA/600/R-93/116 and is described in the Construction Industry Standard 29CFR 1926.1101.

Throughout the sampling process:

- Any material that was presumed to be asbestos containing was inspected and sampled.
- The location of the presumed asbestos containing materials (PACM) was noted.
- The physical condition of the PACM materials was documented.

The investigation focused on the inspection of building materials that may be presumed to be asbestos containing throughout the resort, namely:

- Roof Sheeting
- Interior/ Exterior Ceiling Tiles
- Vinyl Floor Tiles and Mastic Cement
- Siding Panels/ Partitions
- HVAC Ducting Insulation
- Air Handler Rooms
- Other (surfacing) Materials
- Other Miscellaneous Construction Materials

3.0 Data Assessment

Based on the site inspection, six (6) bulk samples were taken and shipped to the laboratory for analysis and identification. (See Appendix A)
The results are provided in Table 1:

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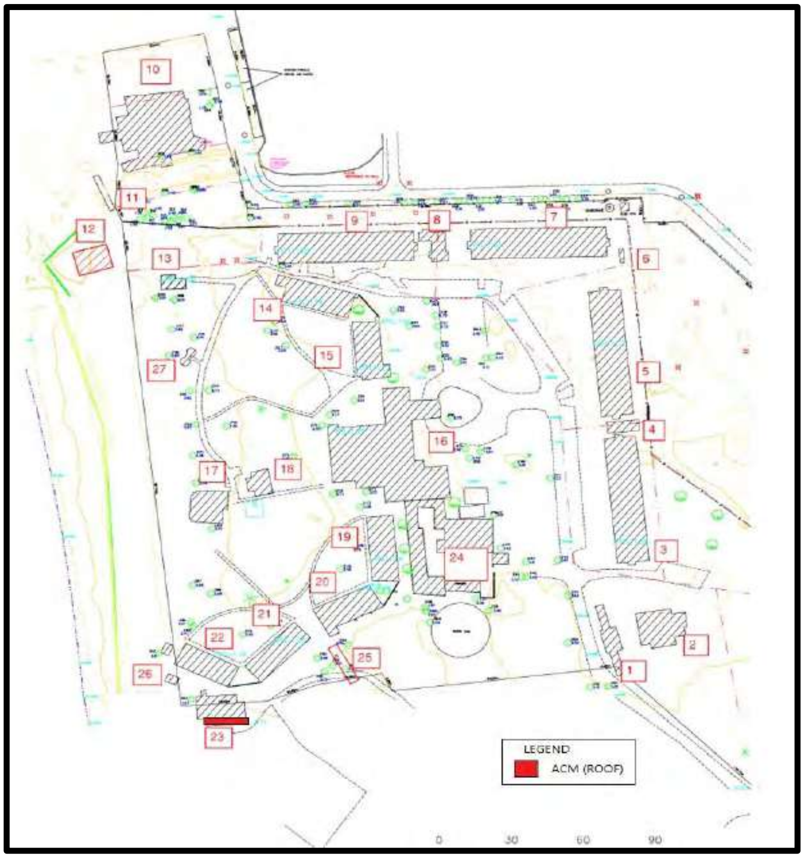
TABLE 1: LABORATORY PLM TEST RESULTS

Sample No.	Location	Description	% ACM	Non-Asbestos
GE NBA B23 R-01	Building 23-Spa	Roof	Chrysotile-20%	Non Fibrous Other-80%
GE NBA B22-R-02	Building 22-"St. Johns"	Roof	None detected	Non Fibrous Other-100%
GE NBA B16-C-06	Building 16-Maintenance	Ceiling Tile	None detected	Cellulose-20% Glass-40% Non Fibrous Other-40%
GE NBA B16-R-08	Building 16-Main Building	Felt	None detected	Synthetic-10% Non Fibrous Other-90%
GE NBA B16-C-10	Building 16-Main Building	Ceiling	None detected	Glass-97% Non Fibrous Other-3%
GE NBA B16 R-11	Building 16-Main Building	Roof	None detected	Glass-15% Non Fibrous Other-85%

Note: Any material containing more than one percent (1%) asbestos is classified as Asbestos Containing Material (ACM)

FIGURE 1: SCHEMATIC OF RESORT LAYOUT



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4.0 Recommendations: Asbestos Management Option

The recommended action to manage the asbestos containing roof material is outlined in Table 2.

TABLE 2: CONDITION ASSESSMENT

Sample No.	Location	Description	Category	Condition	Damage Distribution (%)	Hazard Rating	Action	Est. Area (sq ft)
GE NBA B23 R-01	Building 23-Spa	Roof	II Non Friable	Good	<1 (localized)	1	L, I, M	800

*Hazard Rating: **Good**-No damage (1-3); **Fair**-Some damage (4-6); **Poor**-Significant damage (7)*
*Action Codes: **L**-Label, **I**-Inspect, **M**-Maintain, **R**-Remove, **MG**-Make Good*

The roof of Building 23 (Spa) was confirmed to contain 20% chrysotile asbestos and is classified as a Category II Non-Friable asbestos containing material. For construction demolition purposes, this roof represents 800 sq ft of medium-wave, 3.5 ft x 8ft cemented asbestos sheets. The roof was generally well maintained with negligible localized damage.

