REPORT
ENVIRONMENTAL IMPACT ASSESSMENT FOR SANDALS MONTEGO BAY (OVERWATER BUNGALOWS & VILLAS)

PREPARED FOR:

Sandals

Prepared by:

TEM network TECHNOLOGICAL & ENVIRONMENTAL MANAGEMENT NETWORK LIMITED & esl environmental SOLUTIONS

190 Mountain View Avenue
Kingston 6,
Jamaica W.I.

7 Hillview Ave
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March 18, 2025

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ABBREVIATIONS AND ACRONYMS

TERM/ABBREVIATION	DEFINITION
UTM	Universal Transverse Mercator - System of Coordinates
% Sat	Per cent dissolved oxygen saturation
$\mu g/m^3$	Micrograms per cubic meter
AESTHETICS	Concern with beauty or the appreciation of beauty
AGRRA	Atlantic and Gulf Rapid Reef Assessment protocol to document benthic substrate composition
ANTHROPOGENIC STRESSORS	Resulting from the influence of human beings on nature
AVIFAUNA	Bird Life
A-weighting	The 'common' name for frequency-weighted sound levels, measured over the 'A' frequency range which corresponds to the human hearing range (20 Hz up to 20,000 Hz).
Bn (bn)	Billion
BOD	Biological oxygen demand
CCA	Crustose coralline algae
DAFOR	The DAFOR scale is used for semi-quantitative sampling, to provide a quick estimate of the relative abundance of species (generally plants) in a given area. The letters of DAFOR stand respectively for Dominant, Abundant, Frequent, Occasional and Rare
DEMOGRAPHIC	Relating to the structure of population
DO	Dissolved oxygen
DOWNSPOUT	A vertical pipe used to drain rainwater from a roof
ECOSYSTEM	A biological community and their physical environment
EHU	Environmental Health Unit
ENDEMIC	Native and restricted to a certain place
ES	Environmental Score (from RIAM)
ESSJ	Economic and Social Survey Jamaica
FAUNA	All animals of a particular area
FLORA	Plant life occurring in a particular region
ft^2	Square Foot
GDP	Gross Domestic Product (Broad measure of a nation's overall activity)
GFDRR	World Bank's Global Facility for Disaster Reduction and Recovery
Greywater	Wastewater from baths, sinks, washing machine and kitchen
Hardstanding	Ground surface with hard material
Impact Zone	Geographical area that will be affected by a proposed or actual action

Invasive Species	A species that is not native to a specific location and has a tendency to spread to a degree that can damage the environment, economy or human health
IPCC	United Nations (UN) Intergovernmental Panel on Climate Change (IPCC)
IUCN Red List	International Union for Conservation of Nature and Natural Resources, Red List of Threatened Species
JNHT	Jamaica National Heritage Trust
LA90	LA90: A-weighted, sound level just exceeded for 90% of the measurement period and calculated by statistical analysis.
LAeq	LAeq - equivalent continuous sound level is the sound level in decibels, having the same total sound energy as the fluctuating level measured; also known as the time-average sound level (LAT).
LAmax	The highest value measured by the sound level meter over a given period of time
LVIA	Landscape and Visual Impact Assessment
LVIA	Landscape and Visual Impact Assessment
m2	Square Meter
MBMP	Montego Bay Marine Park
MEA	Millennium Ecosystem Assessment framework
Mg C	Megagramme or a tonne of Carbon
Mitigation	Action to reduce severity
MOAF	Ministry of Agriculture and Fisheries
MPN	The most probable number (MPN) is a method used to estimate the viable numbers of bacteria per volume in a given sample
NASA	National Aeronautics and Space Administration
NEPA	National Environment & Planning Agency
NO3N	Nitrate as nitrogen
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No observed adverse effect level - The greatest concentration or amount of a substance at which no detectable adverse effects occur in an exposed population.
NPV	Net Present Value
NRCA	Natural Resource Conservation Authority
NTU	Nephelometric or Normal turbid units
o-PO4P	Reactive phosphate as phosphorous
PAR	Photosynthetically active radiation
Peak	The maximum value reached by the sound pressure. This is the true Peak of the sound pressure wave.
PIOJ	Planning Institute of Jamaica
ppt	Parts per thousand - units commonly used to express salinity level
Putrescible Solid Waste	Solid Waste which contains organic matter which can be broken down by micro-organism
RDT	Roving Diver Technique

RIAM	Rapid Impact Assessment Matrix
RV	Range Value (from RIAM)
SCC	Social Cost of Carbon - a concept that reflects the marginal external costs of emissions: it represents the monetised damage caused by each additional unit of carbon dioxide, or the carbon equivalent of another greenhouse gas, emitted into the atmosphere.
SCC	Social Cost of Carbon
SCTLD	Stony Coral Tissue Loss Disease
SMAP	The Soil Moisture Active Passive (SMAP) satellite maps global soil moisture and detects whether soils are frozen or thawed. This mission helps reduce uncertainties in predicting weather and climate; and enhances our ability to monitor and predict natural hazards such as floods and droughts.
SMB	Sandals Montego Bay
SRC	Scientific Research Council
STATIN	Statistical Institute
tC	Tonne of carbon
tCO2	Tonne of carbon dioxide
TEM Network	Technological & Environmental Management Network
Terrestrial	Relating to the earth/land
TUR (NTU)	Turbidity as normal turbidity units
USACE	U.S. Army Corps of Engineers
WRA	Water Resources Authority

1 EXECUTIVE SUMMARY

1.1 Background

This Environmental Impact Assessment (EIA) addresses the development proposed by Sandals Resorts International (SRI) which includes construction of 18 overwater bungalows, pylons, a supporting boardwalk carrying utility pipes, 10 villa style suites, wetland conversion and coastal modification.

The study area for the EIA is an arc extending 1 km south, east and west of the proposed site and adjacent coastal areas. This study area is considered sufficient to capture the various land uses and existing key coastal resources.

The EIA included a literature review and fieldwork to establish baseline conditions and identify potential impacts (positive and negative) that might be associated with the project.

1.2 Legislation and Regulatory Considerations

There are 13 legal instruments, 4 Policy Initiatives and 5 International Conventions relevant to this project.

The Natural Resources Conservation Authority (NRCA) Act 1991 is the primary legislation providing the regulatory framework for activities affecting the environment. The NRCA Act is executed by the National Environment and Planning Agency (NEPA).

Other Legal instruments include the Town and Country Planning Act, Town and Country Planning (St. James Parish) Provisional Development Order 2018, National Solid Waste Management Act 2001 and the Parish Councils Building Act 2016.

Policy Initiatives of particular relevance include the Protected Areas System Master Plan, Policy on Sea Grass Beds, the Wetlands Policy and National Policy & Guidelines on Overwater Structures.

1.3 Scope and Project Description

To allow for the assessment of the cumulative impacts of the overall development, the scope of the EIA covers all aspects of the proposed development including:

- Proposed accommodation construction and amenities (18 overwater bungalows, 10 villa style units as well as associated parking areas for guest and staff)
- Proposed wetland modification to facilitate hotel construction and parking areas
- Proposed coastal modification works
- Ancillary facilities and activities to be undertaken as part of the above listed works

1.3.1 History and Background of the Project

Sandals' first overwater bungalows were constructed in late 2016, representing the Caribbean's first such offering to compete with similar facilities in the French Polynesia. Since then, Sandals has constructed more overwater bungalows at its facilities located at Sandals South Coast Jamaica, Sandals Grande St. Lucian and Sandals St. Vincent. Montego Bay would represent the 6th location of Sandals Overwater bungalows in the Caribbean and 3rd in Jamaica.

1.3.2 Site characteristics

The Sandals Montego Bay resort is located on the headland just to the east of the Montego Bay harbour in proximity to the MBJ Sangster International Airport.

The shoreline is protected by a shallow reef crest about 300 to 500 m seaward. The reef crest is relatively shallow (0.5 m to 1.0 m deep) with considerable alongshore variations in terms of continuity and depth.

The proposed development is expected to take place on the eastern border of the Sandals Montego Bay resort site and an adjoining wetland to the east, an area of approximately 2Ha being part of parcel registered to the Airport Authority of Jamaica.

FIGURE 1-1: SHORELINE OF STUDY AREA PROTECTED BY EXISTING REEF CREST

1.4 Master Plan

The services of Sandals Montego Bay will be augmented by the construction of 18 overwater bungalows along the eastern border of the existing development and 10 villa style units to the east of the overwater bungalows. Additionally, the area designated for the villa style units will also accommodate a parking area for staff which will be constructed first due to recent developments, including an increasing spate of car thefts. Currently staff parking is situated along the roadside making the new facility a priority. The salient features of the project description include:

- Access: The project site will be accessed using lands east of SMB which will also be utilised as the storage/staging area for the proposed overwater bungalows.
- Site Drainage: There are no rivers or gullies on the site; however, there is a major drainage discharge outlet for surface water runoff approximately 320m east of the site boundary. This localised drainage takes authorised storm water runoff to the sea and is also tidally impacted, as noted by the presence of sluice gates controlling tidal flows.

- Expected Project Components and Alternative Materials: Construction of buildings over the ocean somewhat restricts the choices of materials. Components under consideration include Glass Reinforced Polymer (GRP), PVC, stainless steel, aluminum, thatch and clay tiles.
- Details of Infrastructure Development and Waste Generation: Temporary wastewater treatment facilities will be constructed for site workers while the development will connect to the existing treatment facilities.
- Waste Quantities During Construction: 4 waste skips per villa x 18 = 72 skips total = 72 x 20 yds. = 1440 Cu yd.
- Waste Quantities During Operation: 1 skip per month – 1 cu yd. per OWS + general waste = 18+4 cu yds. = 22 cu yds. Waste will be sent through a compactor before being taken off property.

1.4.1 Provision of utilities

- The daily demand for potable water is estimated at 400 liters/room/day. The source of Potable Water is NWC which services the area.
- The source of electricity will be Jamaica Public Service Co.

1.4.2 Project Phasing

The construction of OWBs and villas is scheduled to start in late 2024 and will take approximately 18 months to complete.

1.5 Description of the Environment

1.5.1 Physical environment

1.5.1.1 Coastal Dynamics

Waves

As controlled by the trade wind, the ENE incident waves are by far the most dominant, occurring at 60.8% of the time with an average significant wave height of 0.32 m and average peak wave period of 5.26 s.

The second most frequent incident waves are from the NE direction, at 17.6% of the time, also controlled by the easterly trade wind.

The third most frequent incident waves are from NNE, occurring at 5.7%, with an average significant wave height of 0.52 m with a peak wave period of 4.51 s.

The fourth most frequent incident waves are from the north, occurring at 5.6%, with an average significant wave height of 0.55 m with a peak wave period of 4.64

The most energetic waves come from the NNW direction, with the average significant wave height of 0.65 m and average peak wave period of 4.87 s.

The NNW wave occurs 3.64% of the time but although the frequency of occurrence is not high, it is still very significant. The storm waves from NNW are very energetic due to the much longer wind fetch from the Cuba landmass with the average of the top 2% and top 1% highest waves being the most energetic for the greater study area, at 2.17 m and 2.28 m, respectively with average peak wave period of 6.79 s and 6.87 s, respectively

The easterly approaching waves, including ENE, NE and NNE waves, occur 84.1% of the time, being driven by the trade winds. Energetic wave conditions are apparently influenced by the northerly winds associated with passages of winter cold fronts, and therefore approach from a northerly direction.

Sediment Transport

Based on different beach characteristics, the entire shoreline can be divided into three sections (**Figure 1-2**). The eastern section (Section 1), the middle section (Section 2), spanning between the eighth and tenth groynes (from the east), and the western section (Section 3).

The erosive nature of Section 1 shoreline corresponds with the relatively higher wave along this section under the dominant ENE and NE incident wave conditions. Section 3 benefits from the westward longshore sand transport and the protection from the reef crest, resulting in a relatively wide beach. Longshore transport is confined by the groynes. However, based on the westward increasing trend of beach width, the pre-2017 groynes allowed some of the westward longshore sand transport to move through. This was likely the reason that the groyne field was reinforced in 2017-2018.

FIGURE 1-2: BEACH CHARACTERISTICS AND SECTIONS ALONG THE SANDALS MONTEGO BAY SHORELINE

The beach conditions after 2017 were largely controlled by the engineering solutions. The third and fifth groynes from the east were removed and the remaining groynes were reinforced with T-heads and Y-heads. The original fifth groyne was replaced by a short, detached breakwater. The removal of the groynes resulted in longer sections of beach between the groynes. In addition, the beach between the groynes was nourished concurrently with the groyne improvement. The artificial beach appears to be quite stable since 2018 based on the time-series aerial photos from Google Earth. The beach to the west of the groyne field remains stable, as compared to the state before the groyne improvement. The westward longshore sand transport discussed above is largely interrupted by the groyne field. The beach to the west of the groyne field appears to be in a state of equilibrium before and after the groyne improvement, as indicated by the rather stable shoreline.

Modeling of Nearshore Wave and Flow Conditions

A nearshore reef with a crest of 0.5 to 1 m below mean sea level extends along the study area. This reef crest is 300 to 500 m seaward of the Sandals Montego Bay shoreline. The shallow water over the reef crest induces significant wave breaking, particularly under energetic storm conditions, and subsequently reduces wave height substantially landward of the reef. The reef crest is not continuous, with several gaps existing within the reef system. Due to the configuration of the reef crest, a relatively large amount of wave energy propagates through the gaps, particularly during storm conditions.

Modeled Wave Field under Existing Condition

As expected, the reef crest has significant influence on the wave propagation. Wave-height reduction and wave refraction occur at the reef crest. Under average wave condition, the wave height reduced from 0.55 m seaward of the reef crest to typically 0.4 to 0.5 m landward. Under storm wave condition, the incident wave height is significantly reduced by the reef crest from generally 1.6 m seaward to 0.4 to 0.6 m landward. The percentage wave energy reduction by the reef crest under storm condition is much greater than that under average wave condition.

Modeled Wave Field with a 0.7 m Surge

A storm surge would increase the water depth over the reef crest and subsequently weaken its ability to dissipate incident wave energy. Similar to the mean sea level case, the eastern portion of the resort tends to have lower waves than those in the western portion. This is related to better protection by the reef. In summary, the wave modeling results suggest that the proposed overwater bungalow locations in the eastern portion of the resort have lower waves than the potential bungalow locations to the west.

Simulated Wave Field under Modified Condition at Mean Sea Level

Based on the modelling, the pilings are expected to have minimal influence on the overall nearshore wave field. Given the very small size of the pilings relative to the project site, minimal and highly localised influence is expected.

Sediment Plume Dispersal Modeling for the Construction Phase

A very energetic winter storm impacted the Sandals Montego Bay Resort on February 6, 2024. Widespread beach erosion and infrastructure damage were caused by this rather rare storm. Damage along the sandy beach was observed during the field investigation on February 11, 2024.

Despite the protection offered by the reef crest, some wave energy reached the shoreline and induced suspension of bottom sediment. However, sediment suspension at the proposed overwater bungalows site was considerably less significant.

Widespread damage to the wood deck was observed at several of the piers. The elevation of the deck to the water level was measured during the field investigation. Little to no damage was observed at decks that are more than 1.5 m above sea level. On the other hand, widespread damage was observed at decks that are lower than 1.5 m above sea level, with the degree of damage increasing with lower elevation.

Based on analysis of plume suspension and dispersion, the following measures are recommended to control potential plume dispersion:

1) During the overwater unit construction, particular operations that may induce suspension of bottom sediments such as installation of pilings, should be conducted under calm conditions when the wind-driven current is much weaker than the velocity predicted for energetic conditions. This would significantly reduce the dispersion of suspended sediments.
2) At sites with high mud content in the bottom sediment, plume barriers should be used to limit the dispersion of the suspended sediment. If feasible, plume barriers should be applied for the entire area.
3) Since the current tends to be directed to the west as driven by the easterly trade wind, the plume barriers should be deployed to the west of the construction operations.

Overall, the suspended sediments, even the mud-sized ones that may be induced by the construction operations would remain in the water column for less than one hour even under worst case scenarios. Its impact to the reef system, which is located over 200 m seaward, should not be significant.

1.5.1.2 *Water Quality*

Baseline water quality was evaluated by a combination of field and laboratory analyses to determine the following parameters:

- Turbidity (NTU)
- Dissolved Oxygen (mg/l)
- pH
- Temperature (°C)
- TDS (mg/l)
- Salinity (ppt)
- Conductivity (µS/cm)
- Nutrients (Nitrates and Phosphates) (mg/l)
- Faecal Coliform (MPN/100ml)
- Biological Oxygen Demand (BOD) (mg/l)
- TSS (mg/l)

Wet Season

Phosphate-P averaged 0.003mg/l at all sites. The range was 0.002mgl to 0.005mg/l. The highest average was determined for the background station outside the reef (SMB1) and just west of the easternmost site (SMB4). These levels compare to the NEPA interim standard of 0.003mg/l.

Biological Oxygen Demand (BOD) averaged 1.21mg/l at all sites with a range of 0.72mg/l to 1.79m/l. BOD was highest at the background site and lowest at the easternmost site within the footprint of the proposed overwater bungalows (SMB5). BOD exceeded the NEPA interim standard at the background site, as well as at the site just west of the easternmost site (SMB3). At the other sites, BOD was within the interim standard.

Dissolved Oxygen (DO) averaged 5.0mg/l at all sites with a range of 4.4mg/l to 5.9mg/l. With the exception of the background site, all sites were near or slightly less than the (U.S. EPA, 1986) standard. Considering that these levels are daytime levels it is likely that levels could fall below the standard during nocturnal hours when photosynthetic oxygen is absent.

Faecal Coliform (FC) averaged 2 MPN/100ml at all sites with a range of >2 to 4 MPN/100ml. The highest level was determined for the sample taken at the background site (SMB1). These levels were well within the standard.

pH was almost uniform ranging from 8.0 to 8.1, with an average of 8.0 across all sites.

Temperature (T°C) was in the narrow range of 30.40C° to 30.55±.06°C. These readings are slightly higher than the reference value quoted by the UWI Mona, Climate Studies Group (2017, 2022).

Total Suspended Solids (TSS) averaged 5mg/l with a range of 0.3mg/l to 11.7mg/l. TSS was lowest at the background site and highest at the site just west of the easternmost site (SMB4).

Turbidity levels averaged 7.8NTU with a range of 0.5NTU to 14.9NTU. These data yielded turbidity to TSS ratio of 1:1.6.

Salinity was in the narrow range of 34.2ppt to 34.3ppt. The higher levels were determined for the background site (SMB1) and the easternmost site (SMB5). The other sites within the proposed project footprint (SMB2, SMB3, SMB4) had a slightly lower salinity (34.2ppt).

Dry Season

Phosphate-P averaged 0.003mg/l at all sites. The range was 0.002mgl to 0.004mg/l. The easternmost site and the site westerly and adjacent (SMB5 and SMB4) had an average of 0.004, exceeding the NEPA interim standard of 0.003mg/l.

Biological Oxygen Demand (BOD) averaged 1.07mg/l at all sites with a range of 0.37mg/l to 1.60 mg/l. BOD exceeded the NEPA interim standard of 1.16 mg/L at the background site, east of the westernmost site (SMB3) and at the easternmost site (SMB5). At the other sites (SMB2 and SMB4), BOD was within the interim standard.

Dissolved oxygen (DO) averaged 6.5mg/l at all sites with a range of 6.0mg/l to 6.8mg/l. These values were all better than the US-EPA (1986) criterion value for marine waters.

Faecal coliform (FC) average was generally < 2 MPN/100ml at all sites. These levels were well within the WHO (2003) guideline for recreational water 2003 (< 40 MPN/100ml).

pH was almost uniform at all sites averaging 8.1 and being in the range 8.1 to 8.2.

Temperature (T°C) was in the narrow range 27.6°C (SMB1T) to 28.1°C (SMB5B). These levels are slightly higher than the reference value quoted by the UWI Mona, Climate Studies Group (2017, 2022).

Total Suspended Solids (TSS) averaged 4.7mg/l with a range of 3.3mg/l to 6.7mg/l. TSS was lowest at the background site and highest at the site just east of the westernmost site (SMB3).

Turbidity levels averaged 5.3NTU at the top of the water column and 4.4NTU at the bottom of the water column. Turbidity ranged from 2.7NTU to 9.3NTU. The lowest level measured at the background site (SMB1) and the highest level measured at the site just east of the westernmost site (SMB3). At the westernmost site (SMB2) turbidity was 6.0NTU and west of the easternmost site (SMB4T) turbidity was 2.7NTU at the surface and 3.0NTU at the bottom of the water column.

Salinity was in the narrow range of 35.8ppt to 36.4ppt. The higher levels were determined for the background site (SMB1). All the other sites (SMB2, SMB3, SMB4, SMB5) had a salinity of 35.9 ppt.

1.5.1.3 Noise Levels of undeveloped site and the ambient noise in the area of influence

FIGURE 1-3: NOISE MONITORING SITES

Noise levels were measured at two sites (**Figure 1-3**): Sandals Montego Bay just west of the site proposed for the construction of the overwater bungalows and another at the undeveloped site proposed for construction of the bungalows east of the present developed area.

Noise Level at Sandals Montego Bay - Just West of Site Proposed for Overwater Bungalows

The average noise level (Leq) measured over a 30-minute period commencing 13:56 on January 31, 2023, was 70.5dbA, which was above the standard for a commercial zone. The maximum noise level over the period was 95.6 dBA while the L90 or value measured 90% of the time (also referred to as the background noise level) was 55.9dBA. The Peak was 111.7dBC. The time history (**Figure 1-4**) shows noise levels associated with aircraft take offs between approximately 85dBA and 90dBA.

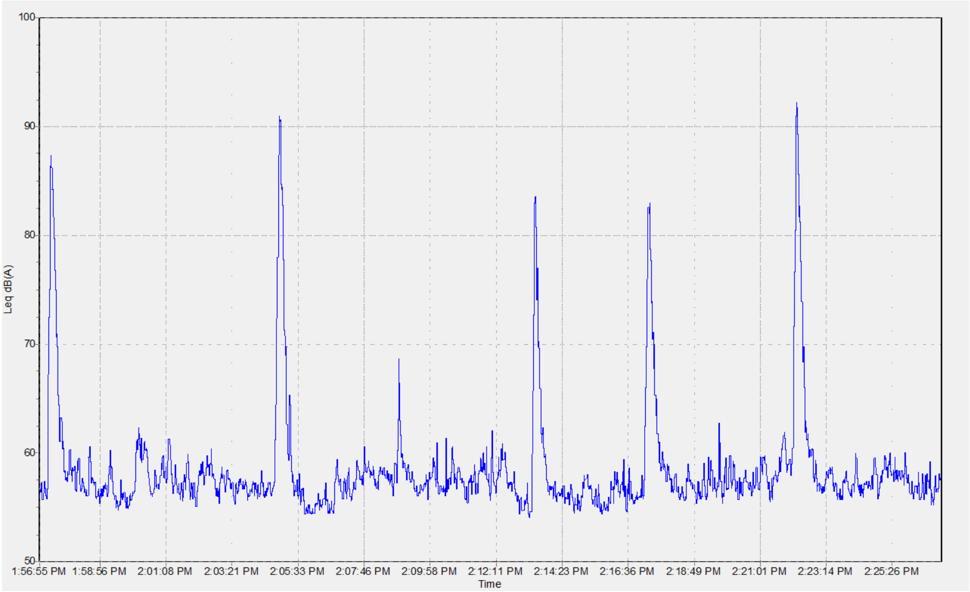

FIGURE 1-4: NOISE HISTORY – SHORT TERM MONITORING JANUARY 31, 2023

1.5.1.4 Sources of Existing Pollution

No obvious pollution sources were observed in the vicinity of the study area. There is a sewage treatment plant (STP) that serves the existing site, and is licenced as an oxidation ditch system with discharge to irrigation. This STP is to be decommissioned and the hotel connected to the Rose Hall sewage treatment plant. A major drainage discharge outlet for surface water runoff located approximately 320m east of the eastern site boundary takes storm water runoff to the sea. This is expected to seasonally affect turbidity levels in the study area.

1.5.1.5 Results of a Geotechnical Assessment for the site

The geotechnical investigation conducted at Sandals Overwater Bungalows, Montego Bay, St James includes a geological evaluation, subsurface soil description and classification, Standard Penetration Tests (SPT), soils laboratory and geotechnical analyses of the soils.

The type of foundation recommended is pile foundation with the pile tip embedded in the limestone bedrock. Driven or cast-in-place piles can be considered, however, the preferred option is for **cast-in-place piles**, given that there is likely to be weakening of the rock wall around the pile during the driving process which would reduce frictional resistance in the rock. It is important that the drilling process for the construction of the piles will create minimal disturbance of the rock around the tip of the pile.

Given that the pile will largely depend on end bearing resistance into the bedrock and that the bungalows are designed to be lightly loaded structures, it is expected that settlement will be kept within the tolerable limit of 25mm, based on the working load to be determined by the structural engineer.

It is the opinion of the geotechnical engineer that the Sandals site in Montego Bay, St James, can be used for construction of the proposed overwater bungalows.

1.5.2 Biological Environment

1.5.2.1 Marine Survey

The survey focused on the shoreline ecosystem along the Sandals Montego Bay (SMB) property (**Figure 1-5**). The study examined the spatial extent and condition of the seagrass beds and the presence/absence of endemic, protected, ecologically and commercially important species of flora and fauna in and immediately adjacent to the proposed project site.

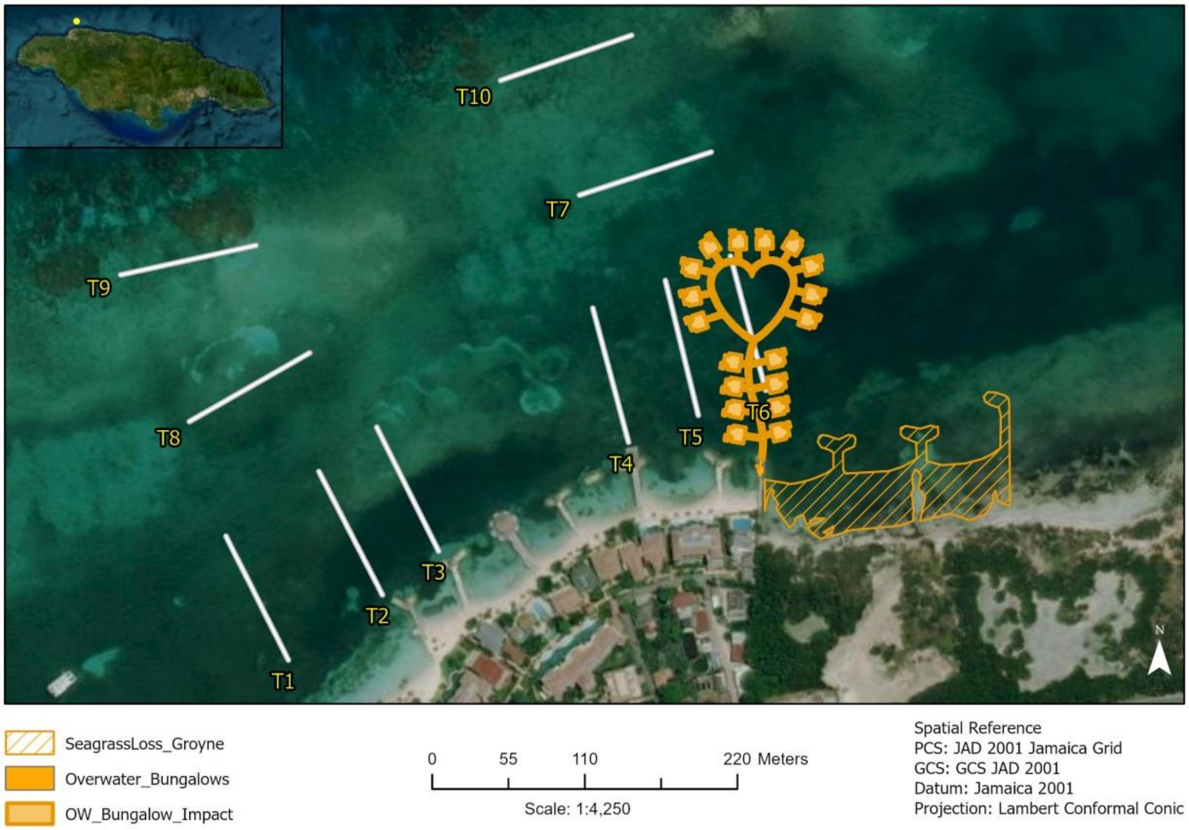

FIGURE 1-5: LOCATION OF THE BENTHIC SURVEYS AT THE SANDALS MONTEGO BAY LOCATION

Seagrasses

Transects conducted in the backreef area (T1-T8) revealed dense *Thallasia testudinum* meadows interspersed with macroalgae, including green algal species such as *Halimeda, Penicillus*, and *Udotea* and brown algae (*Sargassum, Dictyota, Padina*, spp.), typically found growing between seagrass shoots.

Seagrass cover ranges from ~100% inshore and tapers off to 38% near the crest (T10). On average, 86% of the seagrass cover is attributed to *T. testudinum,* and 14% to the variable distribution of *S. filiforme* (**Figure 1-6**).

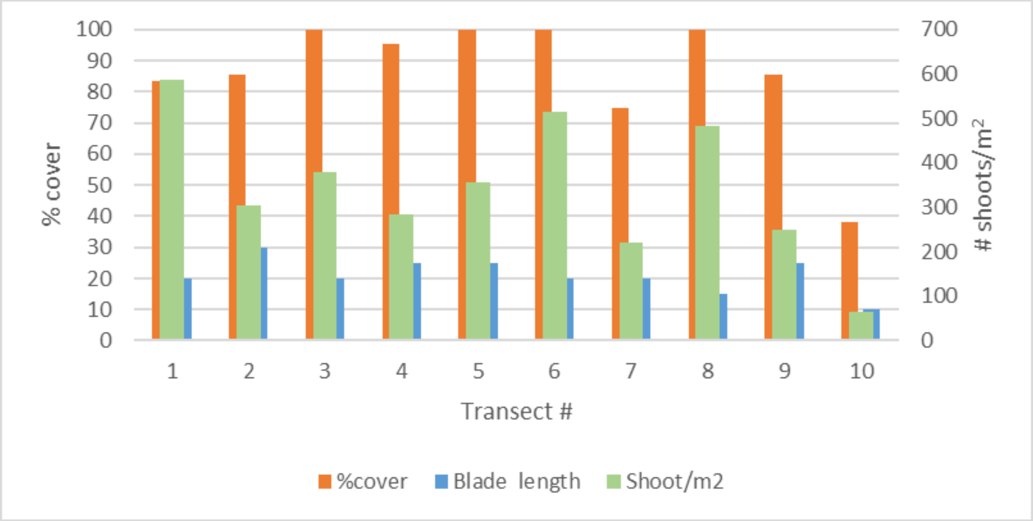

FIGURE 1-6: SHOOT DENSITY AND % COVER AND DISTRIBUTION OF SEAGRASS FOUND ALONG THE TEN 100M TRANSECTS SURVEYED AT THE PROJECT SITE. (T TES=*THALASSIA TESTUDINUM*; S FIL= *SYRINGODIUM FILIFORME*).

Thalassia shoot densities range from 66 shoots/m^2 to 587 shoots/m^2, with grass blade lengths varying from 10-30 cm. The shoot density, condition, and blade lengths indicate a healthy and mature seagrass habitat.

Macroinvertebrates

No turtle nests were observed during the field surveys or reported by security personnel interviewed. However, the use of north coast beaches by sea turtles, especially the critically endangered hawksbill is well documented.

The most frequently encountered fauna in the seagrass beds at the study site included the Variegated Sea Urchin (*Lytechinus variegatus*), West Indian Sea Egg (*Tripneustes ventricosus*), as well as the Long-spined Sea Urchin (*Diadema antillarum*), the occasional Cushion Sea Star (*Oreaster reticulatus)* and queen conch (*Aliger gigas*).

Fishes

Thirty-one (31) fish species were observed during transect and roving surveys twelve (12) of which were observed in the seagrass meadows. By contrast, all 31 fish species were observed during the transect and roving surveys on the reef crest and surrounding areas. The fish were primarily juveniles, ranging from 5-15 cm in length. Parrotfish (Scaridae) and members of the wrasse family were the most abundant of these.

Reef crest

A total of fifteen coral species were recorded on the reef crest. The most prevalent coral species on the reef crest include *Siderastrea siderea*, *Siderastrea radians*, *Orbicella annularis, Orbicella faveolata, Pseudodiploria strigosa, and Pseudodiploria clivosa. Orbicella annularis and faveolata* are listed as "Endangered" on the IUCN Red List of Threatened Species. *Manicina areolata colonies were frequently observed in the seagrass meadows.*

The coral colonies are predominantly healthy, although some vulnerable species show signs of infection by the Stony Coral Tissue Loss Disease (SCTLD) that has affected coral tracts throughout the Caribbean.

1.5.2.2 *Terrestrial Survey*

Flora

The species observed were mostly native. No endemic species were documented. Native flora represents approximately 75 percent of the species with exotics representing the remaining 25 percent. There were no species observed that were listed as vulnerable, endangered, or critically endangered on the IUCN (2024).

The project area has 2 wetland areas: one degraded mangrove/salina area to the east; and another buttonwood dominant wetland toward the west, with no standing water but surrounding a concrete pond. Floral species found on the proposed development site include Woman's Tongue (*Albizia lebbeck*), Black Mangrove (*Avicennia germinans*) and Salt Wort (*Batis marina*).

Fauna

Sixty-three (63) species of birds were identified during the assessment. These species included: Resident-Non endemic (n=34), Introduced (n=4), Migrant (n=21) and Resident-endemic (n=3). The low number of endemic birds could be attributed to the low number of trees on the Sandal's property; not many of the endemics are found in coastal wetlands in Jamaica. In addition, the area is highly disturbed.

Twenty-one winter migrants (Warblers= 9, duck=1, Water thrush= 1, gulls=2, yellowlegs=2, sandpipers=3, heron=1 and other = 2) were identified in the study. The majority of the bird species were observed in the coastal forest adjacent to the property. Fewer bird species were observed in the built-up section of the property.

Only 1 bird species with special designated status by the IUCN (2024) was observed across the study area: White-crowned Pigeon (*Patagioenas leucocephala*), listed as near-threatened species. No wetland birds were observed nesting in the mangroves.

One amphibian, *Eleutherodactylus johnstonei,* was recorded on the property over the sample period. No amphibians of special conservation status were identified in the study.

Invertebrates encountered included 5 butterfly species from 3 families, and twenty arthropods. None of the species were endemic or of any special conservation status.

Eight bats were recorded across the study area, all native to Jamaica. Five (5) bat species identified were insectivores, one (1) piscivore (fish-eating bat), one (1) nectarivore and one (1) frugivore. None of the species recorded during the assessment have a special conservation status designation on the IUCN (2024).

1.5.3 Natural Hazards

Storm surge has been computed to vary from 1.8m to 2.4m and up to 3.1m at the Montego Bay Freeport. Storm surge impact due to hurricanes and the waves generated by the wind associated with hurricanes can affect exposed structures, such as overwater rooms.

Earthquakes in Jamaica are generally associated with the Plantain-Garden Fault in eastern Jamaica. Montego Bay has recorded structural damage from an earthquake in March 1957. It is recorded that a small shock was felt in Montego Bay that agitated vessels in October 1787.

Tsunami risk associated with any large magnitude earthquake, is considered to be low when compared to the Pacific. In the records, there are no reports of anyone being killed by a tsunami in Jamaica.

Hurricanes and associated hazards - Although hurricanes are commonly perceived as frequent occurrences in the region, Jamaica actually experiences a relatively low incidence of hurricanes, especially those of catastrophic intensity. Nevertheless, the island faces annual impacts from both hurricanes and tropical storms.

1.6 Socio-economic Environment and Public Participation

1.6.1 Socio-economic Environment

Montego Bay

The project site is located within the city of Montego Bay. According to the 2011 census data, the population within a 5km radius of the project site is 86,588 (STATIN, 2012). Approximately 6,889 of those persons can be found within a one-mile radius of the project site. Estimates for 2022 (assuming proportions remain constant) show approximately 88,587 persons within the 5-mile radius and 7,206 persons within a one-mile radius of the site.

The parish of St. James has one of the lowest poverty rates in Jamaica. The parish's poverty rate is 11.2%. The parish witnessed a 31.8% increase in its poverty rate in the 4-year period between 2008 and 2012.

The parish of St. James accounts for 5.2% (11,616) of registered farmers, and 4.6% (1,083) registered fisherfolk in 2015.

In 2021, Montego Bay, with 8,468 rooms, accounted for 40.2% of total room capacity in Jamaica. This represented a 46.5% increase from the 5,782 capacity in 2020, but a 11.6% decrease from 9,578 in 2019 (pre COVID-19 PHSM). Montego Bay's occupancy rate was 48.3% in 2021, which was 9.6% lower than 2020 rate (38.7%), and 20.6 % lower than pre COVID-19 PHSM, averaging 68.9% for the period 2018-2019. Approximately 32.2% of the total number of persons employed in Jamaica's accommodation/hotel sector work in Montego Bay.

Project Economy

The room capacity of the resort is 272. Sandals Resorts International (SRI) intends to expand and enhance this resort with:

- construction of eighteen (18) single-storey overwater bungalows;
- construction of ten (10) single storey villa-style units;
- beach improvements that will feature the construction of a sea wall, rock groynes, a rock revetment; and
- construction of boardwalks/linkways, a swimming pool, and a bar

The project will increase the room capacity of the resort to 290, representing 11% of Montego Bay's capacity. At a construction budget of US$9,000,000, this project will add 50 new permanent jobs to the industry after construction. Jobs created will include butlers, housekeepers, cooks, chef, landscaper, waiters, concierge representative and lifeguards.

Land Use/Zoning

The land use categories identified within 1km, 2km and the wider environs of Sandals Montego Resort were residential, resort, civil aviation, commercial, industrial, institutional, office, *inter alia*. The majority of land parcels within the select areas, 1 and 2 km from the subject site, were residential.

The project site and neighboring properties to the east and west (including the currently operating Sandals Montego Bay Resort) are zoned as 'Resort' according to the St. James Parish Development Order (2018). The properties to the south along Kent Avenue are zoned as 'Airport & Airport Related'.

Heritage & Cultural Resources

The Jamaica National Heritage Trust identified 23 designated National Heritage Sites within the Parish of St. James. Ten of these sites are located within a 5km radius of the Sandals Montego Bay property and project activities. Mona Geoinformatics identified an additional 34 sites categorised as "Historical Site and Important Location" within the city of Montego Bay.

1.6.2 Public Participation

Surveys were administered to community residents and business entities within this one-kilometre study area. Fisherfolk of the Whitehouse Fishing Beach were also surveyed as a unique stakeholder group. Respondents were from four main communities and resided, or worked in the Whitehouse, Flankers, Norwood and Providence Heights Communities.

Community

Ninety-eight percent (98.0%) of the community participants were aware of the Sandals Resorts International Company, while two percent (2.0%) stated that they did not know of the company by that name. As it pertained to whether respondents were aware of the proposal to construct the eighteen (18) single-storey overwater bungalows and ten villa style units, eighty percent (80.0%) of survey participants stated that they were not aware of the proposal, while 20.0% stated that they knew of the proposal.

Twenty-five percent (25.0%) of respondents confirmed that they had general concerns with the project as proposed, while 73.0% stated that they did not have any general concerns. Two percent (2.0%) of respondents expressed uncertainty.

Nineteen per cent (19.0%) of interviewees stated that they depended on the proposed location, while 81.0% stated that they did not depend on any of the areas. Of the 19.0% of respondents confirming dependence on the area, respondents stated they depended on the area for:

- Accessing the beach for recreation – (53.0%)
- Fishing – (47.0%)

Fifty-one 51.0% of respondents indicated that the proposed project would not impact their lives in any way, 21.0% stated that they were unsure how the project may impact their lives. Fourteen percent (14.0%) of respondents anticipated a positive impact while a similar 14.0% anticipated that their lives would be negatively impacted from the project.

Respondents anticipated greatest positive impact during construction on the following variables:

- Employment Opportunities – (56.0%)
- Businesses and Services nearby the project area - (25.0%)
- The Tourism Product – (21.0%)
- Residential Communities nearby the project area – (17.0%)

It was perceived by community respondents that the areas to realise the greatest negative impact during construction were:

- Fisherfolk – (44.0%)
- Marine Wildlife/Fish Population – (36.0%)
- Marine Water Quality – (28.0%)

Respondents anticipated some positive impact post-construction on the following variables:

- Employment Opportunities – (54.0%)

- The Tourism Product – (23.0%)
- Businesses and Services nearby the project area - (20.0%)
- Residential Communities nearby the project area – (10.0%)

Environmental and related variables are perceived to have negative impact by the largest proportion of respondents. These included:

- Fisherfolk – (56.0%)
- Marine Wildlife/Fish Population – (53.0%)
- Marine Water Quality – (40.0%)

Business

Eighty-four percent (84.0%) of business interviewees stated that they were not aware of the proposal, while 16.0% were aware.

Six percent (6.0%) of business respondents confirmed that they had general concerns with the project as proposed while 81.0% stated that they did not have any general concern. Thirteen percent (13.0%) of respondents expressed uncertainty. Of the 6.0% of business participants who indicated that they had concerns about the project, the following concerns were expressed:

- Loss of fishing area and livelihood of fisherfolk - 50.0%
- Loss of the fish population and associated habitat – 50.0%
- Loss of Mangroves – 50.0%

(*Percentages exceed 100% as some respondents expressed multiple concerns*)

Forty-six per cent (46.0%) indicated that the proposed project would not impact their business in any way, 16.0% stated that they were unsure how the project may impact their business. Nineteen percent (19.0%) of respondents anticipated a positive impact while a similar 19.0% anticipated that their business would be negatively impacted from the project.

Of the 19.0% of respondents indicating a positive impact on their business from the project, impacts anticipated included:

- Increased business opportunity – (67.0%)
- Employment opportunities – (33.0%)

For the 19.0% of interviewees who expected a negative impact on their business from the project, the following negative impacts were stated:

- Loss of income – (67.0%)
- Loss of fishing livelihood – (17.0%)
- Loss of recreational space – (17.0%)
- Unavailability of fish for purchase – 17.0%)

It should be noted that respondents anticipated some positive impact during construction on the following:

- Employment Opportunities – (47.0%)
- The Tourism Product – (25.0%)
- Businesses and Services nearby the project area - (19.0%)
- Residential Communities nearby the project area – (6.0%)

It was perceived by business respondents that the areas to realise the greatest negative impact were:

- Fisherfolk – (63.0%)
- Marine Wildlife/Fish Population – (53.0%)
- Marine Water Quality – (47.0%)

Forty-four percent (44.0%) of respondents indicated that they would be more accepting if mangrove restoration/ replanting was a component of the project (28.0% - strongly agreed and 16.0% - agreed). Sixteen percent (16.0%) expressed disagreement (3.0% - strongly disagreed and 13.0% - disagreed), while 21.0% neither agreed nor disagreed and 19.0% expressed uncertainty.

Fisherfolk

All fisherfolk interviewed (100.0%) were from the Whitehouse Fishing Beach. When the interviewed fishers were asked if they were aware of the proposal to construct eighteen (18) single-storey overwater bungalows, seventy-three percent (73.0%) stated that they were not aware of the proposal, while 27.0% stated that they knew of the proposal.

In response to having concerns specifically to the bungalows being built overwater, 55.0% of interviewees stated that they had concerns while 45.0% indicated that they had no concerns specifically relating to the bungalows being built overwater. Concerns expressed were:

- Loss of the fishing area/Destruction of the fish habitat – (50.0%)
- Migration of fish – (33.0%)
- Increased turbidity – (17.0%)
- Loss of beach access/recreation area – (17.0%)
- Fishing boat channel will be blocked – (17.0%)

Sixty-four percent (64.0%) of interviewed fisherfolk indicated that they had concerns about wetland and coastal modification being a part of the project. Concerns expressed were as follows:

- There will be a loss of fish habitat – (72.0%)
- Increased turbidity – (14.0%)
- No suggestion offered – (14.0%)

Eighteen per cent (18.0%) indicated that the proposed project would not impact their lives/livelihoods in any way, 27.0% stated that they were unsure how the project may impact their lives. Nine percent (9.0%) of respondents anticipated a positive impact while 46.0% anticipated that their business would be negatively impacted from the project. Of the 9.0% of fishers indicating a positive impact on their lives/livelihoods from the project, all anticipated employment as the positive project benefit.

For the 46.0% of interviewed fishers who expected a negative impact on their lives/livelihoods from the project, the following were cited:

- Loss of fishing livelihood – (80.0%)
- Increased costs to venture further out to sea for fishing – (20.0%)
- Anticipated reduction in potable water supply (low water pressure/service disruptions) – (20.0%).

(*Percentages exceeded 100.0% as multiple negative impacts were stated by some business participants.*)

In general, fisherfolk anticipated negative project impacts during construction when asked about specific variables including water quality, fish population, noise and flooding inter alia. On average 43.7% of fishers interviewed anticipated a negative impact. This was followed by 24.4% of interviewees who perceived that there would be no impact on the specific variables during the construction phase of the project. Approximately twenty-one percent (20.8%) of fisherfolk expressed uncertainty, while 11.1% (on average) anticipated a positive impact.

Respondents anticipated some positive impact during construction on the following:

- Employment Opportunities – (46.0%)
- The Tourism Product – (27.0%)
- Businesses and Services nearby the project area - (19.0%)
- Residential Communities nearby the project area – (10.0%)
- Marine Wildlife and fish population – (9.0%)

The greater percentage of fisherfolk were unsure of the project's impacts after construction. On average, 40.0% of fishers interviewed expressed uncertainty. This was followed by 27.2% of interviewees who perceived that there would be negative impact on the specific variables after construction. Approximately twenty-three percent (22.6%) of fishers anticipated no impact post construction while 10.2%, on average, anticipated a positive impact.

MBJ Airports Limited

MBJ Airports anticipated both positive and negative impacts. It was indicated that the positive impact was the Airport enhancing Jamaica's tourism Product offerings. The negative impacts anticipated related to aviation safety, the Obstacle Limitation Surface (OLS) and associated potential flight risk, and potential negative environmental impacts and how these impacts may in turn affect the airport's operations. As mentioned above, it was re-iterated that consultations should be held with the JCAA and the AAJ.

Marine Park

In response to the organisation having general concerns about the project as proposed, the Marine Park Trust expressed the following:

- Disturbing the wetland (during construction and operation) will negatively affect existing ecosystems and marine life.

- Surface run-off from construction, effluent discharge and chemically treated water (if discharged from the swimming pool) will destroy, remaining wetlands, coastal shallow areas and seagrass beds.

The Montego Bay Marine Park Trust indicated that the organisation's concern with the bungalows being built overwater related to the sea-floor (marine substrate) being affected and the need for proper handling of construction debris and waste management.

In relation to piles being installed to facilitate construction and construction of the overwater bungalows the concern was raised in relation to how pollution (in all forms) caused by construction activities will be prevented/mitigated.

To address highlighted concerns, it was recommended that:

- Measures should be implemented to prevent surface run-off during construction.
- Seagrass rehabilitation/restoration should be considered.
- Chlorinated water should not be used in the swimming pools.
- Saltwater purification should be considered for the swimming pool instead of chlorinated water.

Consideration should be given to allowing public access to the beach. The Marine Park Trust indicated that the organisation uses the area to access the beach and also indicated awareness of other entities that use the area to access the beach. It was further explained that the proposed project area falls within the boundaries of the fish sanctuary. It should however be noted that the project site falls just outside the declared boundaries of the designated protected area of the Montego Bay Marine Park.

In response to how the proposed project would in general affect The Marine Park Trust and its core functions, it was expressed that the project would result in habitat loss (nursery areas) and loss of species through death and/or migration. It was indicated that there needed to be complete adherence to all environmental guidelines to address negative impacts.

The Marine Park Trust indicated:

- Strong agreement regarding whether the project would increase the chance of beach erosion.

- Disagreement in relation to being more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting.
- Strong Agreement that any alteration of the beach would negatively affect seagrass beds and their environmental purpose.

1.7 Natural Resource Valuation

Estimates show that the economic contribution from these sites have very modest annual contributions to fisheries values. This confirms the assumption that given the small area the ecosystems are limited in their ability to contribute more significantly to fishers' incomes. It should also again be noted that the wetland area is severely impacted and does not appear to be functioning as a nursery area for juvenile fish (minimal presence or red mangroves) given limited tidal inundation.

The relatively small coastline represented in this study and the patchy reef complex does not allow for a per unit area coral reef valuation exercise. Notably the project seeks to enhance the recreational attributes associated with the existing coastline which would effectively result in an increase in economic value of the coastal asset. Of note most of these benefits will accrue to the developer of this project.

The expected ecosystem services lost will include:

- loss of sequestered carbon, loss of future sequestration of carbon
- decreased habitat complexity, reduced recruitment and juvenile habitat, reduced productivity
- reduced nutrient and detritus conversion rates and productivities
- lost coastal protection services (wave attenuation and sediment accumulation)

1.8 Environmental Impact Assessment

1.8.1 Overwater Bungalows

An assessment of present and potential impacts identified during the field study of the Sandal's Montego Bay property was carried out using the Rapid Impact Assessment Matrix (RIAM).

The assessment considered impacts associated with the following phases of the project:

1. Baseline impacts reflecting the current state of the coastal area, without overwater bungalows.
2. Impacts before and during the construction phase of the overwater suites (without and with mitigation).
3. Impacts during the operational phase.

Baseline

Overall, the baseline conditions reflect a mix of both positive and negative aspects, highlighting the need for careful consideration of the site's environmental and social impact and mitigation measures. Of the 32 environmental components used to assess the baseline conditions at the Sandals MB grounds, 21 are neutral, reflecting the status quo in the coastal area (beach and seagrass) at the time of the survey; 2 are positive, and 9 are negative.

Construction of Overwater Structures

During the construction of the overwater walkway and bungalows, significant environmental impacts can arise from using construction equipment and the processes involved in building infrastructure, such as piling. The operation of heavy machinery generates considerable noise and disturbance, which can disrupt the natural behaviors of both terrestrial and marine wildlife and degrade their habitats, including sensitive seagrass beds.

Of the 41 components considered, 4 are neutral (no impact), 27 are negative, and 10 are positive and include proposed mitigation measures to offset or minimise some of the negative impacts of construction activities.

Recommended mitigation strategies include using silt curtains to contain sediment, scheduling construction activities to avoid sensitive wildlife periods, and implementing strict protocols for handling and disposing of hazardous materials.

Operation of Overwater Bungalows

In the operational phase, of the 42 components used to assess impact, 10 are neutral, 13 are positive and 19 are negative. The construction of overwater structures along with the proposed expansion on the landside east of the current resort will result in permanent alteration of the habitat which will alter the natural dynamics of the coastal ecosystem.

Negative social and economic impacts are minimal and can be mitigated by implementing appropriate rules for guests and by implementing services in support of the local communities.

Mitigation - Construction

Given the role of seagrass beds in providing vital ecosystem services, the recommended mitigation would entail seagrass relocation (transplantation) in advance of any construction activity. Seagrass removal and transplantation can mitigate potential damage by relocating vulnerable seagrass to safer areas before construction begins.

It is also recommended that a low-impact technique for installing pilings be used to avoid or minimise damage to the seagrass beds and the associated marine flora and fauna.

In addition to seagrass relocation, the following interventions should be considered, including any additional criteria stipulated by the regulatory agency:

- Use silt curtains around the construction zone to contain suspended sediments and implement strict protocols for all heavy machine equipment, especially over seagrass beds.
- Apply strict protocols for handling and disposing of hazardous materials. Develop and implement a spill prevention and response plan to minimise the risk of water pollution incidents.
- Implement a site waste management strategy with appropriate storage and provision of waste bins
- Relocation/ transplantation of seagrass that would otherwise be destroyed during piling installation and construction
- Prioritise avoidance of seagrass beds whenever possible. This can be achieved by strategically adjusting the deployment of construction equipment, such as barges and cranes, to areas without seagrass. Stabilisation spuds can be placed in sandy areas to avoid direct contact with

seagrass beds. Consider alternative low-impact construction methods that minimise or eliminate the need for heavy equipment over seagrass areas (e.g., for installation of nearshore piles, consider using the crane from shore).

- An Oil Spill Contingency Plan should also be implemented to ensure preparedness and response capacity to oil spills. Barges, boats, decks, and heavy equipment used during construction must be in a good state of repair to prevent oil, fuel, or hydraulic liquid leaks or spills.

Mitigation - Construction

- Installing transparent materials (e.g., along the walkways) that allow light to penetrate, can be implemented to minimise the impact of shading on seagrass.
- Sensitise construction workers and staff to the Hawksbill turtles' *critically endangered* status, and given clear instructions on what activities should be avoided so as to not interfere with nesting turtles, should they be encountered. It is also recommended to work with the Montego Bay Marine Park and NEPA to determine how to protect Hawksbill turtles and their breeding grounds (e.g., implement a monitoring program and building awareness among tourists).

1.8.2Construction of Groynes and Villas

The construction of new groynes and beach nourishment activities presents both potential impacts and benefits to the marine environment. Notably, the project is expected to result in the loss of approximately 0.7 to 1.0 hectares of seagrass habitat and benthic organisms. This disturbance could affect marine ecology and the ecosystem services typically provided by seagrass, such as sand accretion, carbon sequestration, and habitat for ecologically sensitive or commercially important species. Additionally, increased turbidity during construction may impact fish, larvae, and photosynthetic organisms, while sediment deposition could smother sessile fauna. Other concerns include the risk of fuel spills affecting water quality and minor noise and lighting disturbances from increased boat traffic.

To mitigate these impacts, several measures are recommended.

- First, a suitable site for seagrass relocation should be identified and approved by the National Environment and Planning Agency (NEPA) prior to construction.
- The use of silt screens will help contain sediment dispersion, and real-time turbidity monitoring should be implemented to ensure that levels remain within acceptable thresholds.
- Construction activities should be paused if turbidity exceeds specified limits, and work should also be suspended during unfavorable weather conditions.
- Proper fuel handling techniques and spill response equipment should be maintained on-site to minimise the risk of fuel leaks.
- Noise levels should be monitored throughout the construction phase to ensure compliance with marine wildlife standards.

Despite the potential impacts, the construction of the groynes may also yield significant ecological benefits. The hard substrate and crevices created by the groynes can enhance marine biodiversity, providing habitats for various marine organisms. It is essential to analyse the physical and social impacts of the project further, guided by NEPA assessments. With effective mitigation strategies in place, the majority of ecological impacts can be minimised, allowing for the potential benefits of the groynes to be realised.

TABLE 1-1 SUMMARY IMPACT ASSESSMENT MATRIX

Component Code	Description	Baseline/Without		During Construction		During Operation	
		Magnitude of Impact	Impact Description	Magnitude of Impact	Impact Description	Magnitude of Impact	Impact Description
P/C 1	Coastal dynamics			-1	Slight negative	-1	Slight negative
P/C 2	Hydrology: Runoff/Stormwater management	-2	Moderate negative	-3	Negative	-1	Slight negative
P/C 2M	Mitigation: Hydrology: Stormwater retention ponds, placement of berms at key locations	-	-	3	Positive	1	Slight positive
P/C 2M	Mitigation: Groyne P12	-	-	2	Moderate positive	-1	Slight negative
P/C 3	Hydrology: Stormwater management (overwater	-	-	-1	Slight negative	-1	Slight negative
P/C 3M	Mitigation:Hydrology: Use downspouts with dispersal fixture at base to disperse freshwater	-	-	1	Slight positive	1	Slight positive
P/C 4	WQ: TSS/TUR	-1	Slight negative	-4	Significant negative	-3	Negative
P/C 4M	Mitigation: WQ: TSS/TUR: use of screens around piling installation site	-	-	2	Moderate positive	1	Slight positive
P/C 5-7	WQ: Stormwater impacts: Nutrients (N/P)	-1	Slight negative	-2	Moderate negative	-2	Moderate negative
P/C 8	WQ: Faecal Coliform	0	Neutral/Status quo	-3	Negative	-2	Moderate negative
P/C 9	Safety: Accidents (Oil spill, pools & pumps)	0	Neutral/Status quo	-3	Negative	-1	Slight negative
P/C 9M	Mitigation: Accidents: regular inspection and maintenance; strategic placement of shut-	-	-	1	Slight positve	1	Slight positve
P/C 10	Waste Management:Solid waste/construction	0	Neutral/Status quo	-2	Moderate negative	-1	Slight negative
P/C10M	Mitigation:Site Waste Management strategy:Appropriate storage and provision of waste bins for construction material and for rubbish generated by workers, toilets, dedicated staff to collect rubbish that accumulates on the beach) /Waste management during operational phase	-	-	1	Slight positive	1	Slight positive
P/C 11	Noise	-1	Slight negative	-3	Negative	-1	Slight negative
P/C 12	Air quality	0	Neutral/Status quo	-2	Moderate negative	0	Neutral/Status quo
B/E 1	Terrestrial: Habitat destruction, fragmentation	0	Neutral/Status quo	-3	Negative	-2	Moderate negative
B/E 2	Terrestrial: Loss of biodiversity(flora)	0	Neutral/Status quo	-1	Slight negative	-1	Slight negative
B/E 3	Terrestrial: Loss of biodiversity (fauna, avifauna)	0	Neutral/Status quo	-4	Significant negative	-2	Moderate negative
B/E 3M	MitigationTerrestrial: Use of native floral species for landscaping to attract avifuana and macrofauna	-	-	2	Moderate positive	2	Moderate positive
B/E 4	Marine: Shoreline alteration/habitat degradation	0	Neutral/Status quo	-4	Significant negative	-2	Moderate negative
B/E 5	Marine: Impact of WQ degradation-	-1	Slight negative	-3	Negative	-1	Slight negative
B/E 6	Marine: Loss of seagrass (smotherin])	-1	Slight negative	-4	Significant negative	-3	Negative
B/E 6M	Mitigation Marine: Seagrass transplantation to recipient site	-	-	3	Positive	2	Moderate positive
B/E 7	Marine: Loss of seagrass (operational [shading])	0	Neutral/Status quo	0	No change/status quo	-1	Slight negative
B/E 8	Marine: Loss of coral species (reef crest)	0	Neutral/Status quo	-1	Slight negative	-1	Slight negative
B/E 8M	Mitigation marine: Coral transplantation to reef crest	-	-	1	Slight positive	1	Slight positive
B/E 9	Mari Marine: Loss of fauna (macroinvertebrates,	-	-	-2	Moderate negative	0	No change
B/E 9M	Mitigation_Marine: 1) Relocation of any macroinvertebrates in the seagrass bed 2) Tutle-friendly lights directed away from beach; turtle monitoring program (e.g., collaboration with Montego Bay Marine Park, NEPA) 3) Training for staff and visitors (turtle conservation program)	0	Neutral/Status quo	1	Slight positive	1	Slight positive
S/C 1	Land Use	0	Neutral/Status quo	-1	Slight negative	0	No change
S/C 2	Community Services and Infrastructure	0	Neutral/Status quo	-2	Moderate negative	-2	Moderate negative
S/C 2M	Mitigation:Community Services and Infrastructure/Coordinate with local authorities to improve infrastructure and services to accommodate increasing demand from patrons	-	-	-	-	2	Moderate positive
S/C 3	Perception of Crowding	0	Neutral/Status quo	0	No change/status quo	-1	Slight negative
S/C 4	Perception of Risk and Safety	0	Neutral/Status quo	-1	Slight negative	1	Slight positive
S/C 5	Perception of Natural Resources	0	Neutral/Status quo	-2	Moderate negative	-1	Slight negative
S/C 6	Perception of Amenities and Services	0	Neutral/Status quo	0	No change/status quo	1	Slight positive
S/C 7	Visual Aesthetics	1	Slight positive	-1	Slight negative	2	Moderate positive
E/O 1	Employment and Income	2	Moderate positive	2	Moderate positve	3	Positive
E/O 2	Business Opportunities for craft vendors,	0	Neutral/Status quo	0	No change/status quo	3	Positive
E/O 3	Traffic (land)	0	Neutral/Status quo	-2	Moderate negative	-2	Moderate negative
E/O 4	Community Development	0	Neutral/Status quo	2	Moderate positve	2	Moderate positive
E/O 5	Fisher folk/Marine Park stakeholders (livelihoods	-2	Moderate negative	-3	Negative	-3	Negative impact

1.9 Archaeological Impact Assessment

For the Archaeological Impact Assessment, the JNHT team conducted a random field walk survey on the site of the proposed development. A few artefacts, including brick fragments and ceramic sherds, were found at the site. There were no significant tangible cultural assets observed; the field survey found no significant historical or archaeological resources that will be affected.

JNHT concludes there is presently no evidence of occupation by Jamaica's indigenous population, the Taíno, in this area. With the exception of a wharf in the vicinity there is little evidence to show that the proposed development area was utilised much during the plantation era. The historical maps also show that morass or swamp was in this area, and this is still evident today. The archaeological evidence available at this time is not significant enough to warrant *in situ* preservation. As such the JNHT Archaeology Division has no objection to the proposed development.

1.10 Identification and Analysis of Alternatives

No Action

This option would mean the resort misses out on the potential benefits of overwater villas, such as exceptional views and direct water access. It also avoids the potential environmental, social, or economic issues that could arise from their development.

Construction of overwater bungalows on the western side of the Sandals property

Constructing the overwater bungalows at this location would provide better shelter from storm surges. The environmental impacts would be similar in both locations, specifically loss of seagrass and habitat alteration.

Expansion of the SMB property to the East (230m east of the existing resort)

This alternative is not viable because the existing shorefront and uplands are low in elevation (subject to flooding), chronically erosional, and features little to no recreational sand beach amenity.

Seawall/Revetment Only

This option would provide higher elevation and structural protection of the upland, but it would not provide any beach amenity or useful ocean access and would result in an armouring of the shoreline without a natural sand beach interface between the upland and the sea. This alternative does not meet the objectives and is not preferred.

Beach Nourishment Only

Placement of sand fill with no stabilising structures or other shorefront modification cannot be expected to result in a near- or long-term viable beach improvement at this site, given its existing condition, prevailing currents and morphology.

Beach Nourishment with Nearshore Breakwaters

This alternative is not viable because the existing morphology and pervasive alongshore currents would strip the sand from the beach between the breakwaters and the shoreline.

Beach Nourishment with Groyne Cells

This alternative is viable and recommended in that it creates pocket beach crenulated embayments that are stable in the face of offshore wave energy and alongshore currents.

1.11 Environmental Monitoring and Management

The main objectives of the Environmental Monitoring Plan are to:

- Minimise the effects of the construction and operation of the project on the Physical, Biological and Socioeconomic environment.
- Comply with the regulatory and legislative requirements.

2 Introduction

Jamaica is one of the most recognised tourist destinations of the Caribbean, with Sandals Resorts International (SRI) being the industry leader providing luxurious accommodations for visitors. The SRI group of companies intends to construct eighteen overwater bungalows and 10 villa style suites east of the eastern boundary of the existing Sandals Montego Bay, Kent Avenue.

The development proposal includes 18 overwater suites, pylons, a supporting boardwalk carrying utility pipes, 10 villa style suites, wetland conversion and coastal modification. The NEPA has requested that an Environmental Impact Assessment (EIA) be carried out. The approved Terms of Reference (TOR) for the (EIA) is shown in **Appendix 1.**

The study area for the EIA is an arc extending 1 km south, east and west of the proposed site and adjacent coastal areas **Figure 2-1**. This study area is considered sufficient to capture the various land uses and key coastal resources.