The client has indicated that extensive renovation/ demolition works are to take place at the Jolly Beach/ Tranquillity Bay Resort, it is therefore recommended that BCQS International engage the services of a Certified Asbestos Abatement Contractor to conduct the necessary abatement action to minimize possible asbestos exposure risks to other contractors on site and to the general public during these works.
The Occupational Safety and Health Administration (OSHA) advises that abatement works must be conducted prior to any construction demolition activities.

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Appendix A-PLM Laboratory Results

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EMSL Analytical, Inc.
19501 NE 10th Ave. Bay A N. Miami Beach, FL 33179
Tel/Fax: (305) 650-0577 / (305) 650-0578
http://www.EMSL.com / miamilab@emsl.com

EMSL Order: 172402541
Customer ID: GRNE42
Customer PO:
Project ID:

Attention: Admin
Green Engineering
29 Cascade Main Road
Cascade,

Phone: (868) 624-1132
Fax:
Received Date: 06/11/2024 11:50 AM
Analysis Date: 06/11/2024
Collected Date: 06/04/2024

Project: Nikki Beach Project in Antigua

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
GE-NBA-B23 R-01 *172402541-0001*	Roof	Brown Fibrous Heterogeneous		80% Non-fibrous (Other)	**20% Chrysotile**
GE-NBA-B22 R-02 *172402541-0002*	Roof	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
GE-NBA-B16 C-06 *172402541-0003*	Ceiling	Brown/White Fibrous Heterogeneous	20% Cellulose 40% Glass	40% Non-fibrous (Other)	None Detected
GE-NBA-B16 R-08 *172402541-0004*	Roof Felt	Black Non-Fibrous Homogeneous	10% Synthetic	90% Non-fibrous (Other)	None Detected
GE-NBA-B16 C-10 *172402541-0005*	Ceiling	White/Yellow Fibrous Heterogeneous	97% Glass	3% Non-fibrous (Other)	None Detected
GE-NBA-B16 R-11 *172402541-0006*	Roof	Red/Black Fibrous Heterogeneous	15% Glass	85% Non-fibrous (Other)	None Detected

Analyst(s)
Kim Wallace (6)

Kimberly A. Wallace

Kimberly Wallace, Laboratory Manager
or Other Approved Signatory

Initial report from: 06/12/2024 06:56:35

Appendix B- Laboratory Accreditation (EMSL)

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United States Department of Commerce
National Institute of Standards and Technology

Certificate of Accreditation to ISO/IEC 17025:2017

NVLAP LAB CODE: 200204-0

EMSL Analytical, Inc.

N. Miami Beach, FL

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2024-04-01 through 2025-03-31

Effective Dates

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

For the National Voluntary Laboratory Accreditation Program

National Voluntary
Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

EMSL Analytical, Inc.
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19501 N.E. 10th Ave., Bay A
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Email: kwallace@emsl.com
http://www.emsl.com

ASBESTOS FIBER ANALYSIS — NVLAP LAB CODE 200204-0

Bulk Asbestos Analysis

Code	Description
18/A01	EPA -- 40 CFR Appendix E to Subpart E of Part 763, Interim Method of the Determination of Asbestos in Bulk Insulation Samples
18/A03	EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

Airborne Asbestos Analysis

Code	Description
18/A02	U.S. EPA's "Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Nonmandatory-and Mandatory Section to Determine Completion of Response Actions" as found in 4(CFR, Part 763, Subpart E, Appendix A.

For the National Voluntary Laboratory Accreditation Program

Appendix C- Site Survey Records

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Site Survey Record Antigua, June 2024

Sample Title – GE- Green Engineering NBA – Nikki Building Antigua, B# - Building Number, Material and Sample No.

Date	Functional Area; Building No.	Location	Sample ID	Description	Dimension	Remarks
4/6	23 Spa	Roof	GE NBA B23 R-01.	Red and Grey Roof	800 sq ft	To Analyse
4/6	22 St Johns	Roof	GE NBA B22 R-02	Red Roof Roof on Wooden Frame, Wooden Ceiling	Extensive	To Analyse
4/6	16 Maintenance	Ceiling Tiles	GE NBA B16 C-06	White Material 12x12ins Ceiling Tiles Galvanize Roof	Medium	To Analyse
4/6	16 Main Building	Roof	GE NBA B16 R-08	Black Felt Underly Roofing	Extensive	To Analyse
4/6	16 Main Building	Ceiling	GE NBA B16 C-10	Ceiling Tiles 24x24in Tiles	Extensive	To Analyse
4/6	16 Main Building	Roof	GE NBA B16 R-11	Roofing Material	Extensive	To Analyse

. .