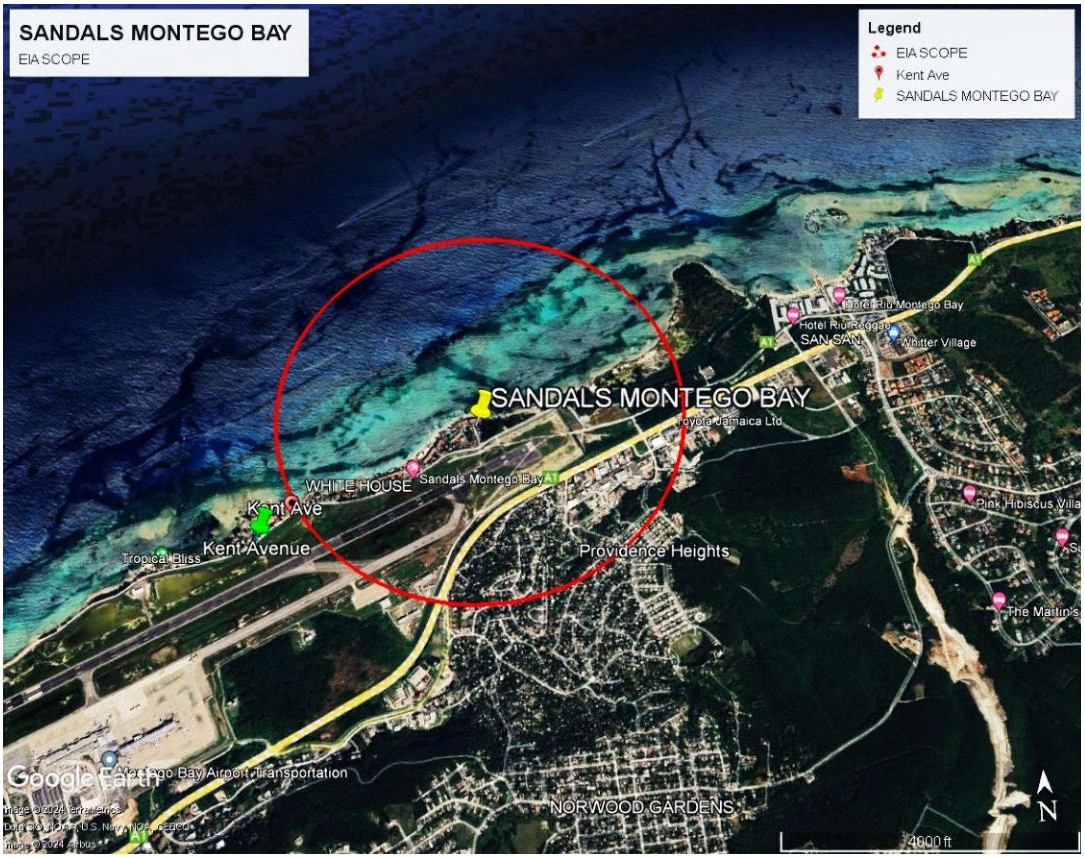

FIGURE 2-1: LOCATION OF SANDALS MONTEGO BAY AND SPHERE OF INFLUENCE

The EIA included a literature review and fieldwork to establish baseline conditions and identify potential impacts (positive and negative) that might be associated with the project. The EIA assumes that a snapshot of data collected along with a literature review will provide sufficient information on the area to inform the impact analysis. While this assumption may be reasonable for normal conditions, it may not necessarily be representative of extreme conditions associated with natural hazards.

3 Legislation and Regulatory Consideration

There are 13 legal instruments, 4 Policy Initiatives and 5 International Conventions relevant to this project (**Table 3-1**).

The Natural Resources Conservation Authority (NRCA) Act is the primary legislation providing the regulatory framework for activities affecting the environment. The NRCA Act is executed by the National Environment and Planning Agency (NEPA). Instruments of particular relevance to this project that fall under the NRCA/NEPA framework include: The Beach Control Act, Wastewater and Sludge Regulations, Air Quality Regulations and the Permits and Licences Regulations.

Other Legal instruments include the Town and Country Planning Act, Town and Country Planning (St. James Parish) Provisional Development Order 2018, National Solid Waste Management Act (2001) and the Parish Councils Building Act (2016). Policy Initiatives of particular relevance include the Protected Areas System Master Plan, Policy on Sea Grass Beds, the Wetlands Policy and Planning Guideline – Overwater Structures.

The International Treaties and Conventions to which Jamaica is a signatory include:

- Convention for the Protection and Development of The Marine Environment of the Wider Caribbean Region (Cartagena Convention) 1983
- The Protocol Concerning Co-operation and Development in Combating Oil Spills in the Wider Caribbean Region (Oil Spills Protocol 1986)
- Convention on Biological Diversity 1993
- Protocol on Specially Protected Areas and Wildlife (SPAW Protocol 2000)
- Protocol Concerning Pollution from Land-Based Sources and Activities (LBS Protocol) 2010

TABLE 3-1: LAWS/REGULATIONS, POLICY INITIATIVES AND INTERNATIONAL ENVIRONMENTAL CONVENTIONS APPLICABLE TO THE PROJECT.

National Laws/Regulations			
Instrument	**Ministry/ Agency**	**Scope**	**Relevance to Project**
Beach Control Act, 1956 (amended 2004)	NEPA	The Act deals with issues such as access to the shoreline, and rights to fishing and public recreation and any future development of the land adjoining the foreshore. Framework for licencing of coastal works and encroachment on the floor of the sea.	The development will need to apply for a beach licence to encroach on the foreshore and the floor of the sea.
Endangered Species (Conservation and Regulation of Trade) Act, 2000	NEPA	Deals with the protection, conservation, management and regulation of trade and related matters for endangered wild fauna and flora species	The location is possibly located to a turtle nesting site
The Fisheries Act 2018	MOAF	Legal framework for the sustainable management of Fisheries resources (species and habitat)	Some habitat loss is expected from this project
Jamaica National Heritage Trust Act 1985	JNHT	The Act establishes the Jamaica National Heritage Trust which has responsibility inter alia for promotion and preservation of national monuments and anything designated as protected national heritage	The JNHT must be notified should any buildings, monuments and artifacts of heritage value be encountered
Local Improvements Act, 1914	St. James Municipal Corporation (SJMC)	Governs the subdivision of lands island wide.	Developer to deposit relevant plans with SJMC

National Laws/Regulations			
Crown Property (Vesting) Act 1960	National Land Agency (NLA)	An act to provide for the vesting of Crown Lands in the Commissioner of Lands, the vesting of certain other Crown property in the Accountant General who has the power to hold and dispose of land and other property of whatever kind.	The development will require permission to encroach on the floor of the sea
National Solid Waste Management Act, 2001	National Solid Waste Management Authority	Regulation and management of solid waste to safeguard public health. The Act provides the legal and institutional framework for ensuring that solid waste materials are collected, stored, transported, recycled, reused or disposed of, in an environmentally sound manner and enhancing public awareness in relation to such waste	Construction and Operation Phases will produce solid waste
Natural Resources Conservation Authority Act, 1991	NEPA	Granting of Environmental Permits in the areas of enterprise, construction or development. Under this legislation NEPA has the authority to request an Environmental Impact Assessment (EIA). The Act also provides framework for effective management of the physical environment, marine parks, national parks and protected areas (NEPA). Formulates standards and codes for the improvement of the quality of the environment.	An EIA is being completed for this project
Natural Resources Conservation (Ambient Air Quality Standards) Regulations),1996	NEPA	Sets ambient standards for specific air pollutants	A monitoring and mitigation plan will be required to control fugitive sources associated with construction

National Laws/Regulations			
Natural Resources Conservation (Montego Bay Marine Park) Order 1992.	NEPA/NRCA	Declares and provides geographic delineation of the Montego Bay Marine Park	The proposed location of the development is in proximity to the eastern boundary of the MBMP
Natural Resources Conservation (Wastewater and Sludge) Regulations 2013	NEPA	Legal framework for the licensing of wastewater treatment plants and discharge of effluent	The development will include arrangements for disposal of sewage
The Parish Councils Building Act 2016	St. James Municipal Corporation	Regulates the carrying out of construction within St. James parish.	Applications for construction must be made to the SJMC
Public Health Act 1974 Public Health (Food Handling) Regulations, 1998	MOH/EHU	Outlines requirements of the environment of the food establishment. Provisions for food of this Act include the rules for preparation, packaging, preservation, transportation and storage of food for consumption.	Licence to operate food handling establishment
Town and Country Planning Act 1958; The Town and Country Planning (Saint James Parish) Provisional Development Order, 2018	TCPA/NEPA	Makes provision for the orderly and progressive development of land, cities, towns and other areas whether urban or rural.	The development is located in the Greater Montego Bay Local Planning Area and will conform to the Provisional Development Order
The Wildlife Protection Act 1945	NRCA/NEPA	Provides the Legal framework for the identification and preservation of protected species	This project is located within a possible marine turtles' habitat.
National Biodiversity Strategy and Action Plan	Ministry of Economic	Involves comprehensive biodiversity strategies and plans to contribute to conservation of Jamaica's	The Project site is in close proximity to the MBMP

- Jamaica (NBSAP) 2016-2021	Growth and Job Creation	habitats (protected areas), ecosystems, species and genetic resources. This includes the integration of economic, social and environmental objectives, polices, strategies, plans and programmes to effectively utilise human and financial resources increase positive impacts. Conservation aligned to CBD.	
Draft National Policy for the Conservation of Sea Grasses - July 1996	NEPA	Framework for promoting conservation of seagrasses in order to sustain their important ecological role	Seagrasses are found in the footprint of the project
Protected Areas System Master Plan (PASMP) 2013 to 2017	Protected Areas Committee (PAC)	The PASMP sets out guidelines for establishing and managing a comprehensive system of protected areas that supports national development by contributing to long-term ecological viability; maintaining ecological processes and systems; and protecting the country's natural and cultural heritage	The project area is adjacent to the MBMP
Planning Guideline – Overwater Structures 01/2016		"All potential developments will require an Environmental Impact Assessment (EIA). The Terms of Reference of the EIA will address concerns specific to the development and must be approved by the National Environment and Planning Authority (NEPA)".	These guidelines apply to structures that are "whole constructed unit suspended above the surface of a water body".
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention) 1986.	NEPA	Signatories agree to reduce and control pollution of the Convention area and to ensure sound environmental management, using the best practicable means at their disposal and in accordance with their capabilities.	Operation of a sewage plant carries the risk of pollution of the Convention area; operation of shipping carries the risk of air pollution, oil spills.

Convention on Biological Diversity, 1993-Cartagena Protocol 2003	NEPA, UNEP	The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biological diversity, the sustainable use of its components	Signatory required to introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimising such effects and, where appropriate, allow for public participation in such procedures
Convention on International Trade in Endangered Species (CITES) of Wild Flora and Fauna 1975.	NEPA	Regulate trade in endangered species	Visitors may wish to take plant or animal species and would need a permit from the management authority
Protocol concerning pollution from Land Based Sources and Activities (LBS Protocol) 2010	UNEP/NEPA	Concerned with national, sub-regional and regional action through a national political commitment at the highest level, and international cooperation to deal (prevent, control) with the problems posed by pollutants entering the Convention area from land-based sources and activities.	Mentions use of EIA to reduce harmful effects of land-based activities. Location of development in proximity to coast and operation of sewage plant and effluent
Specially Protected Areas and Wildlife (SPAW) Protocol 2000	UNEP/ The Caribbean Environment Program	Administers measures to protect, preserve and manage in a sustainable way, areas that require protection to safeguard their special value, and threatened or endangered species of flora and fauna.	The project area is within the MBMP

4 Project Description

Based on the various applications, the nature of the proposed works, their proximity and relationship to each other, in order to allow for the assessment of the cumulative impacts of the overall development, the scope of the EIA covers all aspects of the proposed development including:

- Proposed accommodation construction and amenities (18 overwater bungalows, and 10 villa style units as well as associated parking for guests and staff)
- Proposed wetland modification to facilitate the hotel construction (land clearing, excavation, deposition of fill, and contouring)
- Proposed coastal modification works (construction of 4 groynes, seawall, rock revetment, and beach creation/nourishment)
- Any ancillary facilities and activities to be undertaken as part of the above listed works

While this EIA report considers both the proposed overwater bungalows as well as the villa style units, details of the villa style units are not presented herein as construction of these will be not be undertaken in the immediate future.

4.1 History and background of the project

Overwater rooms debuted nearly 50 years ago in French Polynesia. In subsequent decades overwater villas have spread to the Maldives, Malaysia, Cambodia and the Philippines, but the Caribbean lagged behind[1] up to 2016. In the absence of a specific legal framework for development of these facilities guidelines were drafted by the National Environmental and Planning Agency in 2014 (NEPA 2014). These guidelines were followed by the construction of Sandals' overwater bungalows and villas in late 2016, the Caribbean's first such offering to compete with similar facilities in the French Polynesia. Since then, Sandals has constructed more overwater villas/bungalows at its facilities located at Sandals South Coast Jamaica, Sandals Grande St. Lucian and Sandals St. Vincent.

The construction of the overwater bungalows and the additional villa-styled units is an opportunity for the Sandals Montego Bay resort to diversify room offerings for the benefit of guest, continuing the theme of luxury that the Sandals brand is known for across the world. Montego Bay would represent the 6th location of Sandals Overwater bungalows in the Caribbean and 3rd in Jamaica.

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[1] https://www.cntraveler.com/story/caribbean-first-overwater-bungalows-50-years-in-the-making

4.2 Site Characteristics

4.2.1 Location maps

The study area is located along the northern coast of Jamaica, facing north toward the Caribbean Sea (**Figure 4-1**). The Sandals Montego Bay resort is located on the headland just to the east of the Montego Bay harbour in proximity to the MBJ Sangster International Airport.

FIGURE 4-1: SANDALS MONTEGO BAY - LOCATION

The shoreline is protected by a shallow reef crest about 300 to 500 m seaward. The reef crest is relatively shallow (0.5 m to 1.0 m deep) with considerable alongshore variations in terms of continuity and depth **(Figure 4-2)**.

FIGURE 4-2: SHORELINE OF STUDY AREA PROTECTED BY EXISTING REEF CREST

4.2.2 The total area of the site

The proposed development is expected to take place on the eastern border of the Sandals Montego Bay resort site and an adjoining wetland to the east, an area of approximately 2Ha being Section 1 of parcel registered to the Airport Authority of Jamaica as Volume 1400 Folio 863 (**FIGURE 4-3**).

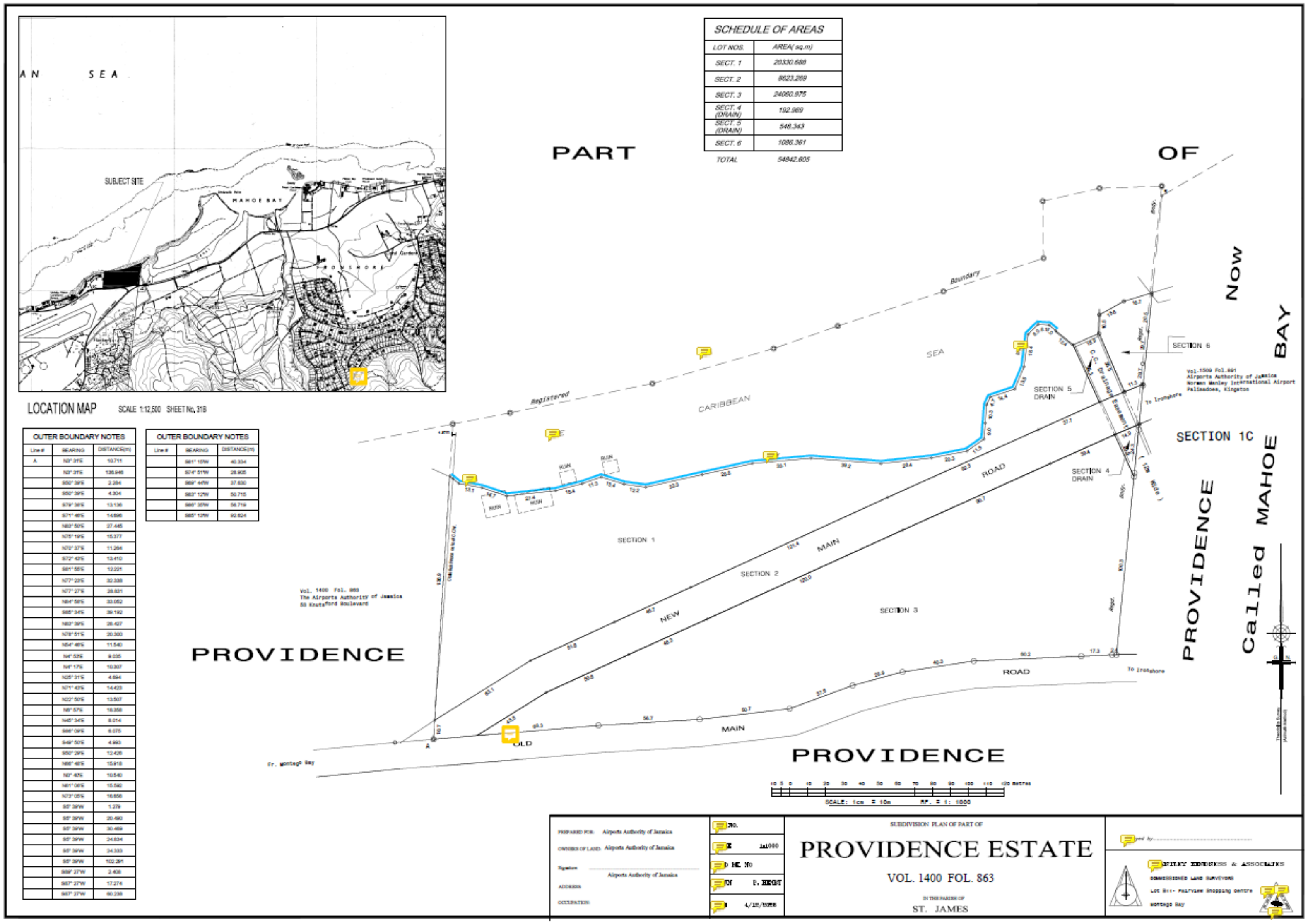


FIGURE 4-3: SITE AREA

4.2.3 Overall master plan for the site

The services of Sandals Montego Bay will be augmented by the construction of 18 overwater bungalows along the eastern border of the existing development and 10 villa style units to the east of the overwater bungalows. The components of the proposed development are shown in the site master plan below (**Figure 4-4**).

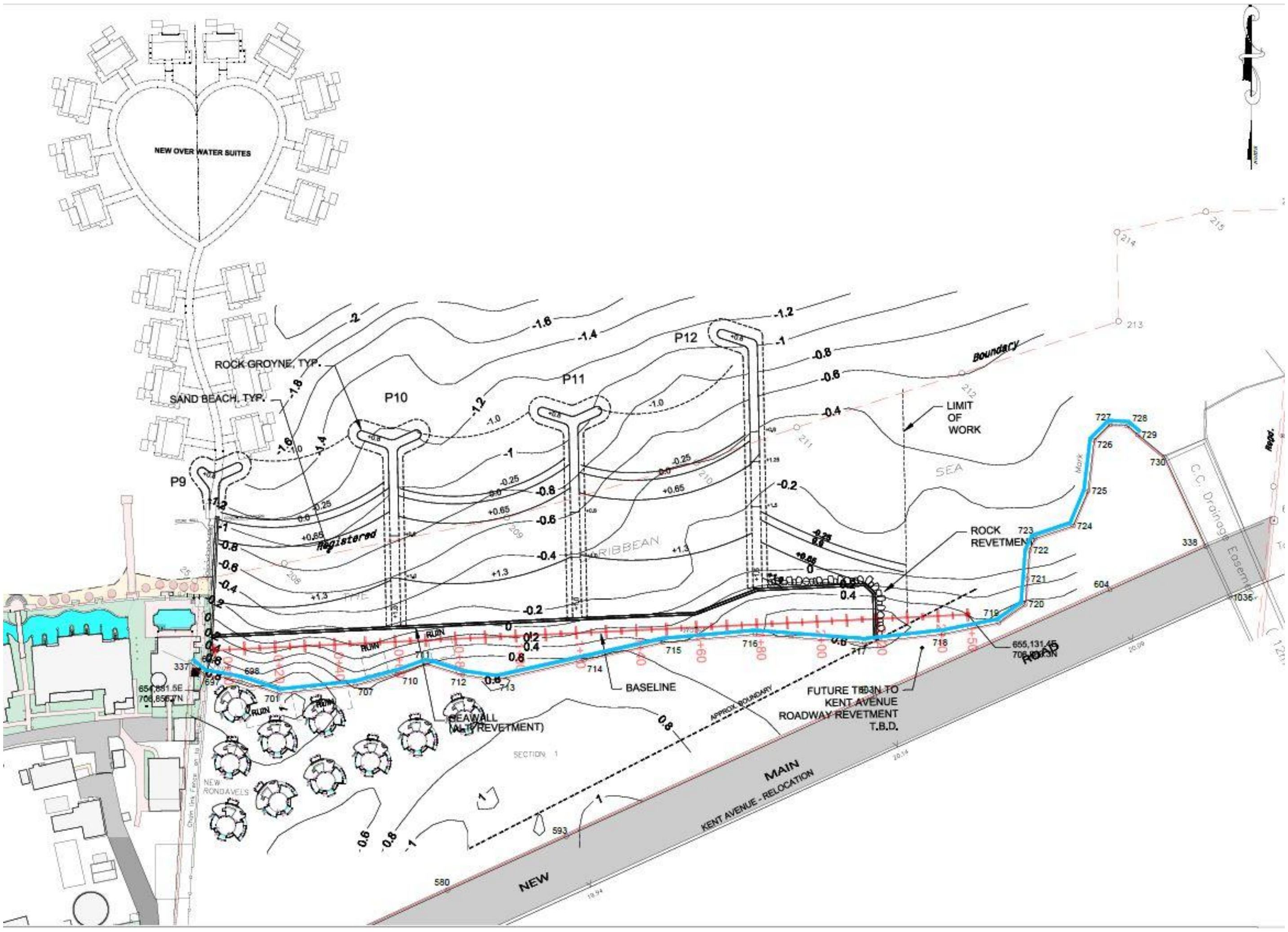


FIGURE 4-4: MASTER PLAN

4.2.4 Details of the design

The design of the bungalows has a Polynesian flair and will use synthetic thatch for the roof, Bahama-style hurricane shutters on the windows and exotic hardwood.

To withstand the elements, pressure-treated wood rafters with insulation, marine-grade plywood and hurricane straps at each rafter will be utilised to comply with manufacturers' instructions and the highest quality workmanship. Access to each unit will be via a 9' (2.743m) wide boardwalk and the units will be surrounded by wooden railings, designed to bear up to 200-pound load. Ambience will be further enhanced by sea-floor windows, ceiling fans and accent lighting (**Figure 4-5** and **Figure 4-6**).

FIGURE 4-5: EXTERIOR DESIGN OF BUNGALOW

FIGURE 4-6: BUNGALOW GUESTROOM & LOUNGE

Each bungalow structure will occupy a total of 613sq. ft. (56.950m^2) of space and will be built approx. 8’ 5” (2.595m) above mean sea-level. The units will consist of (**Figure 4-7**):

- Butler’s kitchen - 64sq. ft. (5.946m^2)
- Toilet room - 21sq. ft. (1.951m^2)
- Guestroom & Lounge - 429sq. ft. (39.855m^2)
- Shower room – 43sq. ft. (3.995m^2)
- Outside spa-style bathroom which sits on a patio that is 8’ 1 3/8” (2.473m) wide
- An expansive patio which features a pool, day bed with integrated lighting, net hammock and a swim up platform

Utility areas:

- Condenser & Water Heater area - 22sq. ft. (2.044m^2)
- HVAC area - 13sq. ft. (1.208m^2)
- Pool Pump - 21sq. ft. (1.951m^2)

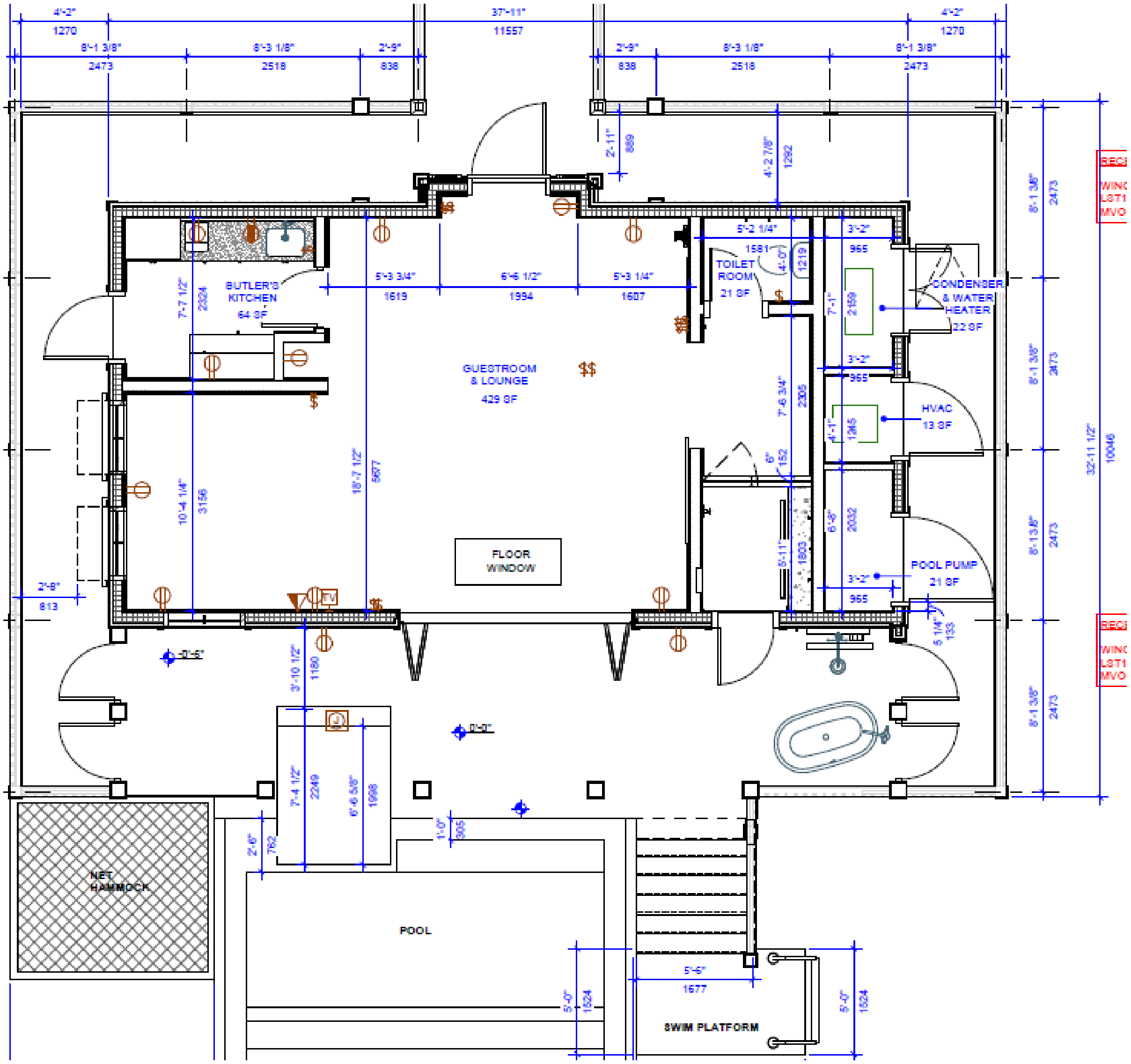


FIGURE 4-7: SCHEMATIC DRAWING OF A BUNGALOW

As previously mentioned, details of the proposed 10 Villa style units are presently unavailable as construction is not scheduled to begin in the immediate future.

4.2.5 Total area of land to be utilised and amenities to serve the proposed development

Approximately 2 Ha will be utilised to install the necessary infrastructure; this will include roads, parking areas, water supply, sewerage and lighting.

4.2.6 Expected project components and alternatives

Construction of buildings over the ocean somewhat restricts the choices of materials, and additional components under consideration include Glass Reinforced Polymer (GRP), PVC, Stainless Steel, Aluminum, Thatch and clay tiles.

4.2.7 Schematic plans

See **Annex 1**.

4.2.8 Details of proposed access to the site to be used

The project site will be accessed using lands east of SMB which will also be utilised as the storage/staging area for the proposed overwater bungalows.

4.2.9 Details of infrastructure development and Waste Generation

While the intention is to connect to the Rose Hall Sewage Treatment Facility, this facility is not yet available, as the developer awaits statutory approvals to proceed to construction.

In the interim, effluent from the new development area would be discharged to the existing wastewater treatment plant, until the connection to the Rose Hall plant is completed. Temporary wastewater treatment facilities will be constructed for site workers.

Organic food waste and similar materials will be collected and transported to an onsite compactor, and a licensed waste management company will be contracted to handle off-site disposal.

Strategically located sewage storage tanks will be used to collect and pump the sewage ashore to a central lift station, from where it will be directed to the on-land Treatment Facility. Secondary containment is provided via an existing, welded, aluminum box. Dimensions and specs are per original approved drawings from the statutory agencies.

Solid waste will be collected in closed carts, transported to the shore, and removed from the area by electric carts to a waste skip, which will be taken off-site by a licensed waste management company.

Waste quantities during construction:

4 waste skips per villa x 18 = 72 skips total = 72 x 20 yds. = 1440 Cu yd.

Waste quantities during operation:

1 skip per month – 1 cu yd. per OWS + general waste = 18+4 cu yds. = 22 cu yds.

Most waste will be sent through a compactor before being taken off property.

4.2.10 Details of the provision of utilities

The daily demand for potable water is estimated at 400 liters/room/day. The source of Potable Water is NWC which services the area.

The source of Electricity will be Jamaica Public Service Co.

4.2.11 Waste Management Plan

- Effluent will be pumped ashore to a lift station and treated in the e Rose Hall Sewage Treatment Plant.
- Organic and other solid waste will be separated and hand carried in closed carts to the shore and trucked to the compactors and skips, which will, in turn, be transported off-site.
- The standard figure for waste disposal of 400GPD will be used for the main rooms as these bungalows are not expected to produce any more or less than the standard rate.
- Construction waste will be brought from the project work site, cast into a dumpster, or carted off to a designated garbage dump with signed tickets for the removals.
- The site will be kept clean and tidy as works proceed.

4.2.12 Detailed list of equipment and machinery

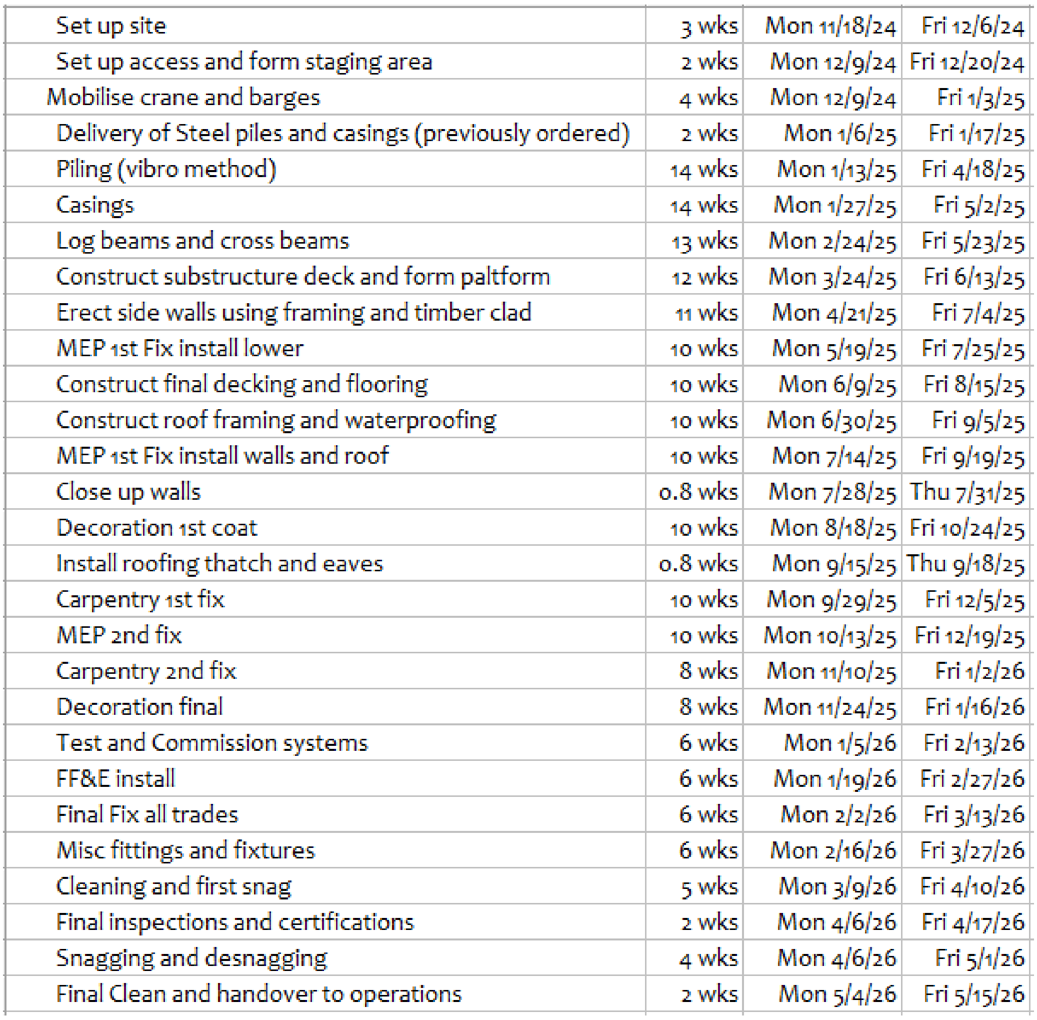
- Up to two (2) 1000t barges with 100T cranes mounted on them
- One (1) 100T landing craft
- Three (3) service crafts (small boats)
- Small power tools generally battery type
- One (1) 70T crane on shore to lift and organise staging areas
- One (1) JCB 560 type teleporter
- Mains power and water will be utilised
- One (1) JCB 330 type excavator (tracked) to keep staging areas usable

- Various trucks including but not limited to 1t pickups, 10t flat beds and 20yds dump trucks
- One (1) 10t Vibro roller for staging area and beach access.

4.2.13 Project Phasing

The project will take place over a period of two years and nine months, with the construction phase happening from September 11, 2024 through to July 31, 2025. Finishing/decorating will commence August 18, 2025 through to Final Clean and Handover to Operations on May, 4, 2026. Detailed timelines are presented in **Table 4-1.**

TABLE 4-1: PROJECT TIMELINES



Set up site	3 wks	Mon 11/18/24	Fri 12/6/24
Set up access and form staging area	2 wks	Mon 12/9/24	Fri 12/20/24
Mobilise crane and barges	4 wks	Mon 12/9/24	Fri 1/3/25
Delivery of Steel piles and casings (previously ordered)	2 wks	Mon 1/6/25	Fri 1/17/25
Piling (vibro method)	14 wks	Mon 1/13/25	Fri 4/18/25
Casings	14 wks	Mon 1/27/25	Fri 5/2/25
Log beams and cross beams	13 wks	Mon 2/24/25	Fri 5/23/25
Construct substructure deck and form paltform	12 wks	Mon 3/24/25	Fri 6/13/25
Erect side walls using framing and timber clad	11 wks	Mon 4/21/25	Fri 7/4/25
MEP 1st Fix install lower	10 wks	Mon 5/19/25	Fri 7/25/25
Construct final decking and flooring	10 wks	Mon 6/9/25	Fri 8/15/25
Construct roof framing and waterproofing	10 wks	Mon 6/30/25	Fri 9/5/25
MEP 1st Fix install walls and roof	10 wks	Mon 7/14/25	Fri 9/19/25
Close up walls	0.8 wks	Mon 7/28/25	Thu 7/31/25
Decoration 1st coat	10 wks	Mon 8/18/25	Fri 10/24/25
Install roofing thatch and eaves	0.8 wks	Mon 9/15/25	Thu 9/18/25
Carpentry 1st fix	10 wks	Mon 9/29/25	Fri 12/5/25
MEP 2nd fix	10 wks	Mon 10/13/25	Fri 12/19/25
Carpentry 2nd fix	8 wks	Mon 11/10/25	Fri 1/2/26
Decoration final	8 wks	Mon 11/24/25	Fri 1/16/26
Test and Commission systems	6 wks	Mon 1/5/26	Fri 2/13/26
FF&E install	6 wks	Mon 1/19/26	Fri 2/27/26
Final Fix all trades	6 wks	Mon 2/2/26	Fri 3/13/26
Misc fittings and fixtures	6 wks	Mon 2/16/26	Fri 3/27/26
Cleaning and first snag	5 wks	Mon 3/9/26	Fri 4/10/26
Final inspections and certifications	2 wks	Mon 4/6/26	Fri 4/17/26
Snagging and desnagging	4 wks	Mon 4/6/26	Fri 5/1/26
Final Clean and handover to operations	2 wks	Mon 5/4/26	Fri 5/15/26

4.2.14 The study area

The landward study area is the entire 2Ha extending from the western boundary to the gully to the east. Seaward, the study is extended offshore to cover seagrass meadows and coral reefs within the project footprint.

4.2.15 Construction Impact Analysis and Control

Noise, dust and waste will be controlled on-site by using low-impact tools, screens and intermittent wetting of areas. A strict focus on maintaining a debris-free environment will be enforced to ensure that no construction materials are disposed of in the ocean. Throughout the project, the site manager will collaborate with Sandals' Water Sports division to conduct regular inspections of the seabed and promptly remove any debris that may accumulate during the course of the work.

4.2.16 Details of the construction methods

A barge(s) equipped with a 100-ton crane will be utilised to install the foundation piles and sub-structure frame for the overwater structures. A staging area will supply the components to the barge via hand carry or landing craft-type vessel off the beach to the east end of the site to prevent guest disturbance on Phase 1.

Piles will be Vibro driven into place to reduce noise, and timber and steel components will be lifted into place using the crane mounted on the barge. Conventional construction techniques will be employed to prevent debris dispersal into the marine environment. Construction waste will be transported to the shore twice daily for proper disposal. On-site management will address noise, dust, and waste using low-impact tools, screens, and dampening of areas.

4.2.17 Seagrass Relocation/Restoration

Seagrass harvesting and transplantation methods will be evaluated for site suitability. The following criteria will be considered in selection of the appropriate transplanting methodology:

I. **Cost**. Available funds for transplanting, post-transplanting adaptive management and long-term monitoring will ultimately influence the type of methodology that is most appropriate for the project.

II. **Species**. Using both fast- and slow-growing native species to mimic natural succession.

III. **Method**: The following methods will be evaluated for suitability:

a) **Sediment-free Method**

Once the donor material is harvested, the sediments are removed to expose the roots and rhizomes. At the recipient site, the harvested planting units (PUs), comprising up to four apical rhizome meristems, are transplanted directly into the sandy substrate or anchored using metal rods (rebar) or similar devices. Alternatively, the PUs can be woven into biodegradable mesh and secured to the sediment.

b) Sediment Method

Sod or turf entails the removal of seagrass along with the sediment and rhizomes intact and ready for planting without additional manipulation. For *Thalassia* with deep root-rhizome systems, this method will require careful harvesting to ensure that the depth of the root-rhizome system is intact. Specialised harvesting equipment may be required.

Plugs, which consist of seagrass plants with roots and rhizomes, can be harvested using coring devices such as PVC pipes or specialised sod plugger. Similar to the sod/turf method, the plugs can be transplanted into peat pots and then into holes created at the recipient site.

IV. **Time of the year**. Transplanting should be planned to avoid periods of high seasonal stress (i.e., storms, high temperatures).

4.2.18 Detailed drainage report for construction and operational phase of development.

There are no rivers or gullies on the site; however, there is a major drainage discharge outlet for surface water runoff approximately 320m east of the site boundary. This localised drainage takes authorised storm water runoff to the sea and is also tidally impacted, as noted by the presence of sluice gates controlling tidal flows.

4.2.19 Details of any required decommissioning of the works and/or facilities

The Sandals maintenance team will monitor all post-construction works and ensure that all deficiencies are resolved as they occur.

5. Description of the Environment

5.1 Physical Environment

5.1.1 Coastal Dynamics

5.1.1.1 Wave Climate

Oceanographic Condition Offshore Sandals Montego Bay Study Site - Computed wave conditions by NOAA's WAVEWATCHIII Caribbean model from the beginning of 2005 to the end of 2016, or 12 years, were extracted. Statistical analysis of this relatively long term wave conditions was conducted and summarised in **Table 5-1** and illustrated in **Figure 5-1**, **Figure 5-2**, **Figure 5-3**, **Figure 5-4**, **Figure 5-5**, **Figure 5-6** and **Figure 5-7**. The waves were partitioned into 16 incident wave angle brackets at 22.5 degrees each bracket (**Table 5-1**).

The average signifciant wave height and average peak wave period within each wave-angle bracket were calculated. The storm conditions are represented by the average of the top 2% and top 1% highest waves within a wave-angle bracket. This statistical wave information provides an overview of the wave conditions at the study site and is discussed in the following. This statistical wave conditions are also used as the input offshore wave conditions for the numerical wave modeling discussed in the following sections.

Offshore Wave Conditions

As controlled by the trade wind, the ENE incident waves are by far the most dominant, occurring at 60.8% of the time with an average significant wave height of 0.32 m and average peak wave period of 5.26 s (**Table 5-1**, **Figure 5-2**, **Figure 5-3**). The average of the top 2% highest waves has a significant wave height of 0.90 m with an average peak period of 6.72 s (**Figure 5-4** and **Figure 5-5**). For the top 1% highest waves, the average significant wave height is 0.98 m with an average peak wave period of 6.99 s, just slightly greater than the average top 2% of the highest waves (**Figure 5-6** and **Figure 5-7**).

Table 5-1: Statistical Wave Conditions Calculated from the 12 year Wave Data Obtained from the WAVEWATCHIII Model. Yellow Highlights Indicate Onshore-Directed Waves. The Station Location is Shown in Fig 3-4.

		% occurrence	average sig H	average wave period	top 2% sig H	top 2% wave period	top 1% sig H	top 1% wave period
Direction			m	S	M	s	m	S
N	348.75-11.249	5.57	0.55	4.64	1.79	6.20	1.95	6.33
NNE	11.25-33.749	5.72	0.52	4.51	1.36	5.73	1.47	5.86
NE	33.75-56.249	17.58	0.39	3.88	1.08	5.54	1.16	5.68
ENE	56.25-78.749	60.81	0.32	5.26	0.90	6.72	0.98	6.99
E	78.75-101.249	0.36	0.40	2.57	0.80	3.08	0.83	3.07
ESE	101.25-123.749	0.08	0.54	2.93	0.94	3.21	0.94	3.21
SE	123.75-146.249	0.05	0.26	2.57	0.52	2.64	0.52	2.64
SSE	146.25-168.749	0.05	0.55	3.05	1.15	3.63	1.15	3.63
S	168.75-191.249	0.10	0.43	2.63	1.23	3.85	1.23	3.85
SSW	191.25-213.749	0.12	0.42	2.84	1.39	4.05	1.39	4.05
SW	213.75-236.249	0.09	0.30	3.68	1.26	3.93	1.26	3.93
WSW	236.25-258.749	0.43	0.37	6.37	1.56	8.34	1.68	8.25
W	258.75-281.249	0.78	0.53	6.31	2.07	7.90	2.13	7.89
WNW	281.25-303.749	2.61	0.45	7.52	1.77	8.01	1.92	7.53
NW	303.75-326.249	1.99	0.60	5.42	2.11	7.03	2.29	7.53

The second most frequent incident waves are from the NE direction, at 17.6% of the time, also controlled by the easterly trade wind (**Table 5-1**). The NE incident waves are slightly more energetic than the ENE waves with an average wave height of 0.39 m and an average peak wave period of 3.88 s (**Figure 5-2** and **Figure 5-3**). The average of the top 2% and top 1% highest waves is also higher, at 1.08 m and 1.16 m, respectively (**Figure 5-4, Figure 5-5, Figure 5-6** and **Figure 5-7**).

The third most frequent incident waves are from NNE, occurring at 5.7%, with an average significant wave height of 0.52 m with a peak wave period of 4.51 s (**Figure 5-2 and Figure 5-3**). The average of the top 2% and top 1% highest waves is quite energetic, at 1.36 m and 1.47 m, respectively (**Figure 5-4, Figure 5-5, Figure 5-6** and **Figure 5-7**). This higher storm waves as compared to the more easterly approaching waves are related to the strong northerly wind associated with the passages of winter cold fronts. However, the NE wind is somewhat sheltered by the Cuba landmass, which is about 150 km to the northeast.

The fourth most frequent incident waves are from the north, occurring at 5.6%, with an average significant wave height of 0.55 m with a peak wave period of 4.64 s (**Figure 5-2** and **Figure 5-3**). The average of the top 2% and top 1% highest waves is quite energetic, at 1.79 m and 1.95 m, respectively with average peak wave period of 6.20s and 6.33 s, respectively (**Figure 5-4, Figure 5-5, Figure 5-6** and **Figure 5-7**). This higher storm waves as compared to the more easterly approaching waves are due to the longer wind fetch from the Cuba landmass.

The most energetic waves come from the NNW direction, with the average significant wave height of 0.65 m and average peak wave period of 4.87 s (**Figure 5-2** and **Figure 5-3**). The NNW wave occurs 3.64% of the time (**Figure 5-1** and **Figure 5-8**). Although the frequency of occurrence is not high, it is still very significant. The storm waves from NNW are very energetic due to the much longer wind fetch from the Cuba landmass. The average of the top 2% and top 1% highest waves is the most energetic for the greater study area, at 2.17 m and 2.28 m, respectively with average peak wave period of 6.79 s and 6.87 s, respectively (**Figure 5-4**, **Figure 5-5**, **Figure 5-6** and **Figure 5-7**). These high waves are apparently related to the strong northerly wind associated with passages of winter cold fronts. The design of the over-the-water units and the shore protection measures should carefully consider the energetic N, NNW and NW (occurring at 2.0% of the time) incident waves. These three relatively energetic wave conditions occur at a combined 11.2% of the time. It is worth noting again that the waves discussed above are offshore conditions, the nearshore wave height should be significantly reduced by the nearshore barrier reef.

In summary, the easterly approaching waves, including ENE, NE and NNE waves, occur at 84.1% of the time, as driven by the trade winds. **Figure 5-8** illustrates the most frequent incident waves in relation to the coast. Energetic wave conditions are apparently influenced by the northerly winds associated with passages of winter cold fronts, and are therefore approaching from northerly directions. The landmass of Cuba to the north provides a certain degree of sheltering. The wind fetches in the NE and NNE directions are considerably shorter than that from the N, NNW and NW directions. This explains the much higher storm waves in the northwesterly directions than the northeasterly direction. The energetic northwesterly waves approach the shoreline more perpendicularly than the northeasterly waves.

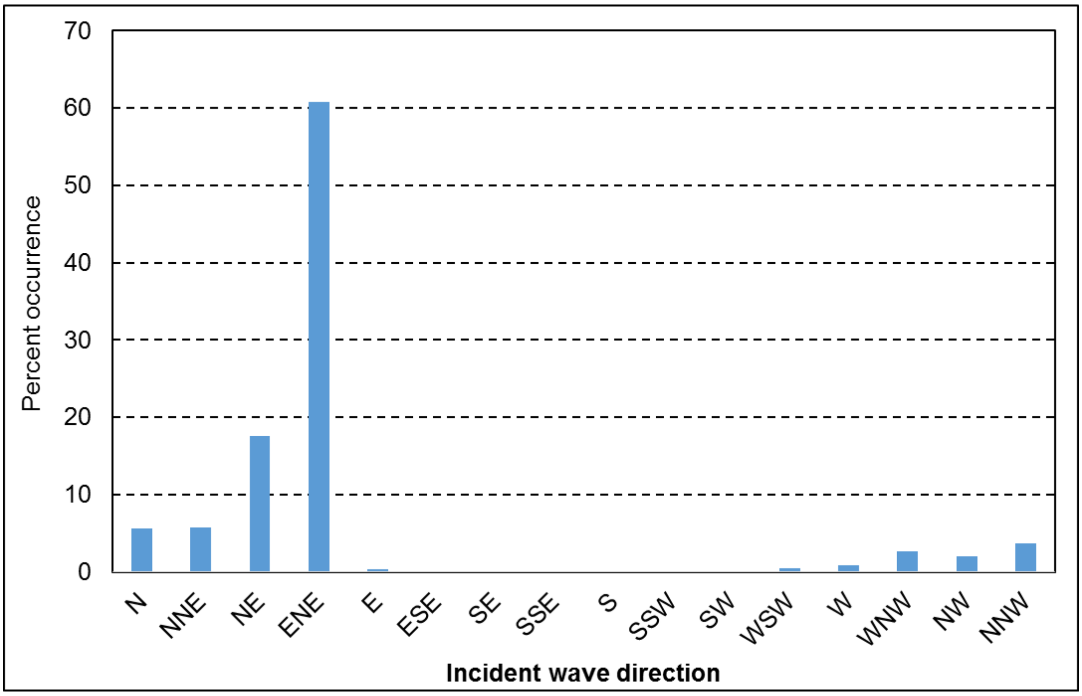


FIGURE 5-1: FREQUENCY OF OCCURRENCE OF WAVES APPROACHING FROM DIFFERENT DIRECTIONS

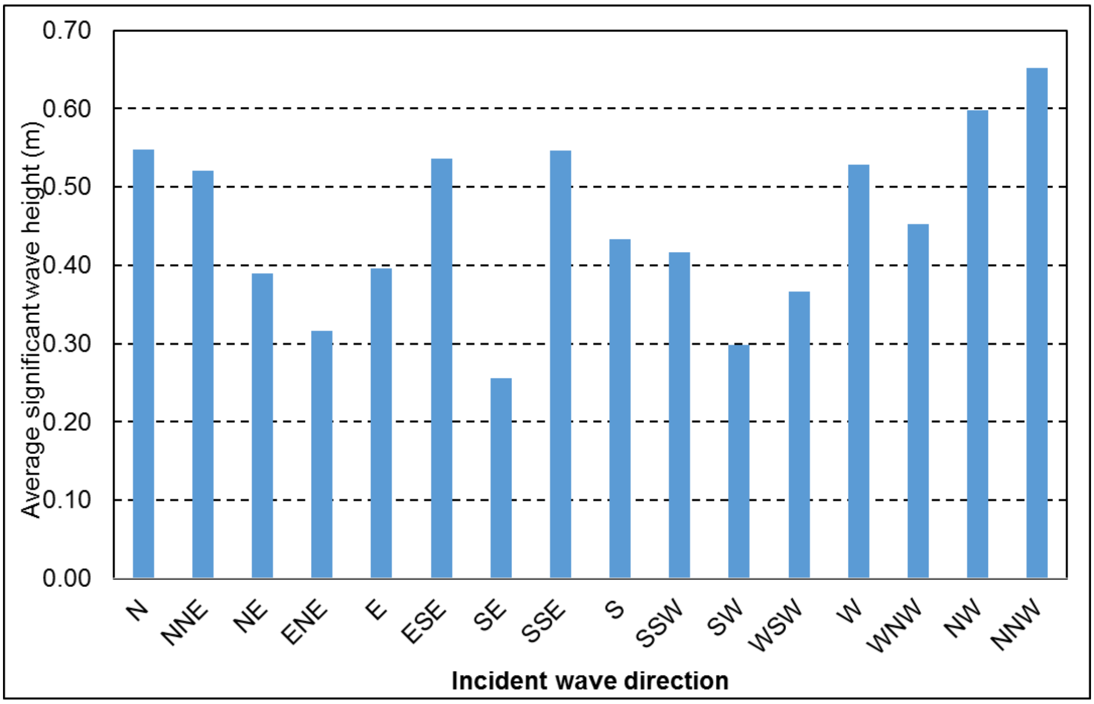


FIGURE 5-2: AVERAGE SIGNIFICANT WAVE HEIGHT WAVES APPROACHING FROM DIFFERENT DIRECTIONS

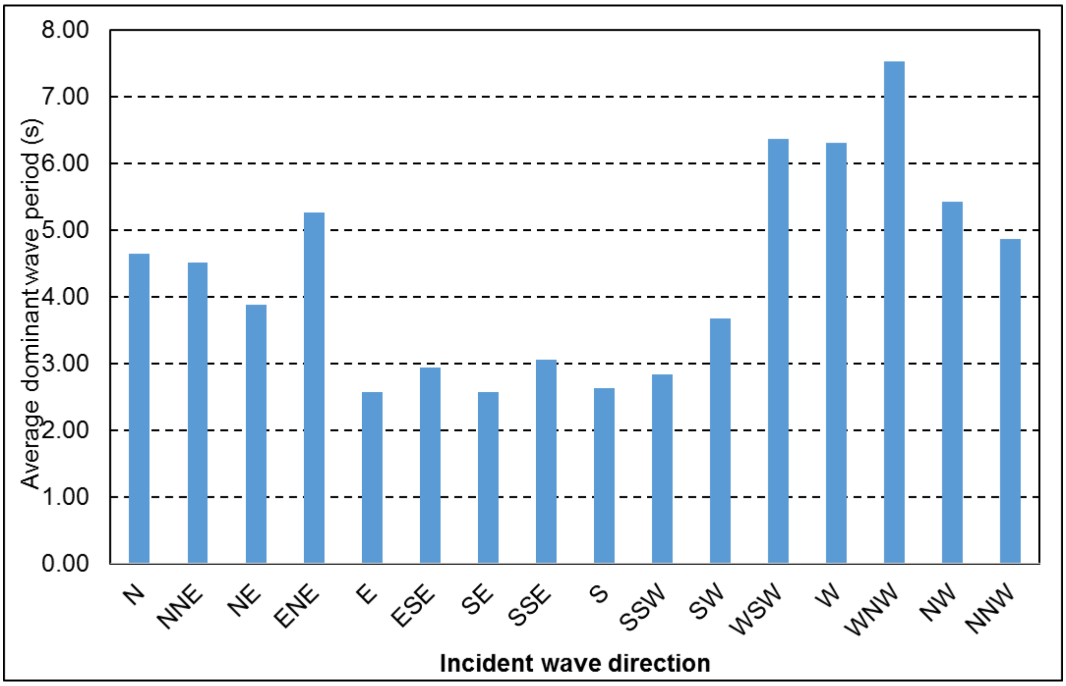


FIGURE 5-3: AVERAGE PEAK WAVE PERIOD WAVES APPROACHING FROM DIFFERENT DIRECTIONS.

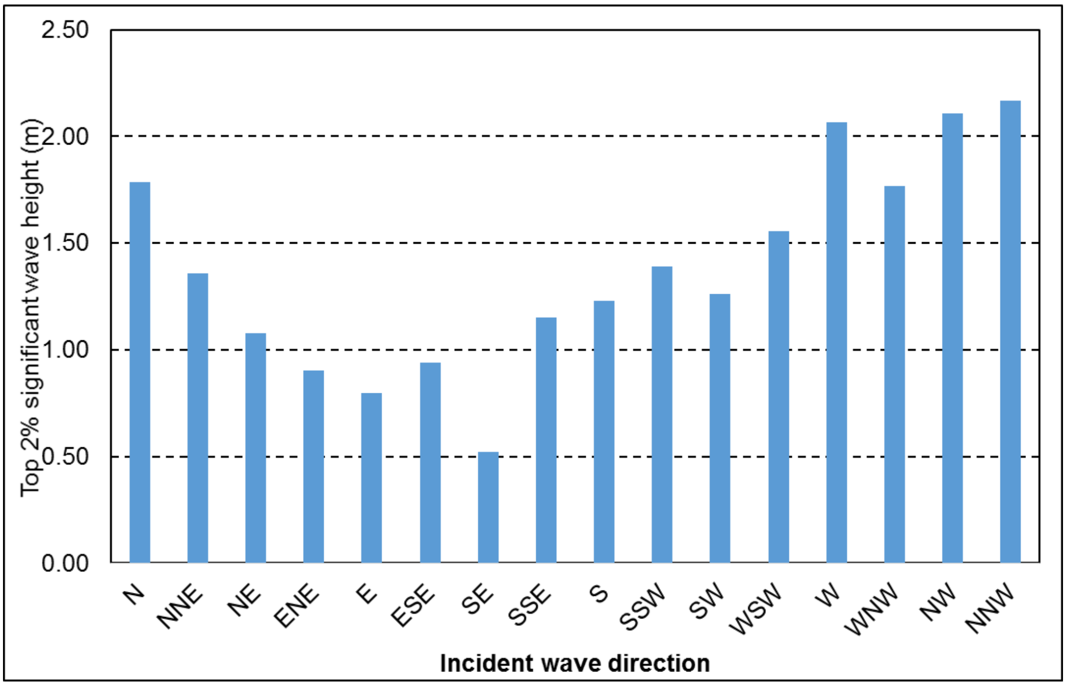


FIGURE 5-4: AVERAGE SIGNIFICANT WAVE HEIGHT OF TOP 2% HIGHEST WAVES APPROACHING FROM DIFFERENT DIRECTIONS.

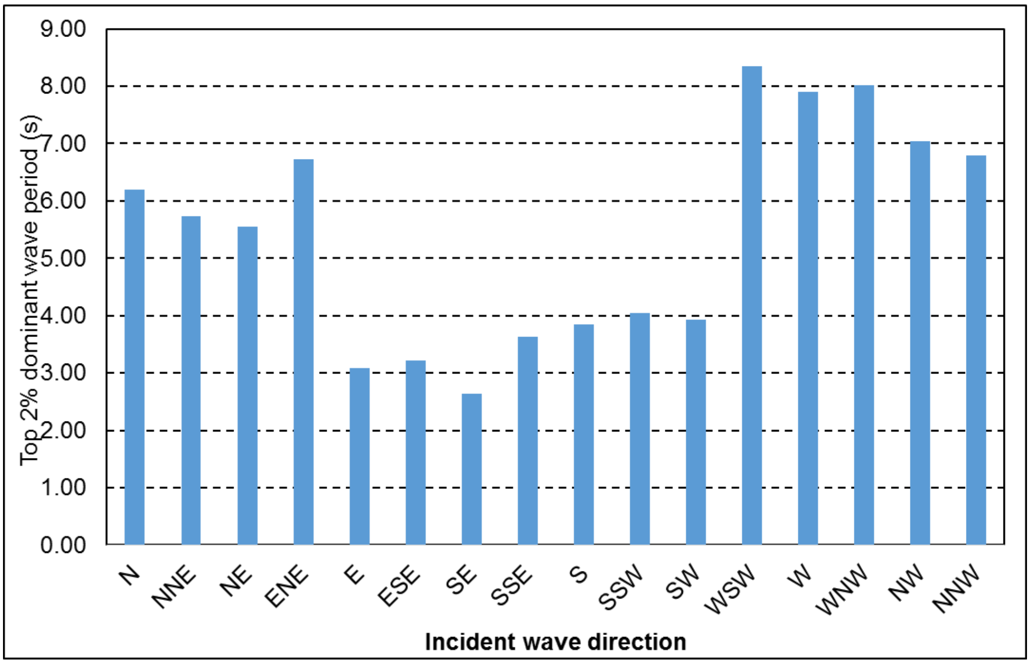


FIGURE 5-5: AVERAGE PEAK WAVE PERIOD OF TOP 2% HIGHEST WAVES APPROACHING

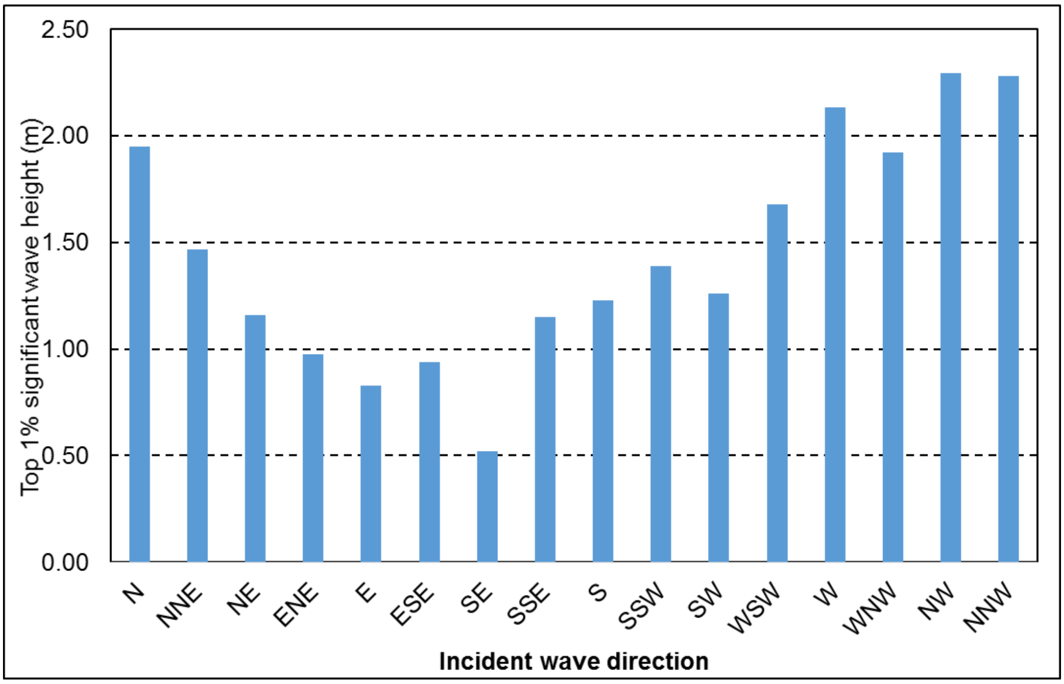


FIGURE 5-6: AVERAGE SIGNIFICANT WAVE HEIGHT OF TOP 1% HIGHEST WAVES APPROACHING FROM DIFFERENT DIRECTIONS

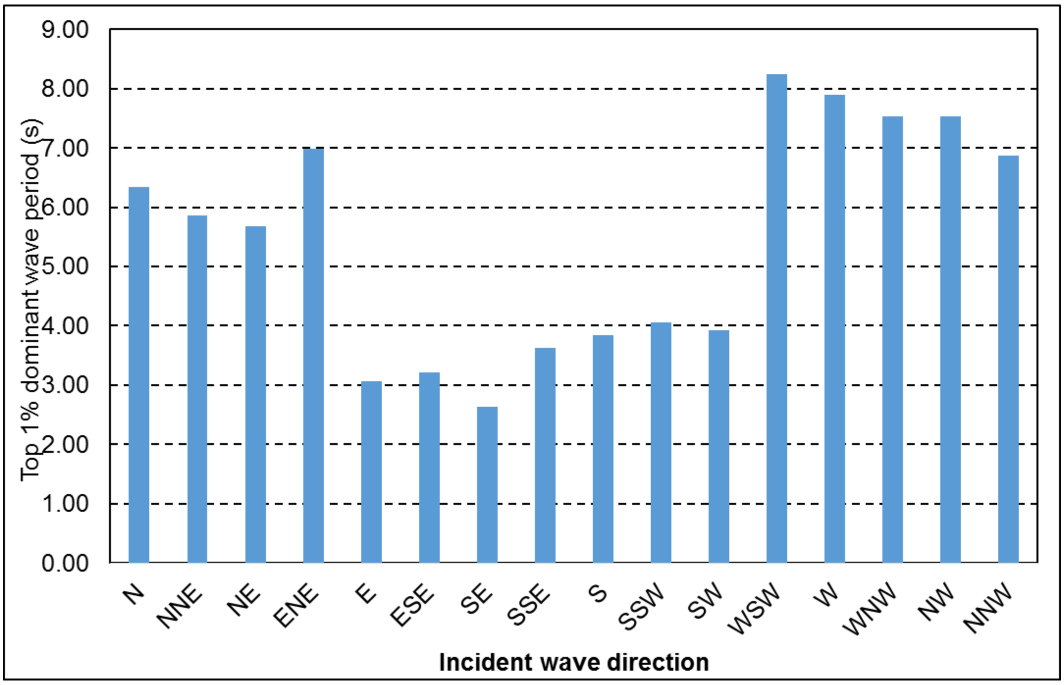


Figure 5-7: Average Peak Wave Period of Top 1% Highest Waves Approaching from Different Directions

Figure 5-8: Most Frequently Occurring offshore Incident Wave Directions.

5.1.1.2 Storm Surge

The elevated water level, often referred to as storm surge, along the reef coast, Sandals Resort at Montego Bay in this case, includes two components. The first component is the surge generated by strong onshore wind, i.e., the traditional definition of storm surge. The elevated water level generated by the wind stress is balanced by friction at the seabed. Therefore, a shallow, gentle, and wide continental shelf, which would produce large bottom friction, provides favorable conditions for generating high storm surges. Since the water depth seaward of the Montego Bay barrier reef increases rapidly to over hundreds of meters, the bottom friction is small and subsequently does not produce high surge due to wind stress. The second component is wave setup and runup. The landward propagation of breaking waves at the barrier reef can pile water near the shoreline resulting in elevated water level.

Computing the first component of storm surge along Montego Bay coast is very difficult because the model requires a very large domain to adequately capture the storm and ocean basin characteristics. Not enough data exists to allow reliable computation. A different approach is taken here. Realising the limitations in computing storm surge along a variety of coastal settings, US NOAA recently adopted a more measurement-based approach (Sweet et al., 2022). Extreme water-level analysis was conducted at tide station with at 30-year measurement data. There are no long-term water-level stations along Jamaica that can be used for extreme water level analysis. However, in terms of conditions for storm-surge generation, Montego Bay bears significant similarities with San Juan, Puerto Rico, where a long-term NOAA tide gauge exist. Water-level measurement data are available at the San Juan station since 1962, or for nearly 60 years. This data was used by NOAA to compute extreme water-level statistics (NOAA[2]). Based on the measured data over the past 60 years, the 100-year storm surge water-level was estimated to be 0.54 m above mean sea level. This rather low storm surge estimate can be explained by the very steep and narrow continental shelf.

Based on the measured data from San Juan, Puerto Rico and the similarity between San Jaun and Montego Bay, the 100-year storm surge for Montego Bay is estimated to be 0.54 m above mean sea level.

For the second elevated water-level component, the combined wave runup and setup can be estimated based on the breaking wave height at the barrier reef. A numerical model was recently developed to

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[2] https://tidesandcurrents.noaa.gov/est/curves.shtml?stnid=9755371

compute wave runup on reef-lined coasts (McCall et al., 2024). McCall et al. (2024) proposed a correction factor (F_r) for barrier reefs when computing the top 2% wave runup ($R_{2\%}$) as:

$$R_{2\%}^{reef} = R_{2\%} F_r \tag{1}$$

$$F_r = \max\left(1 + \alpha_r \frac{\gamma_r}{\sqrt{g H_{s,0}}} \Gamma_{reef}, 0\right) \tag{2}$$

$$\gamma_r = \sqrt{\left|\frac{c_f}{c_{f,ref}} - 1\right|} \tag{3}$$

$$\Gamma_{reef} = \sqrt{\int_{L_{c_f}} \frac{u_{orb}^3(x)}{c_g(x)} dx} \tag{4}$$

The superscript and subscript "reef" refer to reef condition. The detailed parameters are explained in McCall et al. (2024). Based on wave-modeling results (**Figure 5-12 to Figure 5-48**), the above questions were applied to calculate wave setup and runup for storm conditions. The maximum calculated runup was 0.95. It is worth noting that as the overwater units are not located on the beach, the elevated water level at the units should be lower than the maximum runup.

Combining the estimated storm surge based on measurements at San Juan Puerto Rico (0.54 m) and computed wave setup and runup (0.95 m), the total elevated water at the proposed overwater units can reach approximately 1.5 m above mean sea level. This estimate is further verified based on field observations in the study area during a recent energetic storm in February 2024.

5.1.1.3 Baseline Sediment Transport and Circulation Patterns

The beach characteristics along the Sandals Montego Bay shoreline are heavily influenced by engineering solutions. The groyne field was installed before 2001 and can be seen from the earliest Google Earth photos in 2001. Based on different beach characteristics, the entire shoreline can be divided into three sections. The eastern section (**Figure 5-9**, Section 1, the middle section (**Figure 5-9,** Section 2), spanning between the eighth and tenth groynes (from the east), and the western section (**Figure 5-9,** Section 3).

FIGURE 5-9: CHARACTERISTICS ALONG THE SANDALS MONTEGO BAY

The erosive nature of Section 1 shoreline corresponds with the relatively higher wave along this section under the dominant ENE and NE incident wave conditions. Section 3 wide beach benefits from the westward longshore sand transport and the protection from the barrier reef, resulting in relatively wide beach. The rate of the westward longshore transport is difficult to estimate because it is controlled by not only the wave conditions but also by the availability of the sand along the beach and in the nearshore. In addition, the longshore transport is confined by the groynes. However, based on the westward increasing trend of beach width, the pre-2017 groynes allowed some of the westward longshore sand transport to move through. This was likely the reason that the groyne field was reinforced in 2017-2018.

The beach conditions after 2017 are largely controlled by the engineering solutions. The third and fifth groynes from the east were removed. The rest of the groynes were reinforced with T-heads and Y-heads. The original fifth groyne was replaced by a short detached breakwater. The removal of the groynes resulted in longer sections of beach between the groynes. In addition, the beach between the groynes was nourished along with the groyne improvement. The artificial beach appears to be quite stable since 2018 based on the time-series aerial photos from Google Earth. The beach to the west of the groyne field remains stable, as compared to the state before the groyne improvement. The westward longshore sand transport as discussed above is largely interrupted by the groyne field. The beach to the west of the groyne field appears to be in an equilibrium state before and after the groyne improvement, as indicated by the relatively stable shoreline.

5.1.1.4 Modeling of Nearshore Wave and Flow Conditions

The most up-to-date (2022) version of the Coastal Modelling System (CMS), specifically the CMS-Wave and CMS-Flow models, was used in this study (see http://cirpwiki.info/wiki/CMS). The CMS model, developed by the Coastal Inlets Research Program (CIRP) at the US Army Corps of Engineers (USACE), is an integrated suite of numerical models for simulating flow, waves, sediment transport, and morphology change in coastal areas (Buttolph et al., 2006; Reed et al., 2011; Wu et al., 2011; Lin et al., 2011; Larson et al., 2011; Sanchez and Wu, 2011; Sanchez et al., 2014). The CMS model has been broadly used by the USACE and other professionals (e.g., researchers) to quantify barrier island, tidal inlet, and estuary processes (e.g., Demirbilek et al., 2015a, 2015b; Li et al., 2012; Beck and Legault, 2012; Beck and Wang, 2019; Beck et al., 2020; Wang et al., 2011; Wang and Beck, 2012).

The CMS model is composed of four main parts, including flow, wave, sediment transport, and morphology change. The four parts are coupled to ensure that the interactions among wave, current, sediment transport, and morphology change are properly incorporated. In terms of computation modules, the CMS is composed of two main components: CMS-Flow and CMS-Wave. The CMS-Flow is a coupled hydrodynamic and sediment transport model designed to compute depth-averaged flow and sediment transport due to tides, wind, and waves. The CMS-flow solves the conservative form of the shallow water equations and includes terms to account for factors including the Coriolis force, wind stress, wave stress (obtained from CMS-Wave), bottom stress, vegetation flow-drag, bottom friction, and turbulent diffusion. The sediment transport and morphology changes are computed in CMS-Flow module, while all equations are solved using the Finite Volume Method on a non-uniform Cartesian grid.

The CMS-Wave is a spectral wave transformation model and solves the steady-state wave-action balance equation on a non-uniform Cartesian grid. It considers wind-wave generation and growth, diffraction, reflection, dissipation due to bottom friction, white-capping and breaking, wave-wave and wave-current interactions, wave runup, wave setup, and wave transmission through structures. Results of wave modelling, including radiation stress, breaking wave height, and breaking wave angle, are passed to the CMS-Flow module for the computation of wave-driven longshore current and wave-induced sediment suspension and transport. For the Sandals overwater-unit project, both CMS-Wave and CMS-Flow were used to simulate wave and flow fields.

The CMS model construction, execution, and output analyses are facilitated by the graphic interface, SMS (Surface-water Modelling System) (http://cirp.usace.army.mil/products/sms.php). SMS allows convenient construction of telescoping (CMS-Flow) and refined (CMS-Wave) grids which provide high spatial resolution at crucial locations like the beach. The SMS also allows manipulation of the very large dataset (several gigabytes) generated by the model runs. Furthermore, SMS is capable of generating high quality illustrations of the modelling results, including vector plots of current fields and wave fields. SMS can also generate high quality contour plots which are crucial for wave-height change analyses. The SMS was used to construct the numerical wave, flow, and coupled wave-flow model for the study area, as described in the following sections.

The model domain is shown in **Figure 5-10**. The upper panel illustrates the nearshore bathymetry obtained by this study. Overall, the nearshore bathymetry is quite complicated at the Sandals Montego Bay study area. The lower panel illustrates the recommended design, with the units extending seaward from the east most existing groyne.

A nearshore reef with a crest of 0.5 to 1 m below mean sea level extends along the study area. This barrier reef is 300 to 500 m seaward of the Sandals Montego Bay shoreline. The shallow water over the barrier reef induces significant wave breaking, particularly under energetic storm conditions, and subsequently reduces wave height substantially landward of the reef (**Figure 5-11**). The barrier reef is not continuous. Several gaps exist within the reef track. Considerable wave energy can propagate through the gaps in the barrier reef, as also shown in **Figure 5-11**. This overall bathymetry characteristic in the study area has significant influence on nearshore wave field, as discussed in the following.

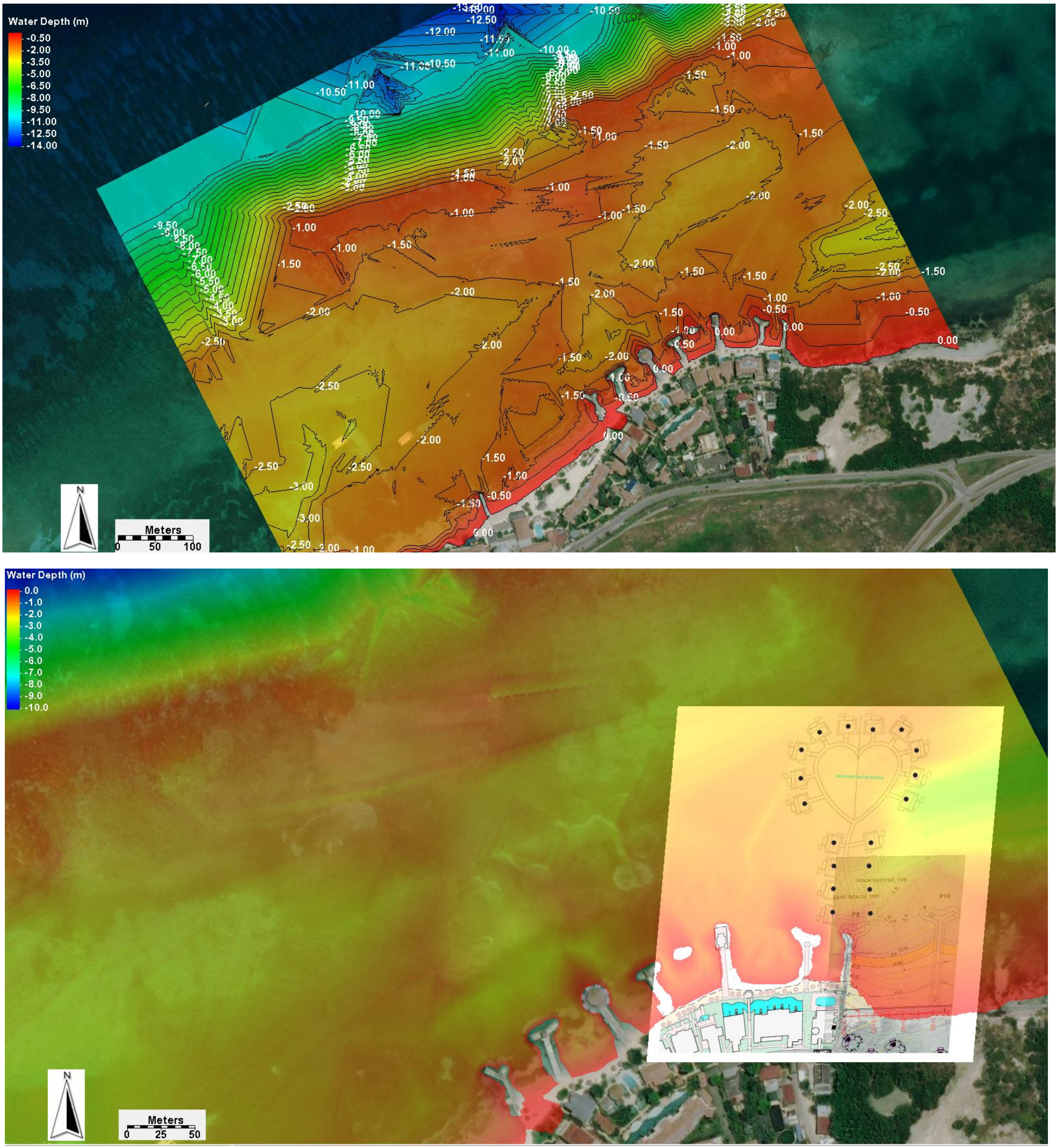


FIGURE 5-10: NEARSHORE BATHYMETRY AT SANDALS MONTEGO BAY STUDY SITE. THE DEPTH IS REFERRED TO MEANS SEA LEVEL. UPPER PANEL: EXISTING BATHYMETRY; MIDDLE PANEL: OPTION 1 DESIGN (TO THE WEST); LOWER PANEL: RECOMMENDED DESIGN (TO THE EAST). NOTE THE COLOR SCHEME AT THE OVERWATER UNITS' LOCATION WAS CHANGED BY THE BACKGROUND IMAGE. THE BATHYMETRY VALUE CAN BE OBTAINED FROM THE CONTOUR LINES.

FIGURE 5-11: WAVE BREAKING OVER THE SHALLOW BARRIER REEF AND WAVE PROPAGATION THROUGH THE GAPS. YELLOW LINE = 200 M.

5.1.1.5 Modeled Wave Field under Existing Condition

The nearshore wave field was simulated using the CMS-WAVE based on the bathymetry surveyed by this study. **Figure 5-12**, **Figure 5-13**, **Figure 5-14**, **Figure 5-15**, **Figure 5-16**, **Figure 5-17, Figure 5-18, Figure 5-19** and **Figure 5-20** illustrate the computed nearshore wave field under existing condition as modeled by the CMS-WAVE. Statistical wave conditions directed onshore as summarised in **Table 5-1** (highlighted in yellow) were used as the input offshore wave to the model. The average wave and the top 1% wave representing energetic storm conditions are illustrated and discussed here. The modeling results for the top 2% wave conditions are rather similar to the top 1% waves and therefore are not repeated here.

The modeled wave field under northerly incident wave condition is shown in **Figure 5-12**, with the upper panel illustrating the average condition and lower panel illustrating the storm condition. The general shoreline orientation in the Sandals Montego Bay study area is approximately 60 degrees, or roughly ENE-WSW. Therefore, the northerly incident wave approaches at an angle to the shoreline. The northerly wave occurs at about 5.6% of the time and is relatively energetic as compared to the dominant easterly approaching waves (**Table 5-1**). As expected, the barrier reef has significant influence on the wave propagation. Wave-height reduction and wave refraction occur at the barrier reef. Under average wave condition, the wave height reduced from 0.55 m seaward of the barrier reef to typically 0.4 to 0.5 m landward of the barrier reef. Substantial wave refraction resulted in nearly shore-perpendicular wave in the nearshore area (**Figure 5-12**). Under storm wave condition, the incident wave height is significantly reduced by the barrier reef from generally 1.6 m seaward to 0.4 to 0.6 m landward. The percentage wave energy reduction by the barrier reef under storm condition is much greater than that under average wave condition.

The modeled wave field under NNE incident wave condition is shown in **Figure 5-13**, with the upper panel illustrating the average condition and lower panel illustrating the storm condition. As compared to the northerly incident wave, the NNE wave approaches the shoreline at a greater angle. The NNE wave occurs at about 5.7% of the time and is relatively energetic as compared to the dominant easterly approaching waves (**Table 5-1**). Similar to the northerly incident wave, the barrier reef has significant influence on the wave propagation. The modeled wave field under average condition is quite similar to that of the northerly incident wave (**Figure 5-13** upper panel). The storm wave at NNE incident is lower than the northern storm wave, however, due to the control of the barrier reef, the wave conditions landward of the reef is also similar to that for the northerly incident wave.

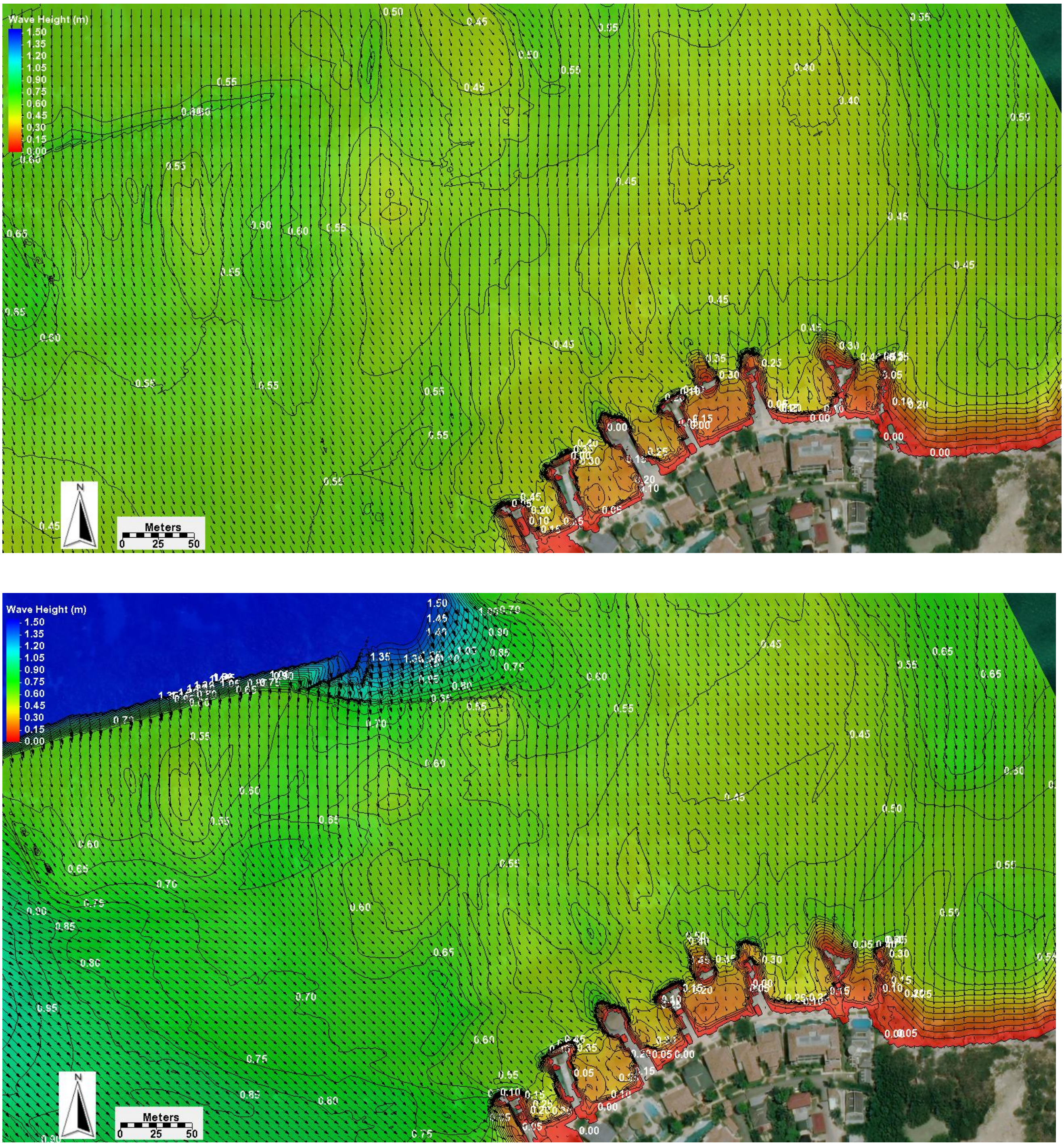


Figure 5-12: Modeled wave field for the N (0 degrees) incident wave. upper panel: average wave condition with a significant wave height of 0.55 m and a peak wave period of 4.64 s. Lower panel: average of top 1% high wave with a significant wave height of 1.95 m and peak wave period of 6.33 s. zooming in to, e.g., 200%, to view details of the wave fields.

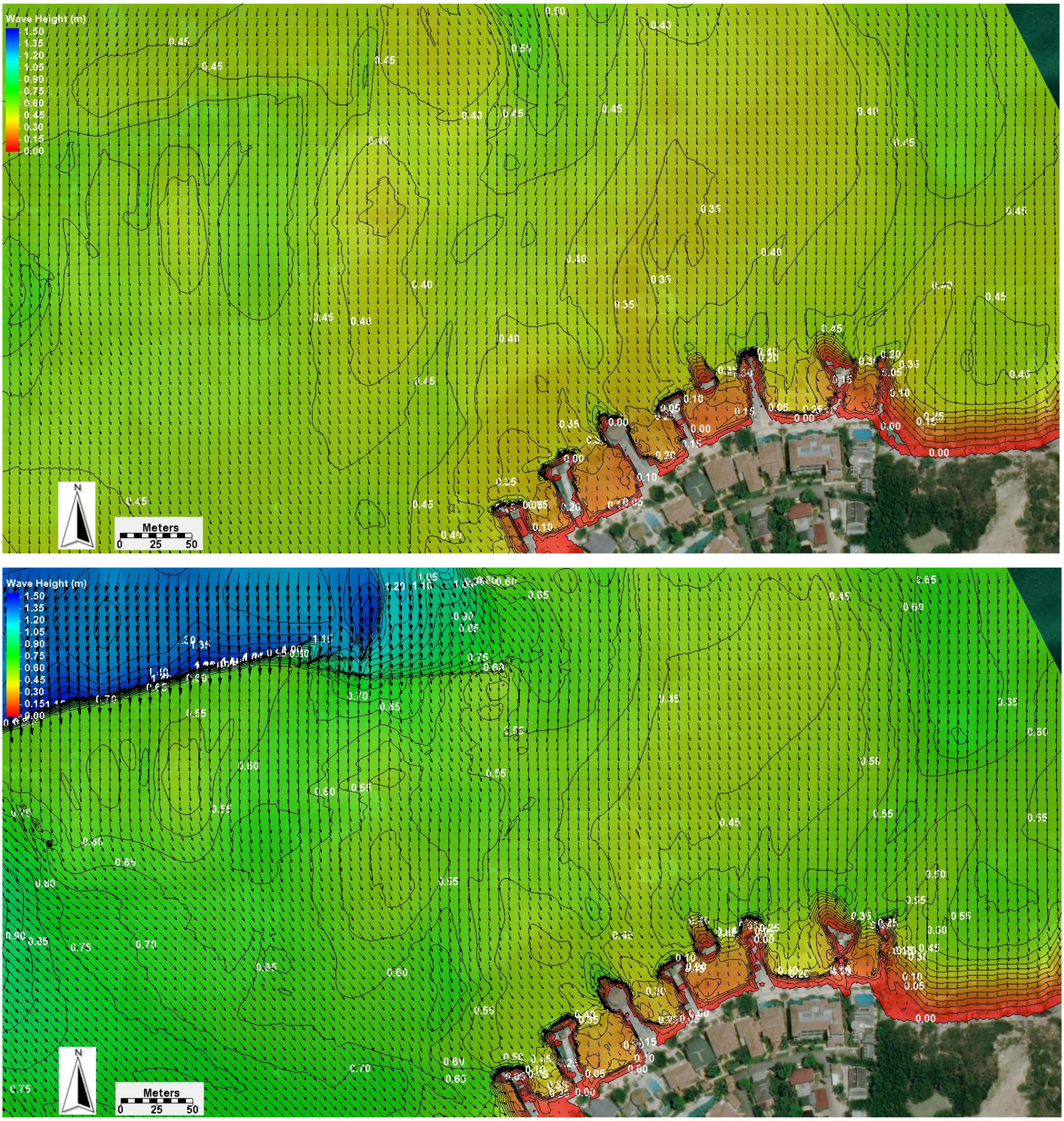


Figure 5-13: Modeled wave field for the NNE (22.5 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.52 m and a peak wave period of 4.51 s. Lower panel: average of top 1% high wave with a significant wave height of 1.47 m and a peak wave period of 5.86 s. zooming in to, e.g., 200%, to view details of the wave fields.

The modeled wave field under NE incident wave condition is shown in **Figure 5-14**. The NE wave occurs more frequently than the N and NNE waves, at 17.6% of the time. However, both the average and storm waves are lower than the N and NNE waves (**Table 5-1).** In addition, the NE wave approaches the shoreline at a much greater angle. Owing to the lower average wave height, the influence of the barrier reef on the wave propagation is less significant as compared to the N and NNE waves. This is reflected in a lesser degree of wave refraction under average condition, resulting in an oblique wave incidence in the nearshore (**Figure 5-12**). Under storm condition, more severe wave refraction occurs resulting in more shore-perpendicular wave in the nearshore (**Figure 5-14** lower panel). The higher waves at the broad headland in the eastern portion of the study area also occur under the NE incident wave due to the wave propagation through the gaps at the barrier reef (**Figure 5-14**).

The wave field under ENE incidence (**Figure 5-15**) is quite similar to that under NE incidence as discussed above. The ENE incident wave is by far the most common, occurring at 60.8% of the time, although it is not the most energetic. The higher wave at the broad headland and the westward longshore sand transport driven by the oblique incident wave, and the fact that this condition occurs very frequently, is the mechanism that controls distribution pattern of the sandy beach in the study area: narrow to nearly no beach around the headland and increasing beach width toward the west. The wave heights are lower than 0.5 m under storm conditions of this most frequent incident wave.

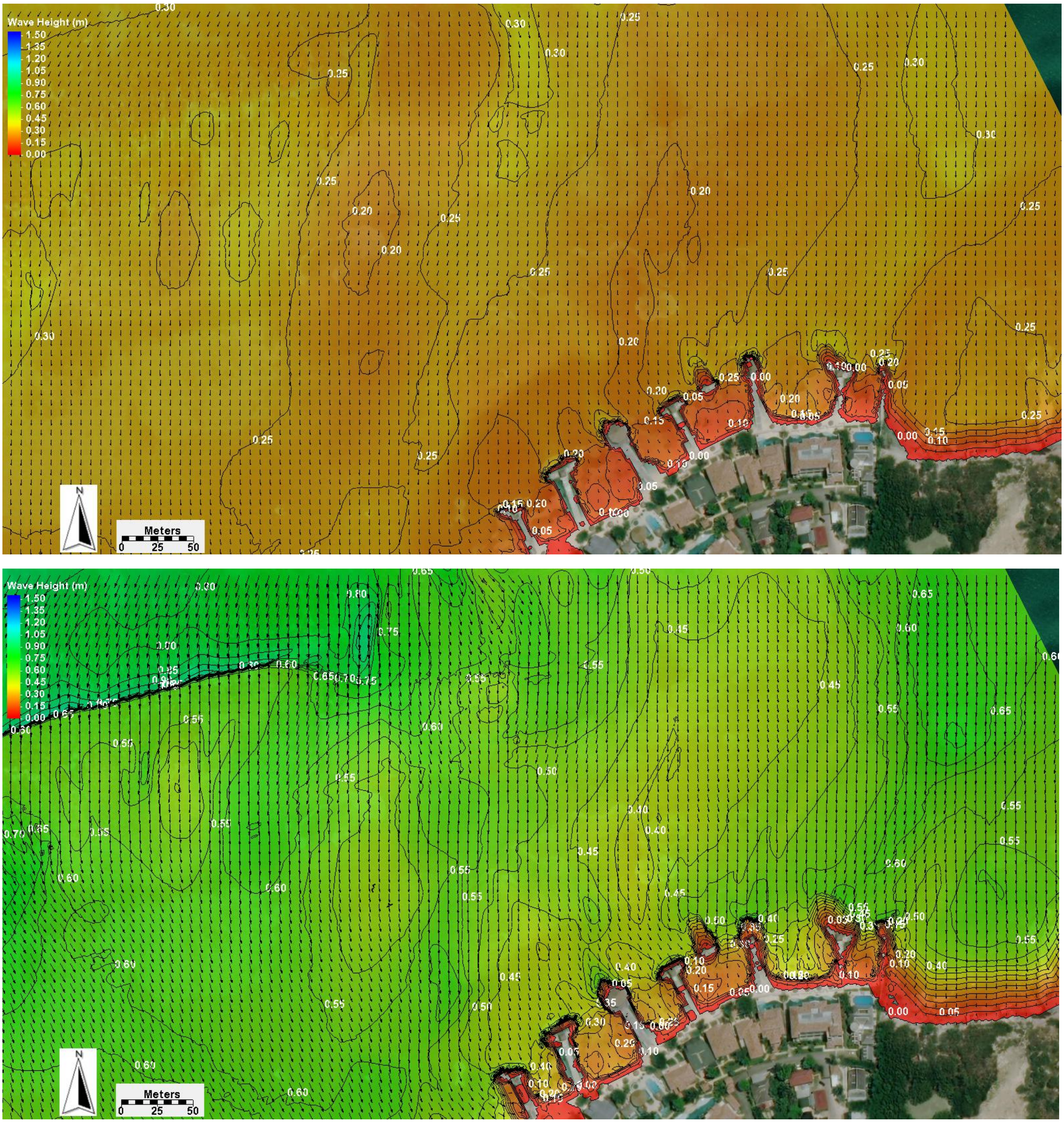


Figure 5-14: Modeled wave field for the NE (45 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.39 m and a peak wave period of 3.88 s. Lower panel: average of top 1% high wave with a significant wave height of 1.16 m and a peak wave period of 5.68 s. Zooming in to, e.g., 200%, to view details of the wave fields.

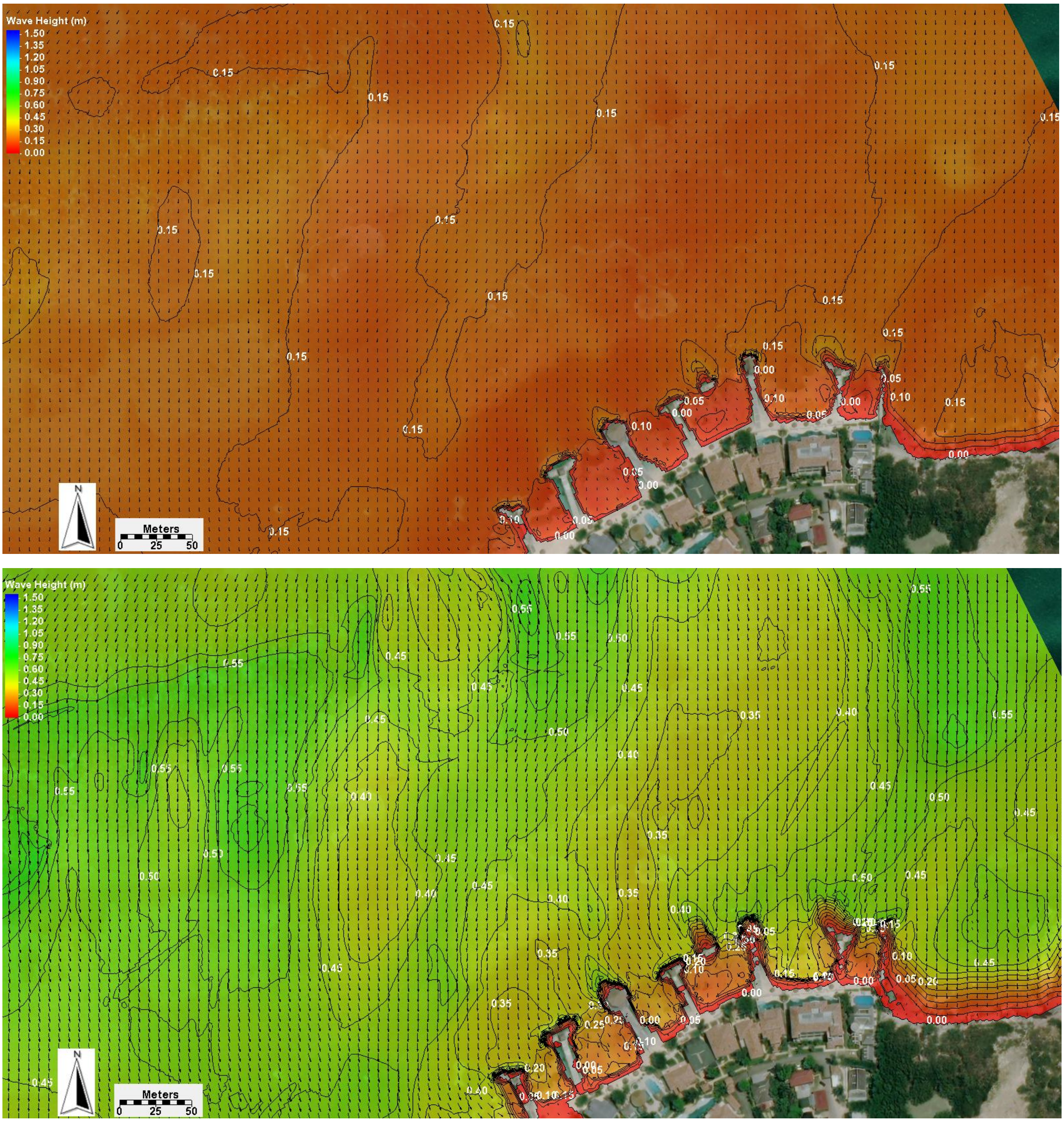


FIGURE 5-15: MODELED WAVE FIELD FOR THE ENE (67.5 DEGREES) INCIDENT WAVE. UPPER PANEL: AVERAGE WAVE CONDITION WITH A SIGNIFICANT WAVE HEIGHT OF 0.32 M AND A PEAK WAVE PERIOD OF 5.26 S. LOWER PANEL: AVERAGE OF TOP 1% HIGH WAVE WITH A SIGNIFICANT WAVE HEIGHT OF 0.98 M AND A PEAK WAVE PERIOD OF 6.99 S. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

The WSW and W incident waves are rare, occurring less than 1% of the time, respectively (**Table 5-1**) The W wave is considerably higher than the WSW wave under both average, 0.53 m versus 0.37 m, and storm conditions, 2.07 m versus 1.56 m. The general wave propagation patterns for these two waves are similar except slightly higher wave under W incidence (**Figure 5-16** and **Figure 5-17**). Compared to the easterly and northerly incident waves as discussed above, due to the reduced protection of the barrier reef along the western portion of the study area, the nearshore waves landward of the reef are higher in the western portion of the study area than in the eastern portion, reaching 0.7 m under storm conditions. This, combined with a slight oblique incident angle near the shoreline, would drive an eastward longshore sand transport. However, due to the rare occurrence of these waves, the beach morphology does not reflect the eastward trend of longshore transport.

The WNW incident wave occurs slightly more frequently, at 2.6% of the time, than the WSW and W waves (**Table 5-1**) as discussed above. The overall wave field is similar to that of the W incident wave (**Figure 5-18**). Overall, the wave height in the western portion of the study area is greater than that in the eastern portion, due to the less protection by the barrier reef for the western portion. Therefore, the WNW incident wave also drives an eastward longshore sand transport along the shoreline. Due to the low occurrence frequency, the WNW wave does not control the beach morphology in the study area, similar to the case of W and WSW waves. The WNW waves result in the highest waves of up to 0.8 m at the western half of the project area. This is part of the reason that the recommended location for the overwater units is located in the eastern portion of the Sandals resort.

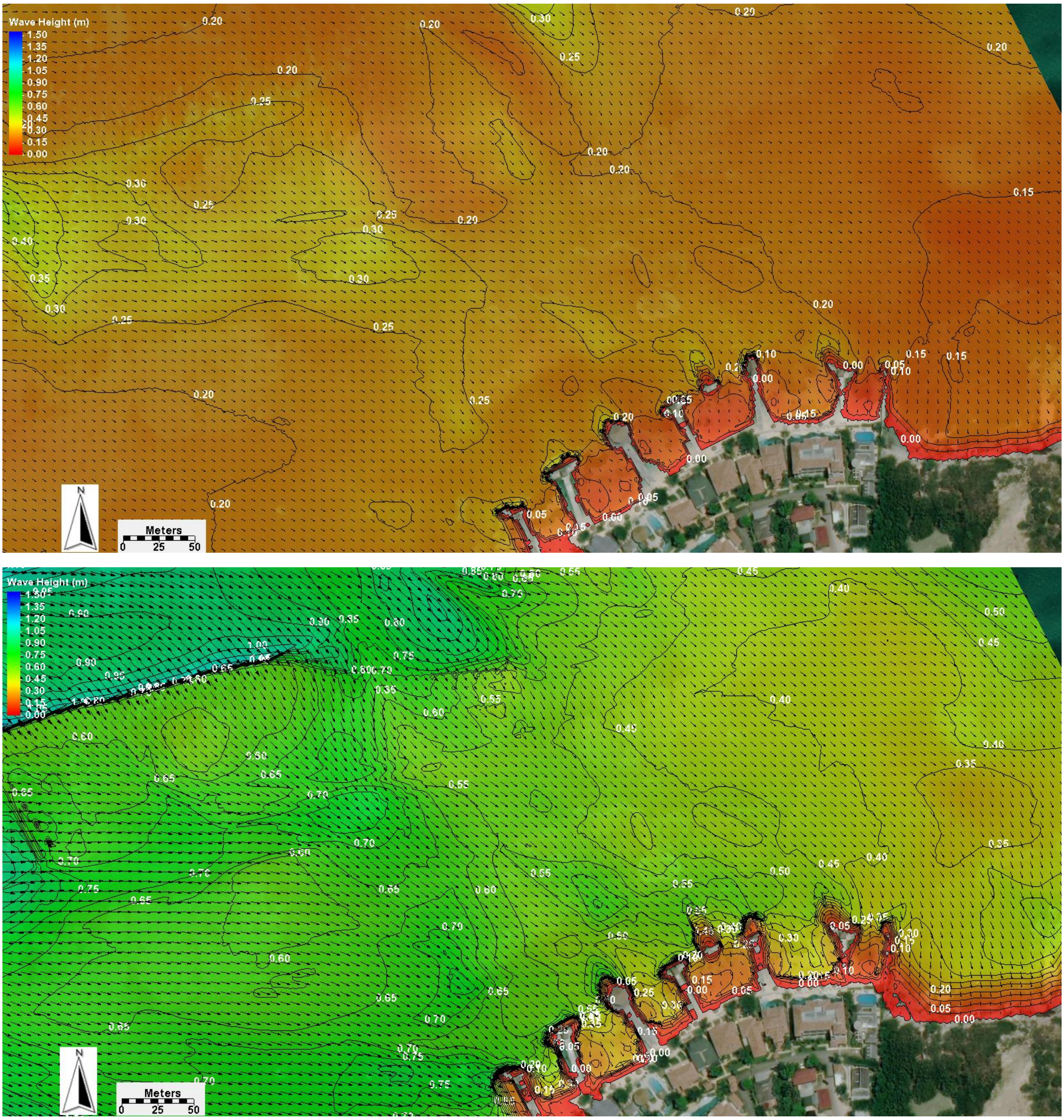


Figure 5-16: Modeled wave field for the WSW (247.5 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.37 m and a peak wave period of 6.37 s. Lower panel: average of top 1% high wave with a significant wave height of 1.68 m and a peak wave period of 8.25 s. zooming in to, e.g., 200%, to view details of the wave fields.

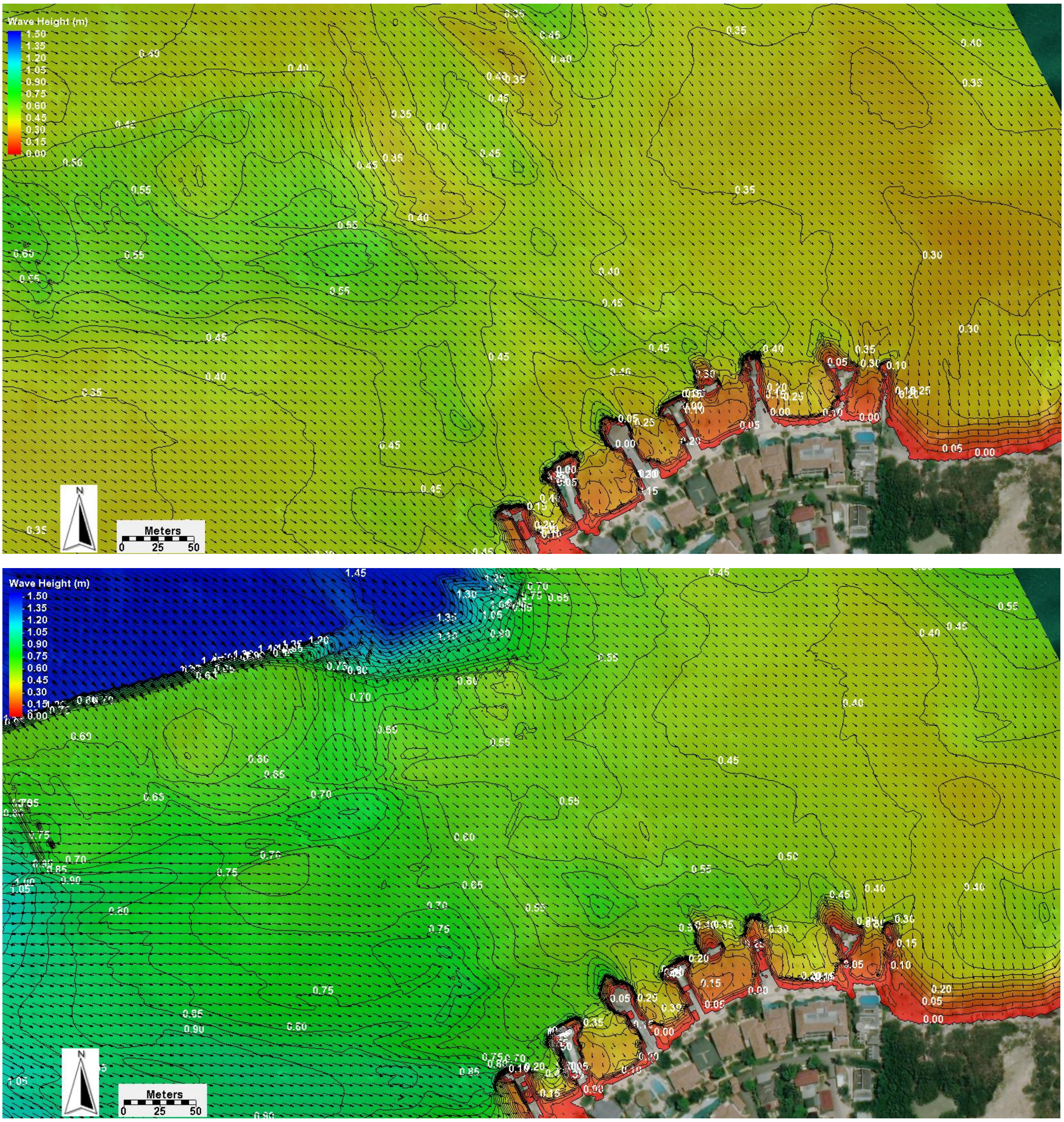


Figure 5-17: Modeled wave field for the W (270 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.53 m and a peak wave period of 6.31 s. Lower panel: average of top 1% high wave with a significant wave height of 2.13 m and a peak wave period of 7.89 s. zooming in to, e.g., 200%, to view details of the wave fields.

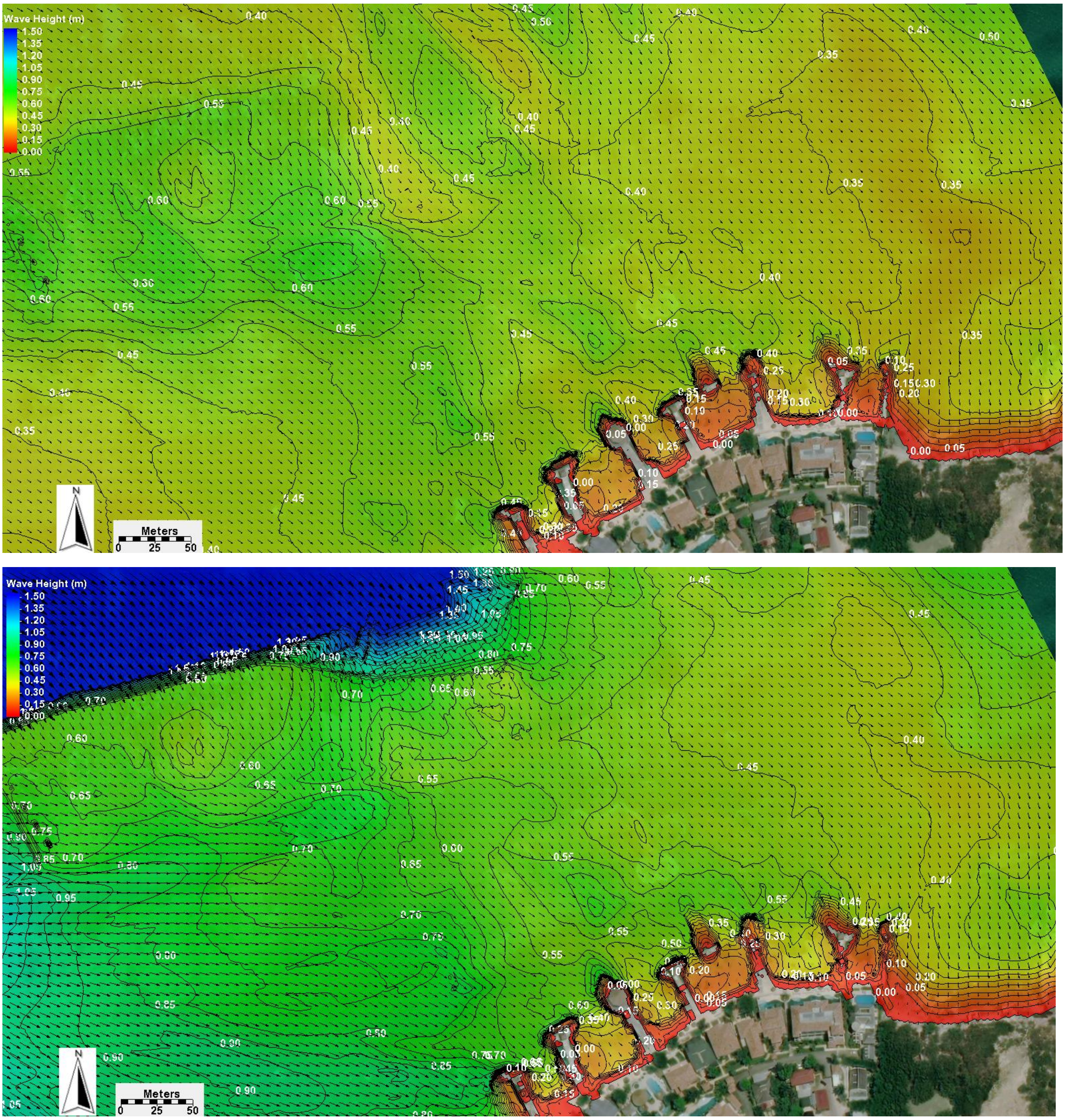


Figure 5-18: Modeled wave field for the WNW (292.5 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.45 m and a peak wave period of 7.52 s. Lower panel: average of top 1% high wave with a significant wave height of 1.92 m and a peak wave period of 7.53 s. zooming in to, e.g., 200%, to view details of the wave fields.

The NW and NNW incident waves are not common, occurring at 2% and 3.6% of the time, respectively (**Table 5-1**). However, they are the most energetic waves, by a considerable margin, under both average and storm conditions. Given the ENE-WSW shoreline and barrier-reef orientation, these waves approach the shoreline at a roughly perpendicular angle. The nearshore wave fields are similar under these two incident conditions. Significant wave height reduction occurs at the barrier reef. The nearshore wave is typically 0.4 to 0.5 m under average condition and 0.6 to 0.7 under storm condition (**Figure 5-19** and **Figure 5-20**). Under both conditions, waves at eastern portion of the resort tend to be 0.1 m to 0.2 m higher than those at the western half of the resort.

In summary, the dominant ENE and NE incident waves result in a relatively higher wave energy around the broad headland in the eastern portion of the study area. This, combined with a westward longshore transport, explains the distribution of sandy beach in the project area, i.e., little to no sandy beach around the headland and widening beach toward the west. The westerly approaching waves, although they tend to be more energetic, do not generate significant eastward longshore sand transport due to their rare occurrence and refraction over the shallow barrier reef. Under nearly all the incident wave conditions, the waves at the western half of the resort are 0.1 m to 0.2 m higher than those at the eastern half. The recommended location for overwater units is in the eastern portion of the resort and is better protected by the barrier reef.

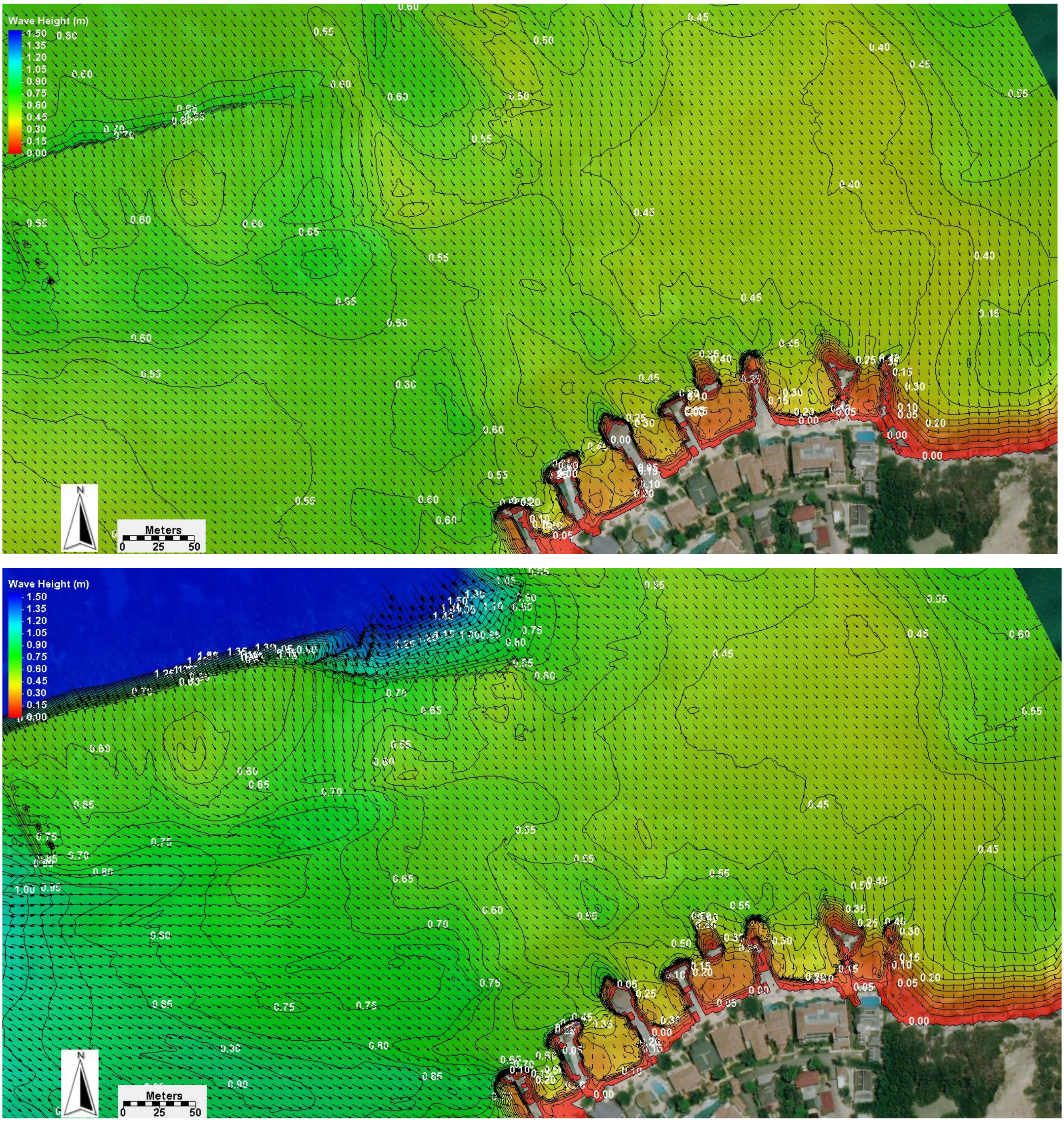


Figure 5-19: Modeled wave field for the NW (315 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.60 m and a peak wave period of 5.42 s. Lower panel: average of top 1% high wave with a significant wave height of 2.29 m and a peak wave period of 7.53 s. zooming in to, e.g., 200%, to view details of the wave fields.

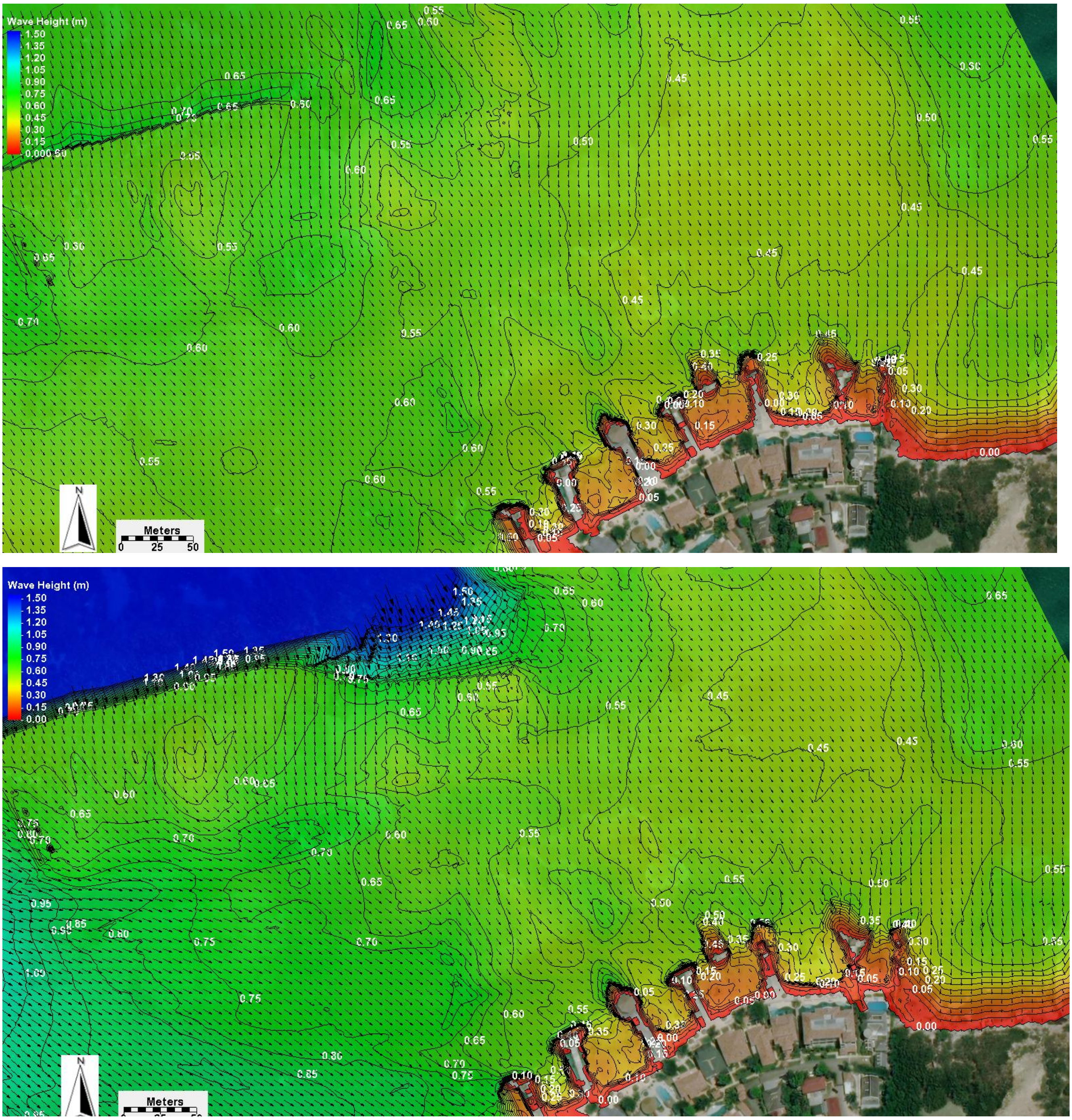


Figure 5-20: Modeled wave field for the NNW (337.5 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.65 m and a peak wave period of 4.87 s. Lower panel: average of top 1% high wave with a significant wave height of 2.28 m and a peak wave period of 6.87 s. zooming in to, e.g., 200%, to view details of the wave fields.

Modeled Wave Field with a 0.7 m Surge.

The simulated wave fields illustrated and discussed above are related to mean sea level. However, under storm conditions, the energetic waves, i.e., the top 1% highest waves, tend to be superimposed on a storm surge. A storm surge would increase the water depth over the barrier reef and subsequently weaken its ability to dissipate incident wave energy. The same wave conditions as discussed above were simulated with a storm surge of 0.7 m. The modeled wave fields are illustrated (**Figure 5-21** through **Figure 5-24)** and discussed in this section.

Under average wave conditions (**Figure 5-21, Figure 5-22, Figure 5-23, Figure 5-25, Figure 5-26, Figure 5-27, Figure 5-28** and **Figure 5-29** upper panel), the simulated wave fields with a storm surge are just slightly higher than those without a surge, as discussed above. This is because the average waves propagate over the barrier reef with limited energy reduction.

Under storm wave conditions (**Figure 5-21**, **Figure 5-22**, **Figure 5-23**, **Figure 5-24**, **Figure 5-25**, **Figure 5-26**, **Figure 5-27**, **Figure 5-28** and **Figure 5-29** lower panel), the nearshore waves superimposed on a 0.7 m storm surge are much higher than those without the surge. The much deeper water, generally 1.5 m versus 0.8 m, over the barrier reef allows significantly more wave energy to pass over the barrier reef and reach the project site. The highest wave can reach 1.40 m in the western half of the Sandals Resort for the W, WNW, and NW incident waves. This is nearly 0.7 m higher than the waves without the surge. For the waves approaching from other directions, storm waves can reach 1.20 m for WSW incident waves. However, for the much more frequent northeasterly waves, the maximum height in the western half of the resort is mostly lower than 1 m, or about 0.4 m higher than the case without a surge.

It is worth noting that the energetic northwesterly incident waves tend to be associated with winter cold front passages, as opposed to tropical storms. The winter waves are less likely to be superimposed over a storm surge. Therefore, the wave heights illustrated in Figures **Figure 5-21** through **Figure 5-29** lower panels likely represent the maximum wave height for the project site.

Similar to the mean sea level case, the eastern portion of the resort tends to have lower waves than those in the western portion. This is related to better protection by the barrier reef. In summary, the wave modelling results suggest that the proposed overwater bungalow locations in the eastern portion of the resort have lower waves than the potential bungalow locations to the west.

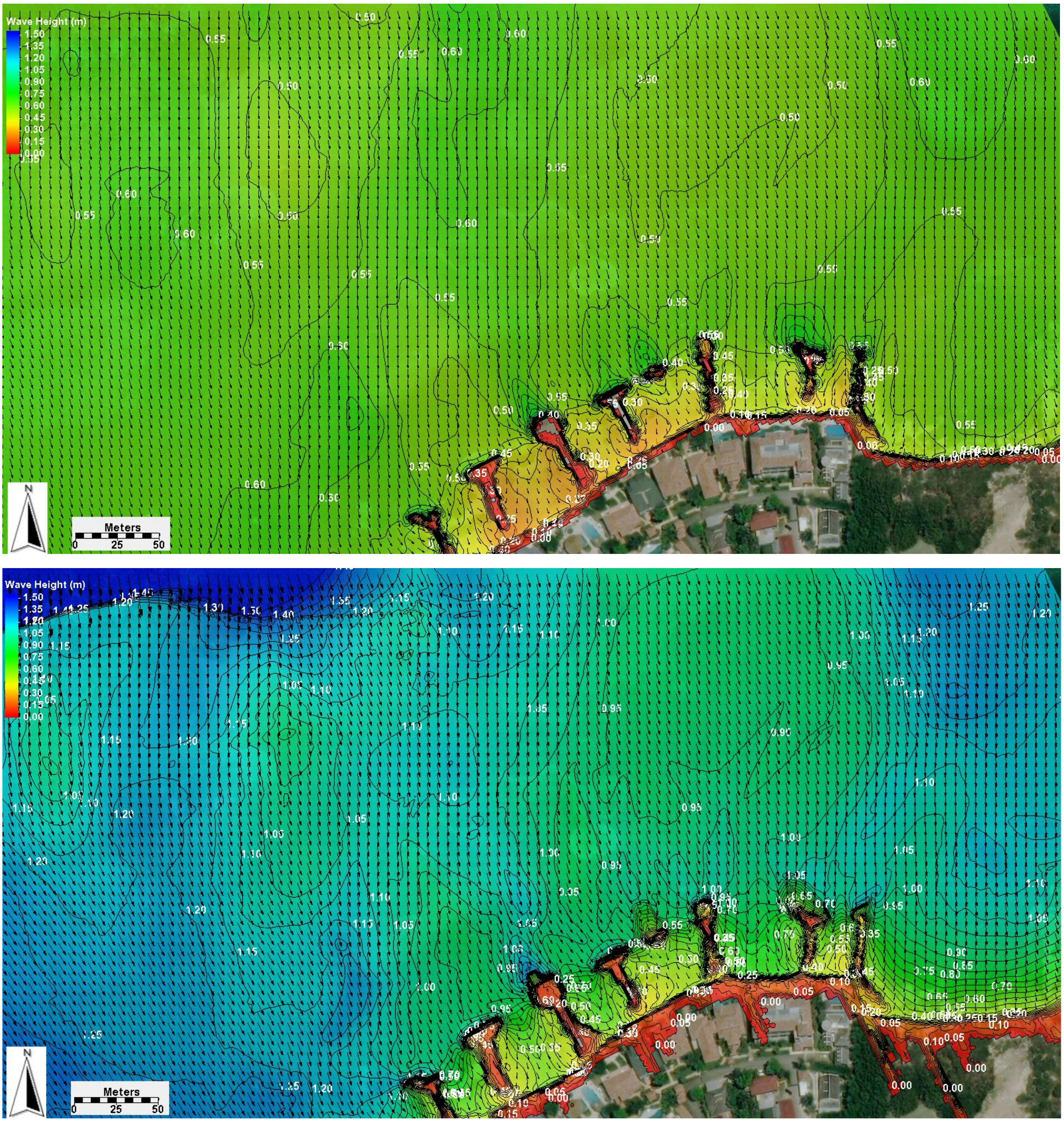


Figure 5-21: Modeled wave field for the N (0 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.55 m and a peak wave period of 4.64 s. Lower panel: average of top 1% high wave with a significant wave height of 1.95 m and peak wave period of 6.33 s. zooming in to, e.g., 200%, to view details of the wave fields.

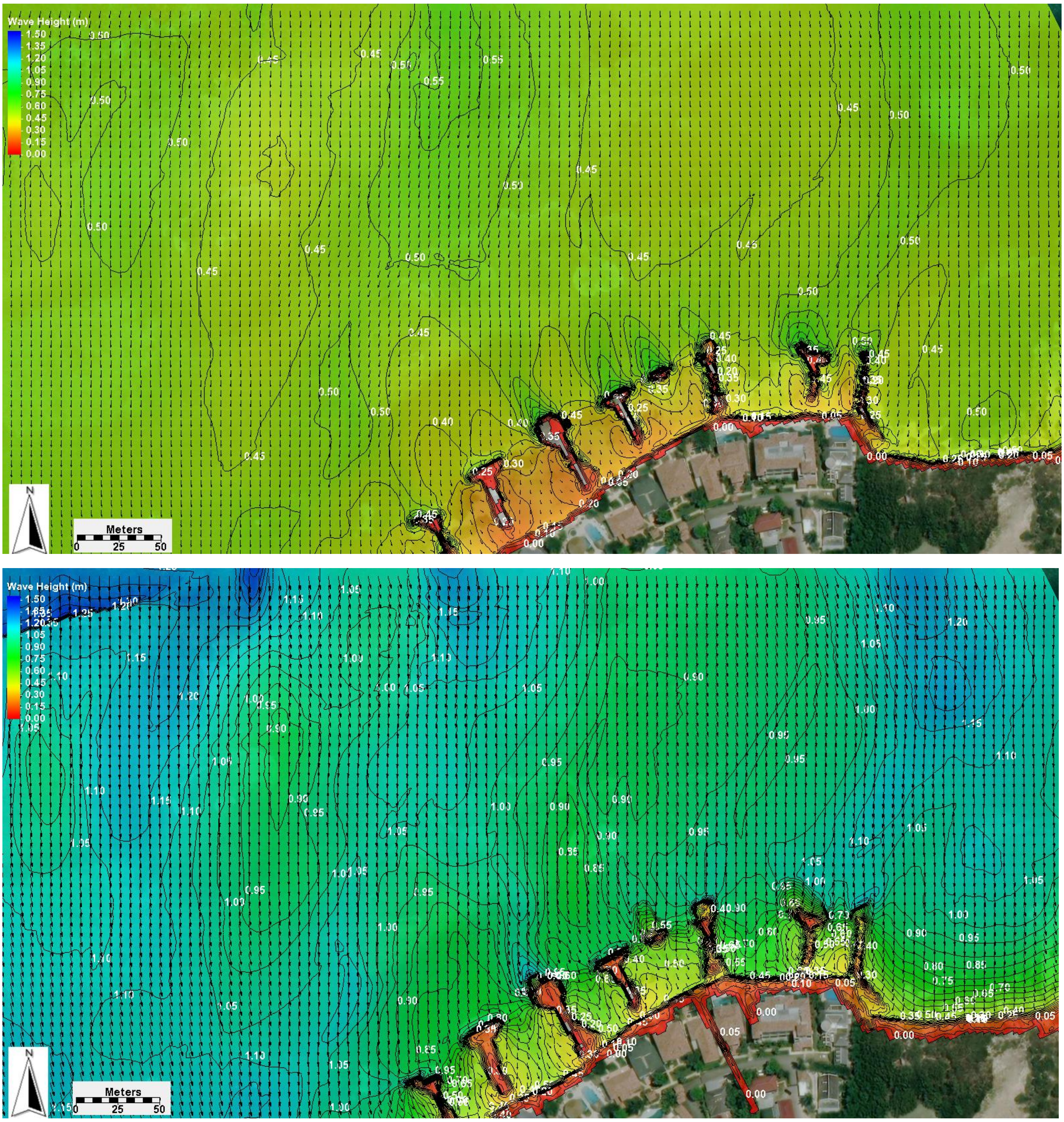


Figure 5-22: Modeled wave field for the NNE (22.5 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.52 m and a peak wave period of 4.51 s. Lower panel: average of top 1% high wave with a significant wave height of 1.47 m and a peak wave period of 5.86 s. zooming in to, e.g., 200%, to view details of the wave fields.

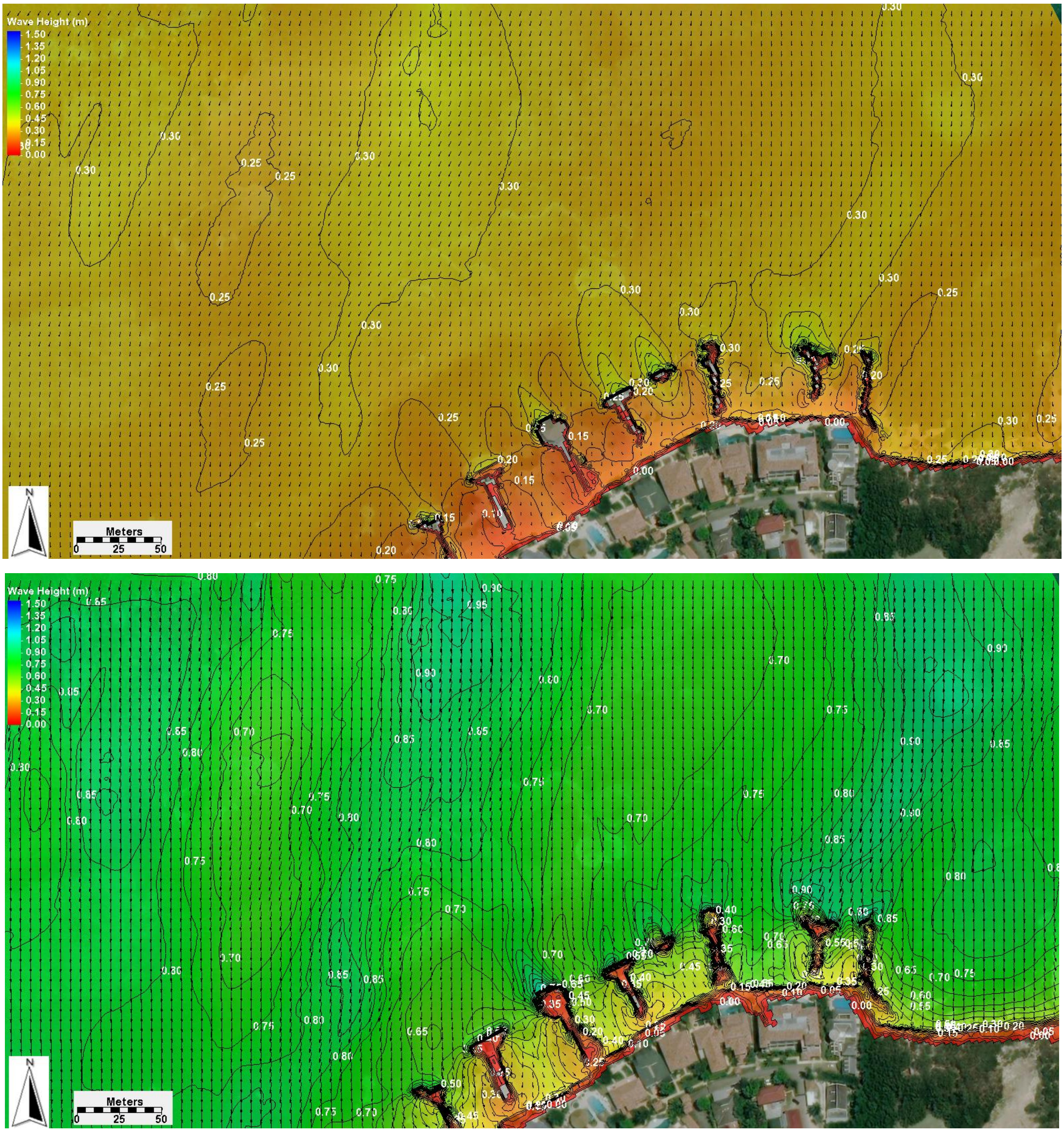


Figure 5-23: Modeled wave field for the NE (45 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.39 m and a peak wave period of 3.88 s. Lower panel: average of top 1% high wave with a significant wave height of 1.16 m and a peak wave period of 5.68 s. zooming in to, e.g., 200%, to view details of the wave fields.

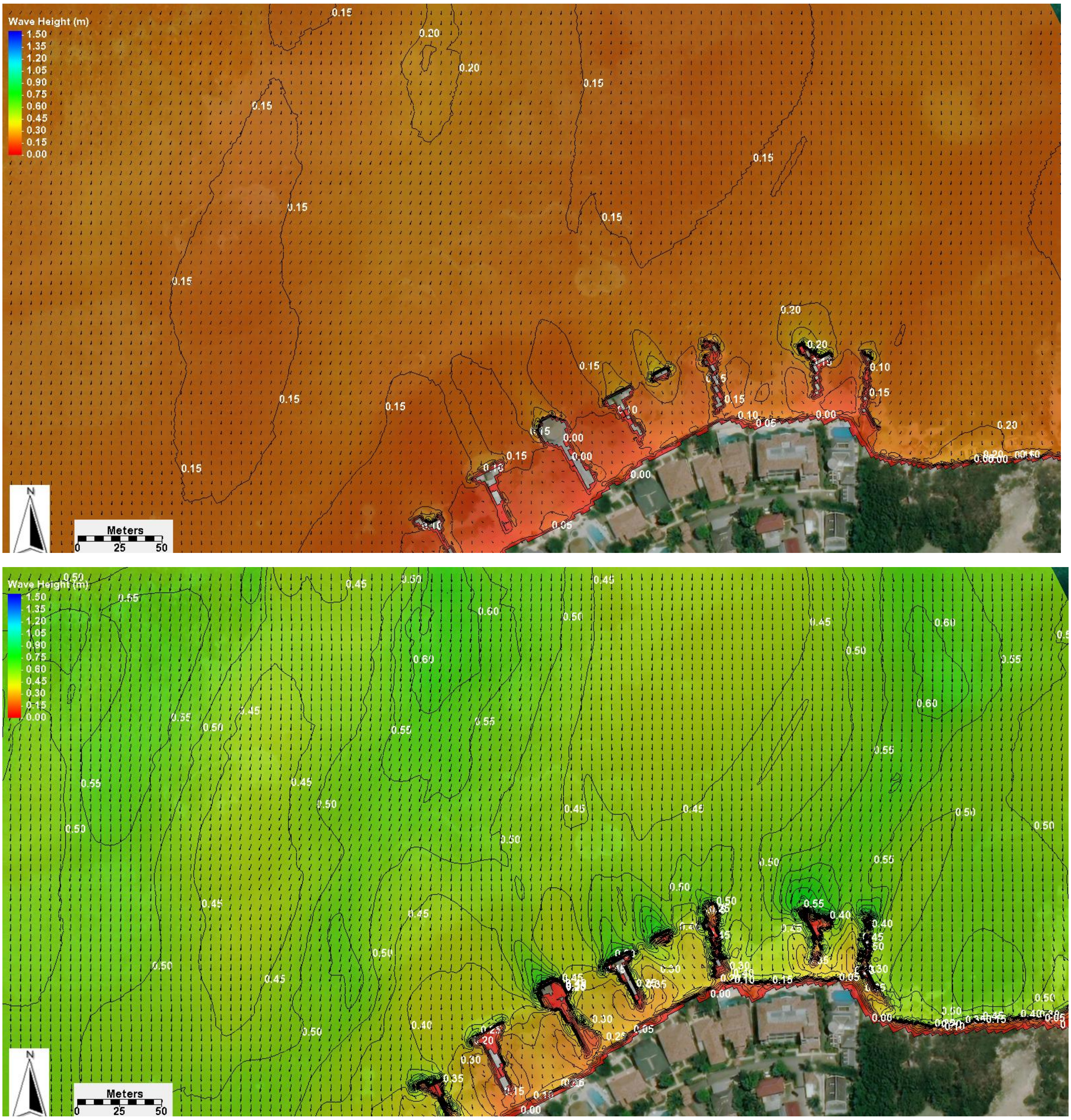


FIGURE 5-24: MODELED WAVE FIELD FOR THE ENE (67.5 DEGREES) INCIDENT WAVE. UPPER PANEL: AVERAGE WAVE CONDITION WITH A SIGNIFICANT WAVE HEIGHT OF 0.32 M AND A PEAK WAVE PERIOD OF 5.26 S. LOWER PANEL: AVERAGE OF TOP 1% HIGH WAVE WITH A SIGNIFICANT WAVE HEIGHT OF 0.98 M AND A PEAK WAVE PERIOD OF 6.99 S. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

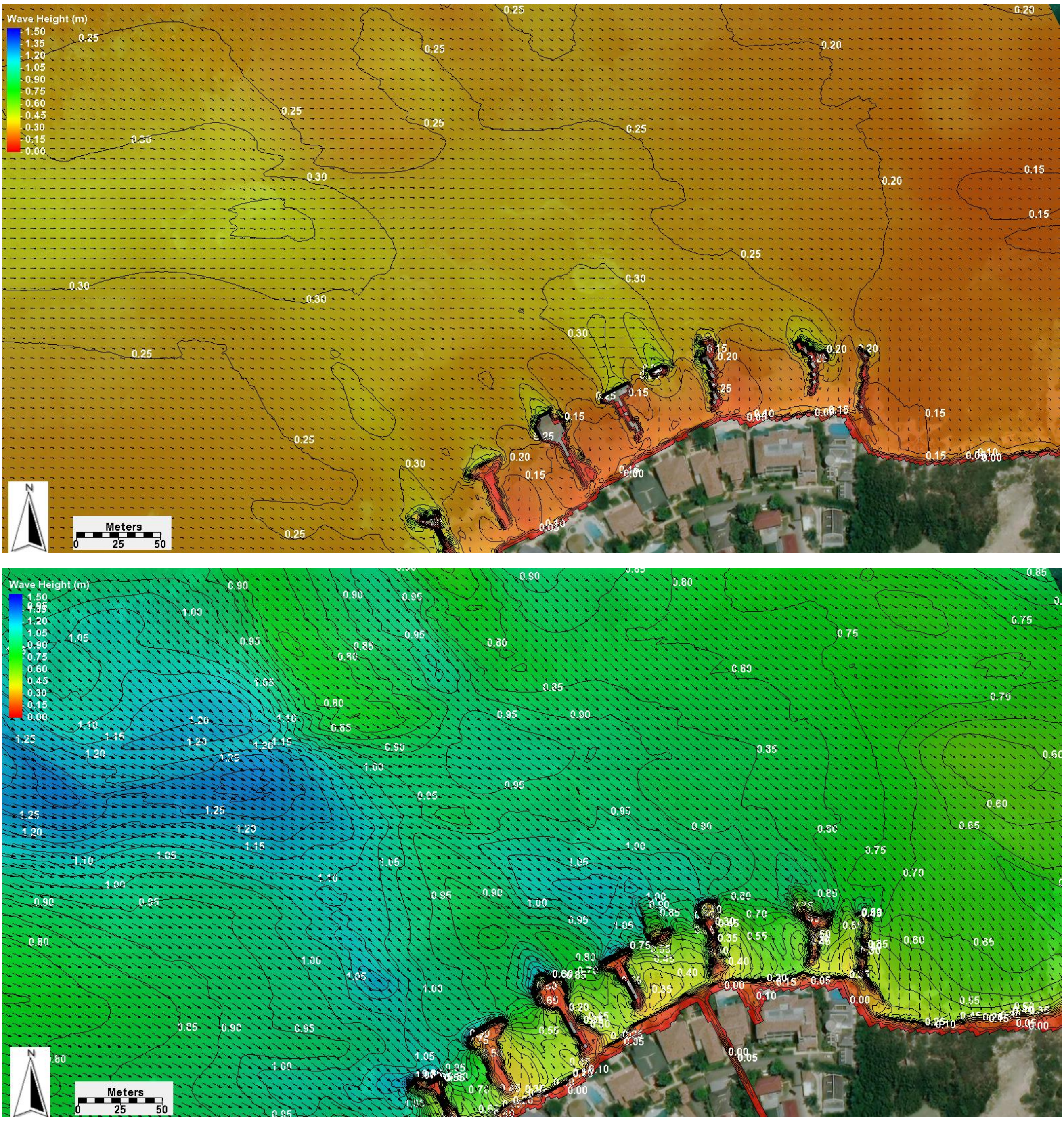


Figure 5-25: Modeled wave field for the WSW (247.5 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.37 m and a peak wave period of 6.37 s. Lower panel: average of top 1% high wave with a significant wave height of 1.68 m and a peak wave period of 8.25 s. zooming in to, e.g., 200%, to view details of the wave fields.

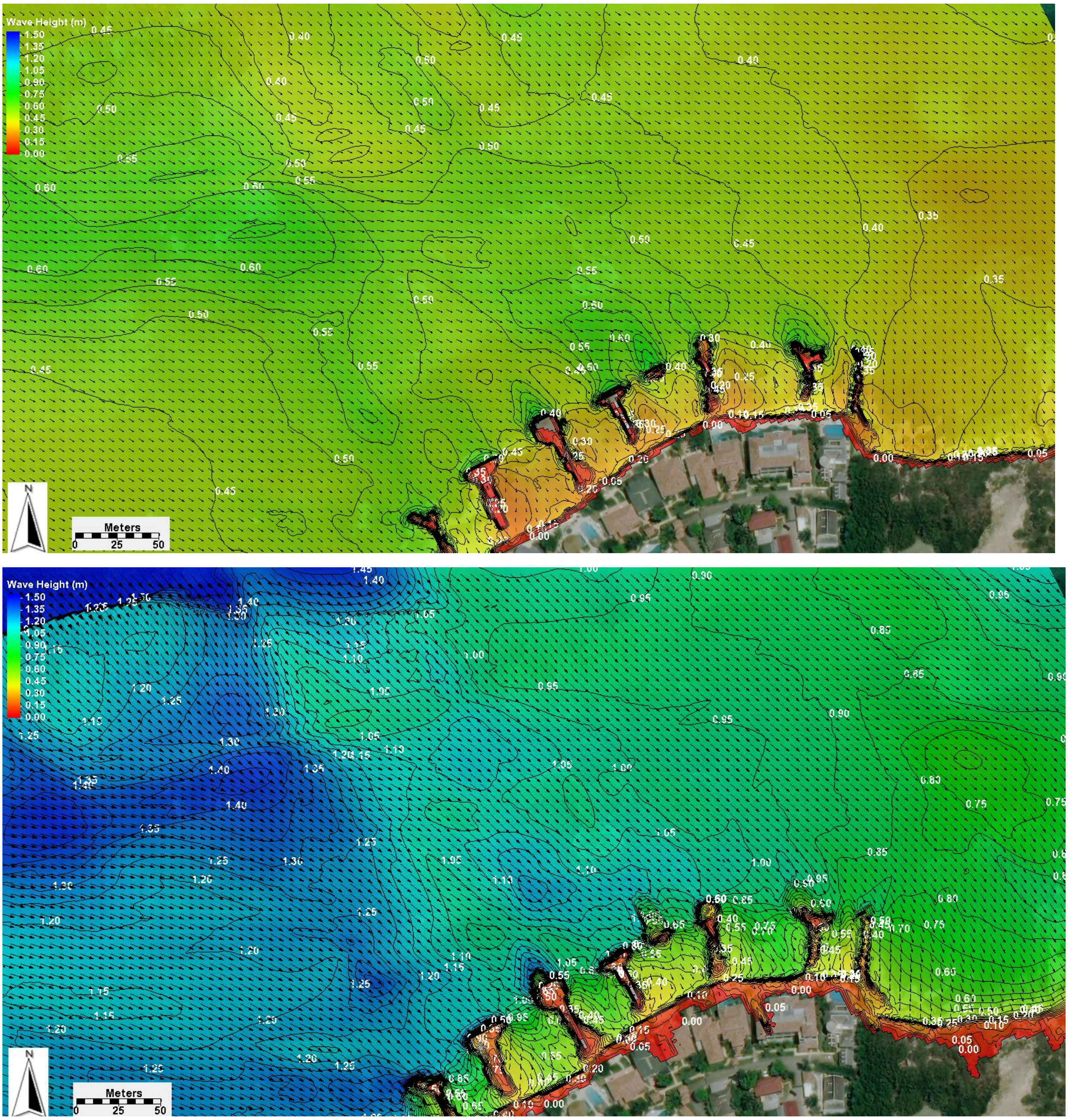


Figure 5-26: Modeled wave field for the W (270 degrees) incident wave. Upper panel: average wave condition with a significant wave height of 0.53 m and a peak wave period of 6.31 s. Lower panel: average of top 1% high wave with a significant wave height of 2.13 m and a peak wave period of 7.89 s. zooming in to, e.g., 200%, to view details of the wave fields.

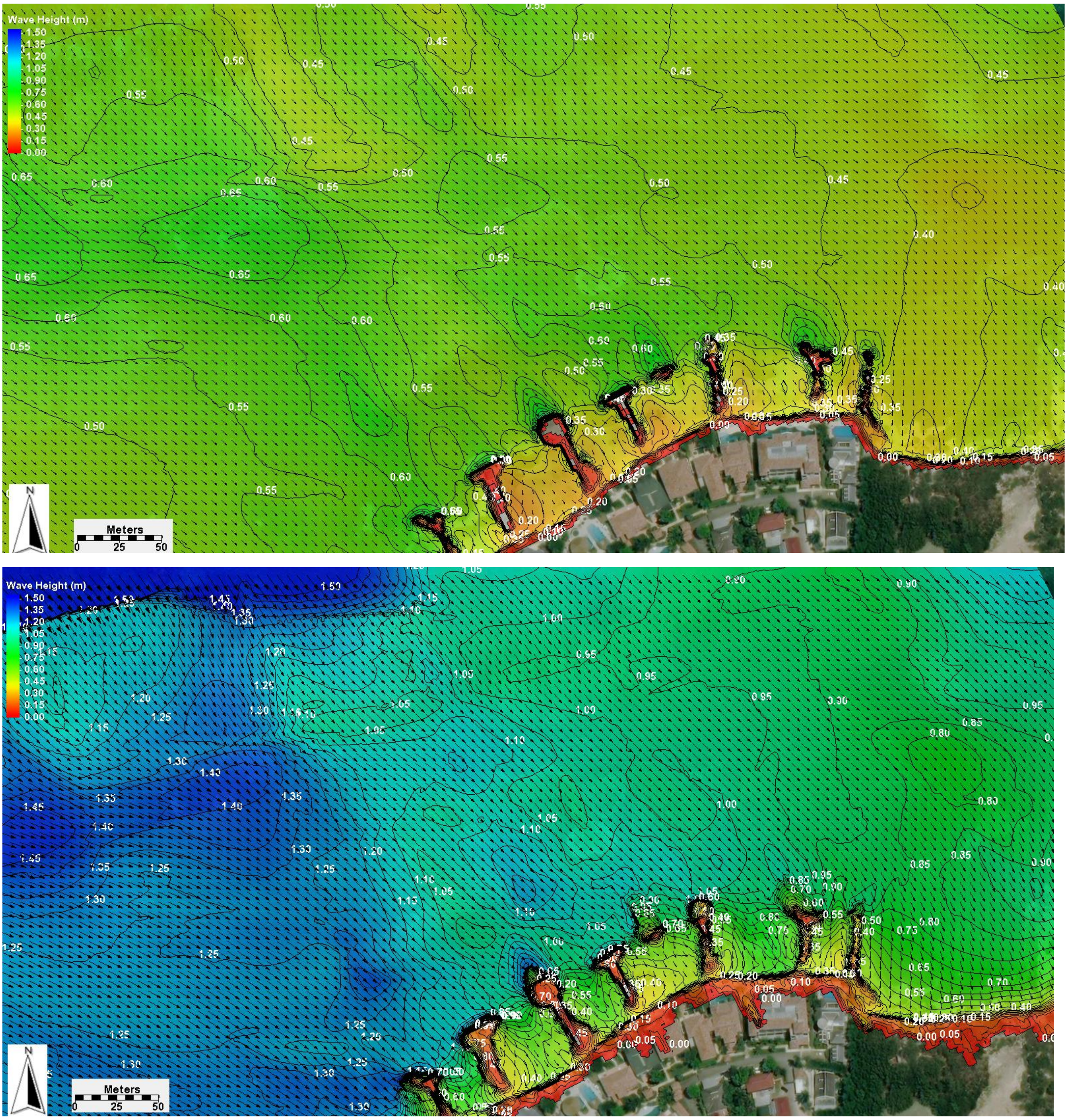


FIGURE 5-27: MODELED WAVE FIELD FOR THE WNW (292.5 DEGREES) INCIDENT WAVE. UPPER PANEL: AVERAGE WAVE CONDITION WITH A SIGNIFICANT WAVE HEIGHT OF 0.45 M AND A PEAK WAVE PERIOD OF 7.52 S. LOWER PANEL: AVERAGE OF TOP 1% HIGH WAVE WITH A SIGNIFICANT WAVE HEIGHT OF 1.92 M AND A PEAK WAVE PERIOD OF 7.53 S. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

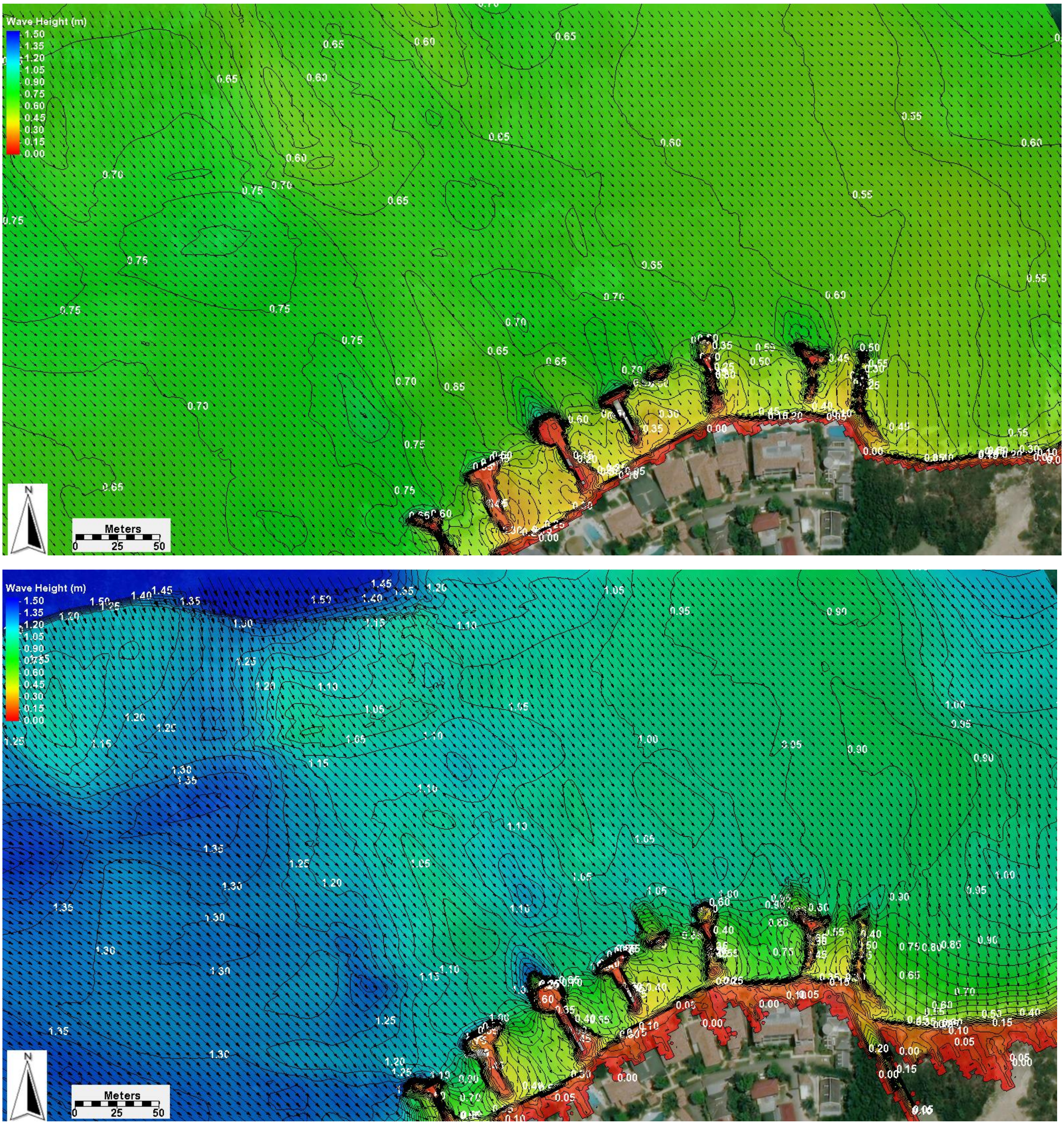


FIGURE 5-28: MODELED WAVE FIELD FOR THE NW (315 DEGREES) INCIDENT WAVE. UPPER PANEL: AVERAGE WAVE CONDITION WITH A SIGNIFICANT WAVE HEIGHT OF 0.60 M AND A PEAK WAVE PERIOD OF 5.42 S. LOWER PANEL: AVERAGE OF TOP 1% HIGH WAVE WITH A SIGNIFICANT WAVE HEIGHT OF 2.29 M AND A PEAK WAVE PERIOD OF 7.53 S. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

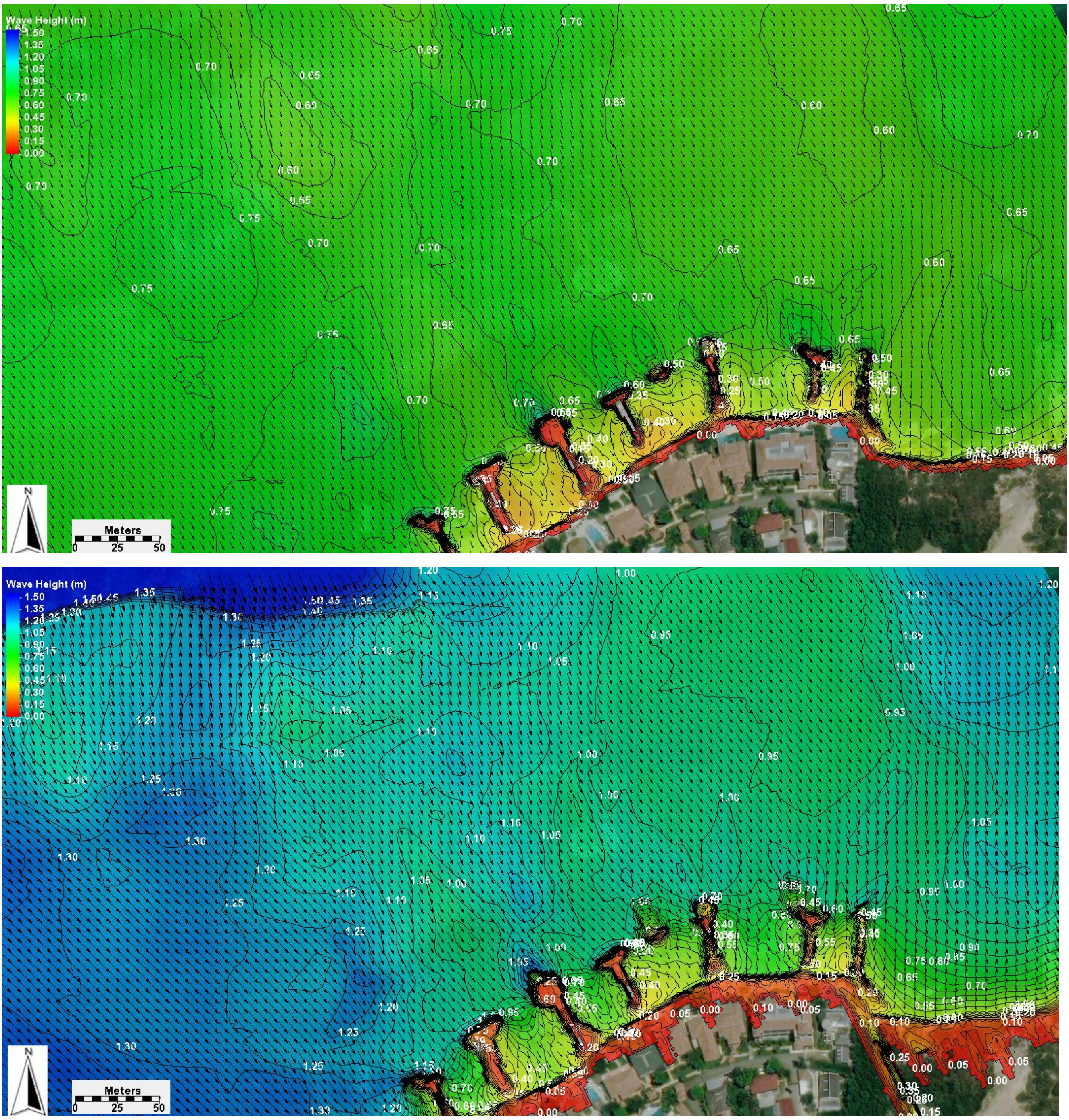


FIGURE 5-29: MODELED WAVE FIELD FOR THE NNW (337.5 DEGREES) INCIDENT WAVE. UPPER PANEL: AVERAGE WAVE CONDITION WITH A SIGNIFICANT WAVE HEIGHT OF 0.65 M AND A PEAK WAVE PERIOD OF 4.87 S. LOWER PANEL: AVERAGE OF TOP 1% HIGH WAVE WITH A SIGNIFICANT WAVE HEIGHT OF 2.28 M AND A PEAK WAVE PERIOD OF 6.87 S. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

5.1.1.6 Simulated Wave Field under Modified Condition at Mean Sea Level

The wave modeling grid used in this study has a size of 2 x 2 m to cover the relatively large project area extending seaward of the barrier reef. The small grid size is necessary to ensure adequate resolution of features such as the barrier reef and the groyne field along the shoreline. However, the 2 x 2 m grid is still much larger than the dimension (i.e., the diameter) of the pilings supporting the overwater units. The diameter of the pilings, as well as the 2 x 2 m grid size, is much smaller than the wavelength which is of the order of 10s of meters. Therefore, the pilings of the overwater units cannot be accurately represented in the wave model due to their much smaller size. Here, all the pilings supporting each overwater unit are represented in a combined manner by one 2 x 2 m grid. Although not resolving individual pilings, the combined representation should provide a reasonable approximation.

The modeled wave fields including the pilings supporting the recommended overwater units are shown in **Figure 5-30**, **Figure 5-31**, **Figure 5-32**, **Figure 5-33**, **Figure 5-34**, **Figure 5-35**, **Figure 5-36**, **Figure 5-37**, **Figure** and **Figure 5-38**. Only the wave field associated with storm conditions is shown. No storm surge was included in this set of model runs.

The pilings have minimal influence on the overall nearshore wave field, as shown in **Figure 5-30, Figure 5-31, Figure 5-32**, **Figure 5-33**, **Figure 5-34**, **Figure 5-35**, **Figure 5-36**, **Figure 5-37**, **Figure** and **Figure 5-38**. Localised wave-piling interactions occur at each overwater unit. However, the minor wave-piling interactions are limited to the immediate vicinity of the piling and do not overlap among different pilings. Overall, the pilings do not have significant influence on the wave field and nearshore wave conditions. Given the very small size of the pilings in comparison with the project site, minimal and highly localised influence is expected.

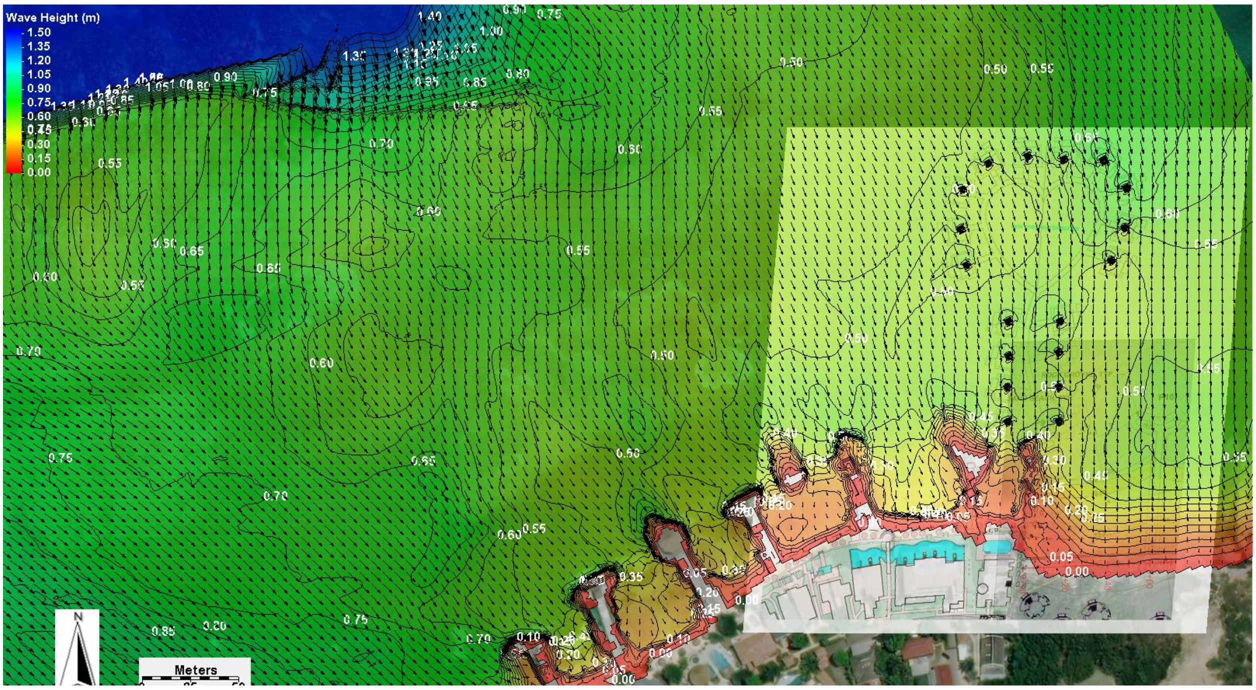


FIGURE 5-30: MODELED WAVE FIELD FOR N (0 DEG) INCIDENT STORM WAVE (HSIG = 1.95 M, TP = 6.33 S) UNDER PROPOSED CONDITIONS. NOTE THE COLOR SCHEME AT THE OVERWATER UNITS' LOCATION WAS CHANGED BY THE BACKGROUND IMAGE. THE WAVE HEIGHT VALUES CAN BE OBTAINED FROM THE CONTOUR LINES. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

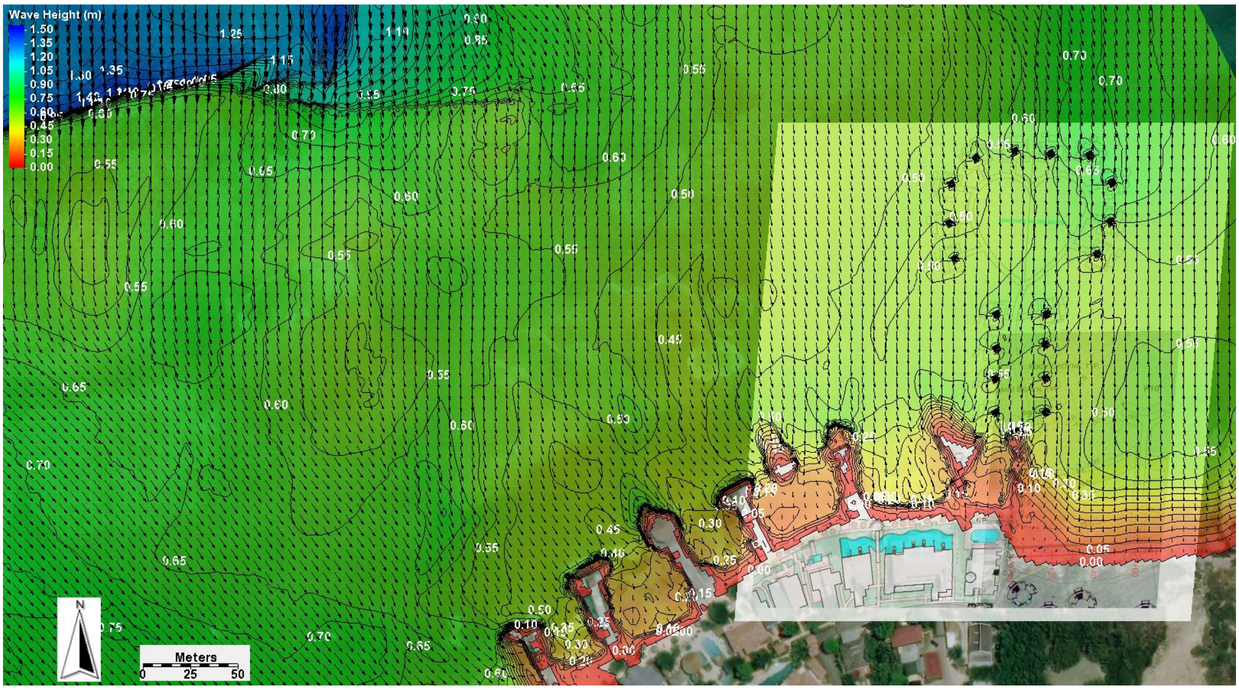


FIGURE 5-31: MODELED WAVE FIELD FOR NNE (22.5 DEG) INCIDENT STORM WAVE (HSIG = 1.47 M, TP = 5.86 S) UNDER PROPOSED CONDITIONS. NOTE THE COLOR SCHEME AT THE OVERWATER UNITS' LOCATION WAS CHANGED BY THE BACKGROUND IMAGE. THE WAVE HEIGHT VALUES CAN BE OBTAINED FROM THE CONTOUR LINES. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

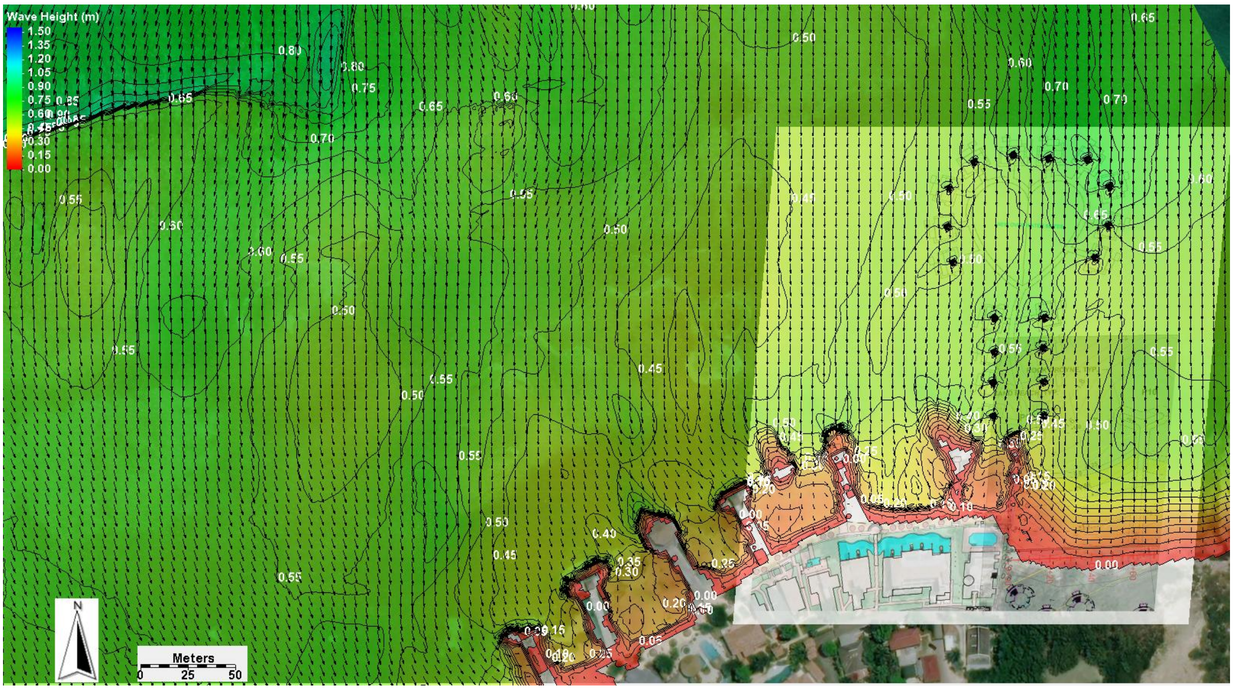


Figure 5-32: Modeled wave field for NE (45 deg) incident storm wave (Hsig = 1.16 m, Tp = 5.68 s) under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

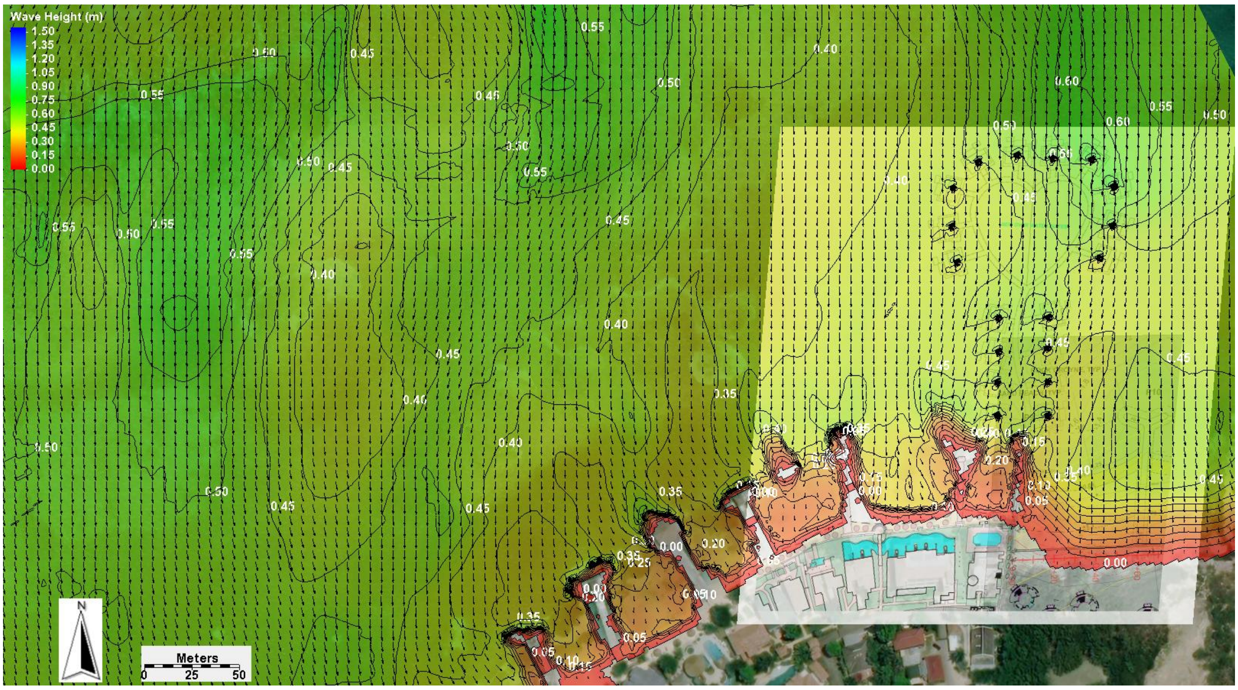


Figure 5-33: Modeled wave field for ENE (67.5 deg) incident storm wave (Hsig = 0.98 m, Tp = 6.99 s) under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

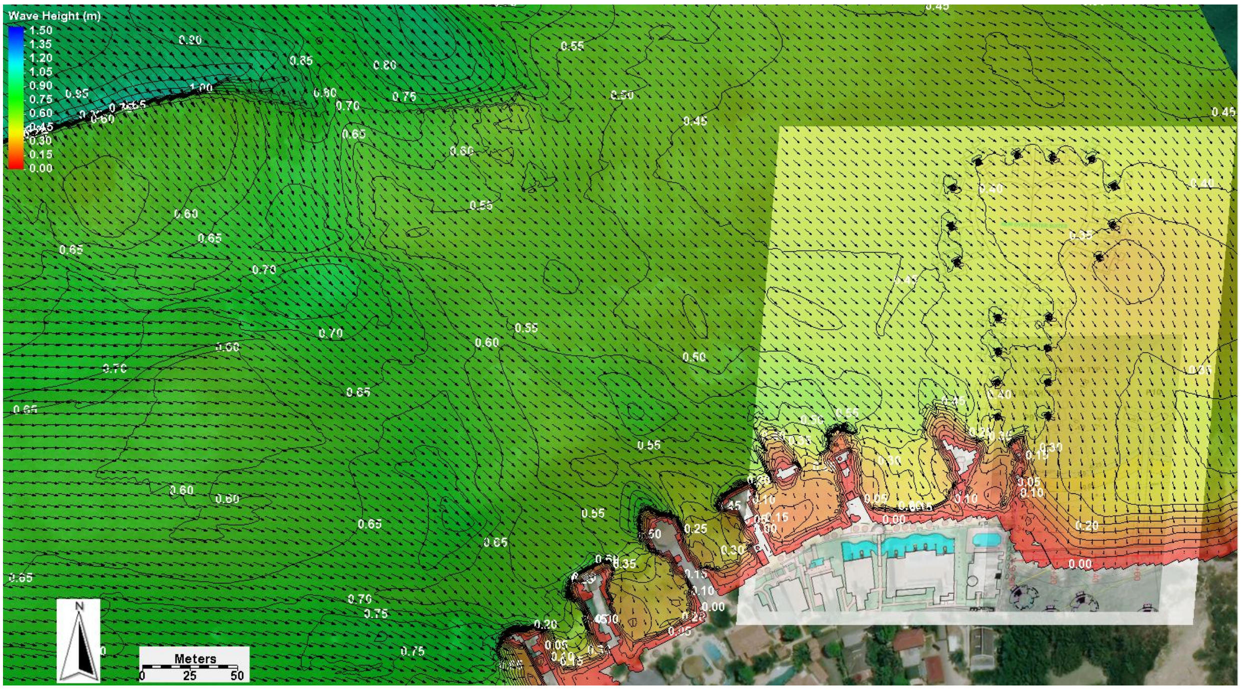


Figure 5-34: Modeled wave field for WSW (247.5 deg) incident storm wave (Hsig = 1.68 m, Tp = 8.25 s) under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

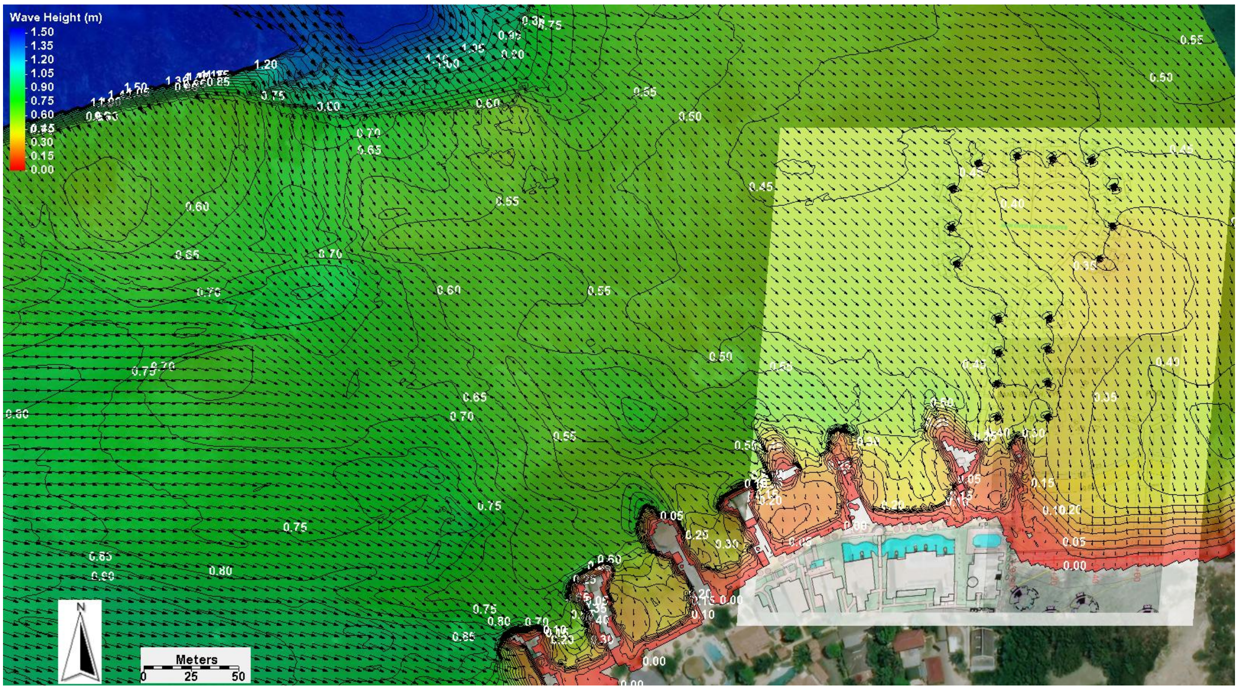


Figure 5-35: Modeled wave field for W (270 deg) incident storm wave (Hsig = 2.13 m, Tp = 7.89 s) under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

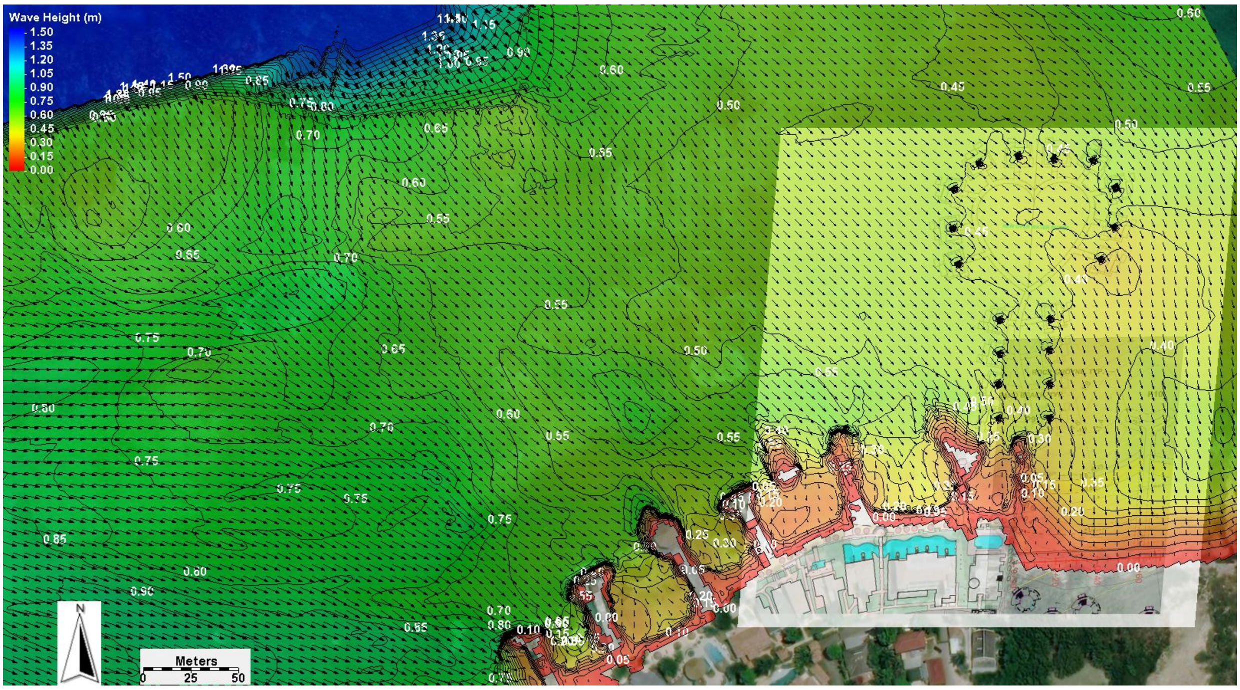


Figure 5-36: Modeled wave field for WNW (292.5 deg) incident storm wave (hsig = 1.92 m, tp = 7.53 s) under proposed conditions. note the color scheme at the overwater units' location was changed by the background image. the wave height values can be obtained from the contour lines. zooming in to, e.g., 200%, to view details of the wave fields.

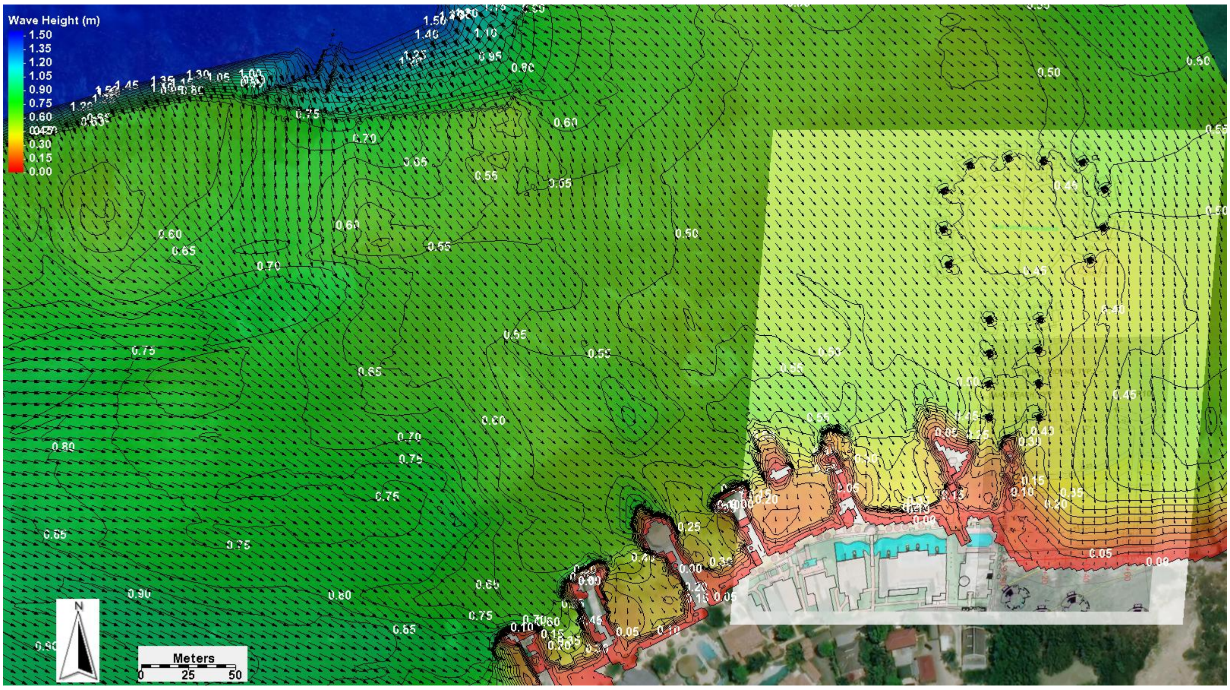


Figure 5-37: Modeled wave field for NW (315 deg) incident storm wave (hsig = 2.29 m, tp = 7.53 s) under proposed conditions. note the color scheme at the overwater units' location was changed by the background image. the wave height values can be obtained from the contour lines. zooming in to, e.g., 200%, to view details of the wave fields.

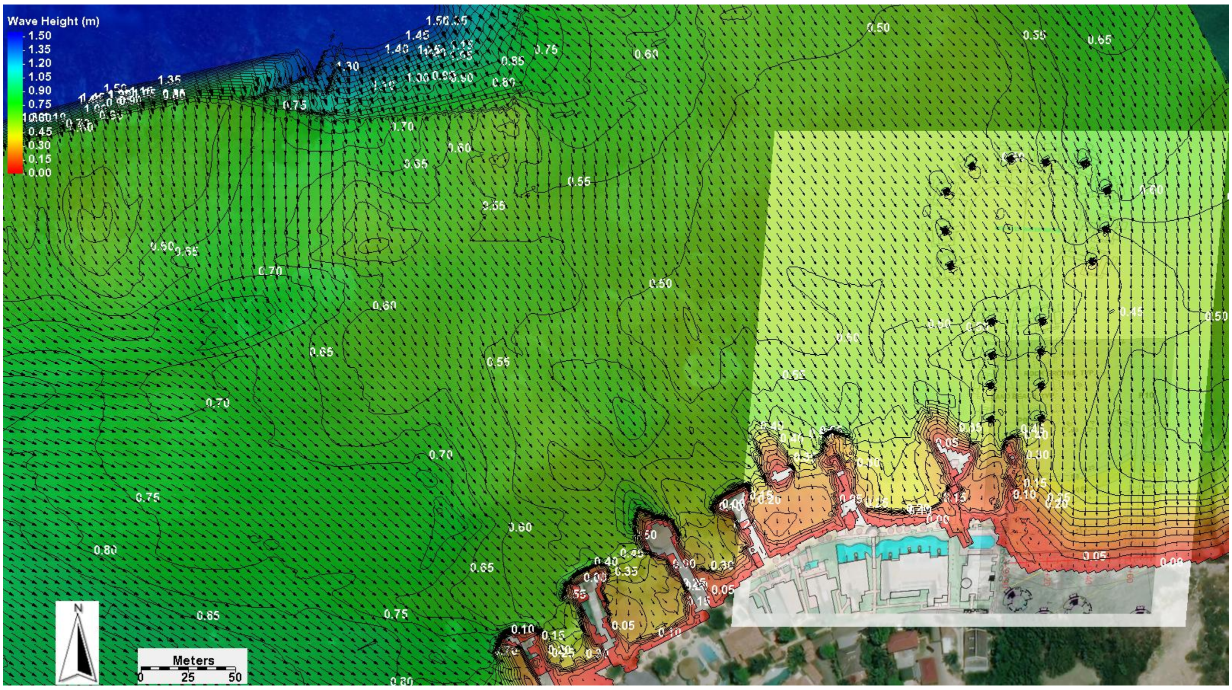


Figure: Modeled wave field for nnw (337.5 deg) incident storm wave (hsig = 2.28 m, tp = 6.87 s) under proposed conditions. note the color scheme at the overwater units' location was changed by the background image. the wave height values can be obtained from the contour lines. zooming in to, e.g., 200%, to view details of the wave fields.

5.1.1.7 Simulated Wave Field under Modified Condition with a 0.7 m Storm Surge

As discussed in the previous sections, a storm surge significantly increases the water depth over the barrier reef. This reduces the wave-energy dissipation by the reef, resulting in relatively high waves of up to 1.4 m in the project area, with generally higher waves in western portion of the resort than in the eastern portion.

The modeled wave fields with a 0.7 m storm surge including the pilings supporting the overwater units are shown in **Figure 5-38, Figure 5-39, Figure 5-40, Figure 5-41, Figure 5-42, Figure 5-43, Figure 5-44, Figure 5-45** and **Figure 5-46**. Under most of the incident wave conditions, the nearshore waves at the western portion of the resort are higher than those at the eastern portion. This is the main reason that the recommended location for the overwater units is located in the eastern portion of the resort. Only the wave field associated with storm conditions is shown in **Figure 5-38, Figure 5-39, Figure 5-40, Figure 5-41, Figure 5-42, Figure 5-43, Figure 5-44, Figure 5-45** and **Figure 5-46.**

Similar to the case without a storm surge as discussed in the previous section, the pilings have minimal influence on the overall nearshore wave fields, as shown in **Figure**, **Figure 5-38, Figure 5-39, Figure 5-40, Figure 5-41, Figure 5-42, Figure 5-43, Figure 5-44, Figure 5-45** and **Figure 5-46**. Localised wave-piling interactions occur at each overwater unit. However, compared to the mean sea level case, the areas of wave-piling interaction are slightly larger with some overlap among different pilings. Overall, the pilings do not have significant influence on the wave field and nearshore wave conditions. Given the very small size of the pilings in comparison with the project site, minimal and highly localised influence is expected even under storm conditions with a surge.

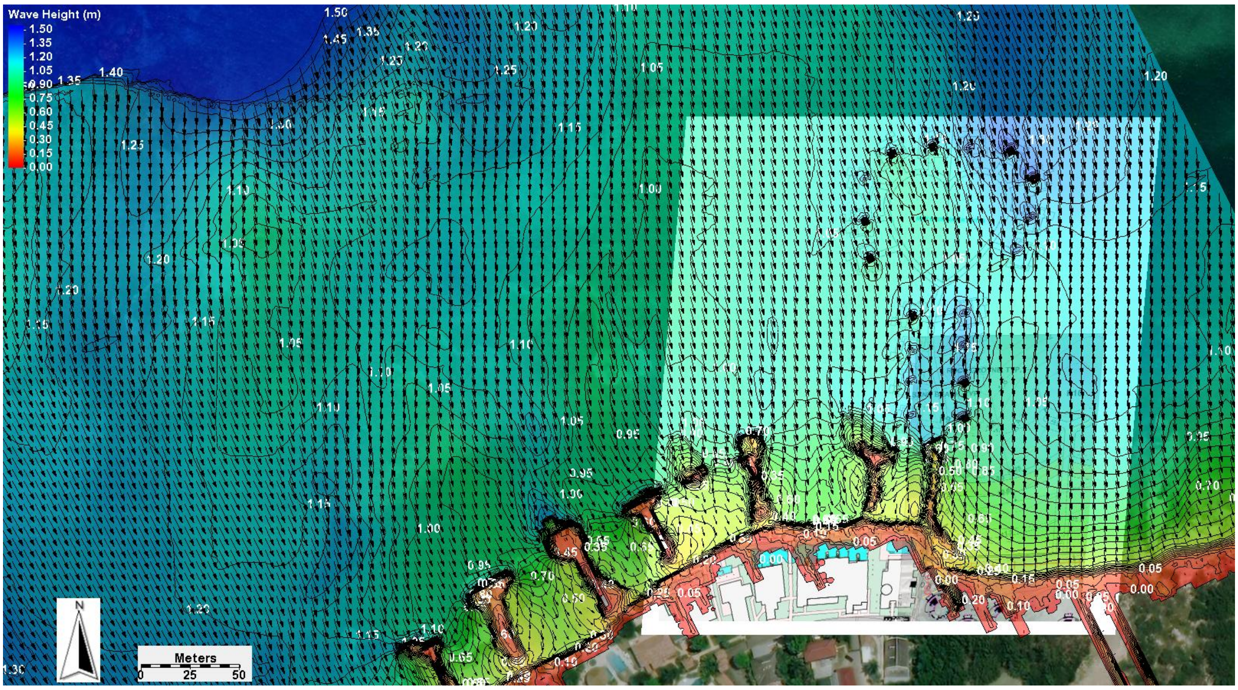


Figure 5-38: Modeled wave field for N (0 deg) incident storm wave (Hsig = 1.95 m, Tp = 6.33 s) with a 0.7 m surge under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

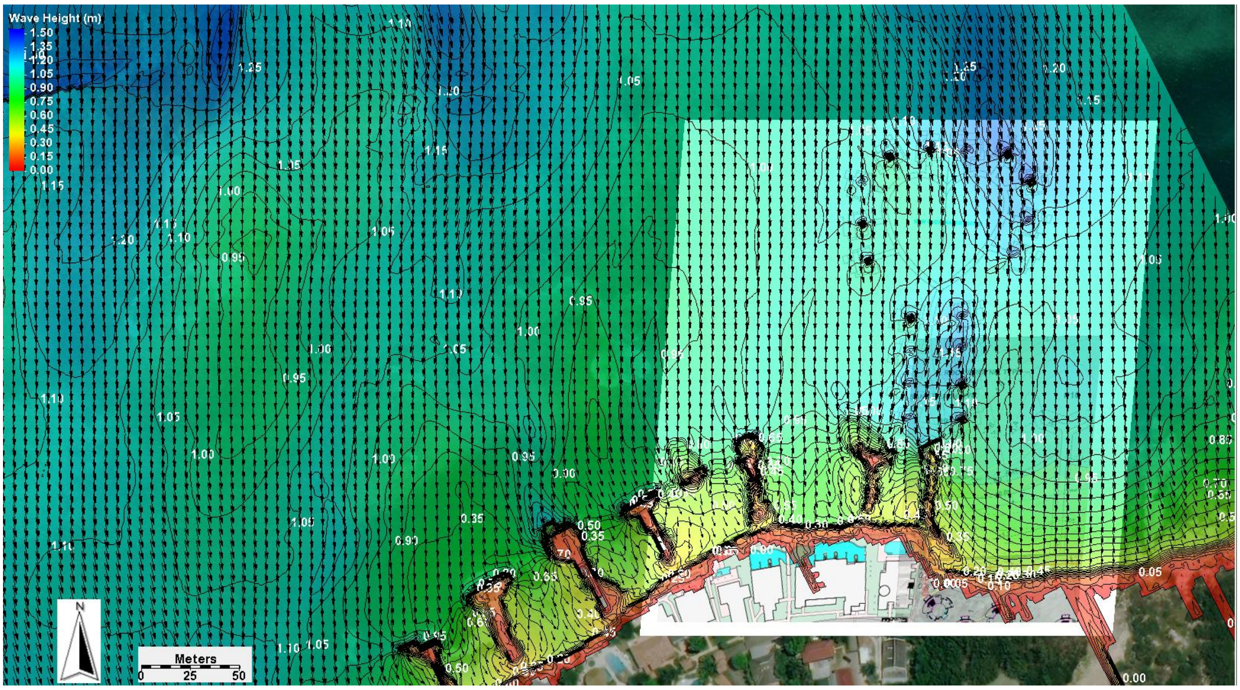


Figure 5-39: Modeled wave field for NNE (22.5 deg) incident storm wave (Hsig = 1.47 m, Tp = 5.86 s) with a 0.7 m surge under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

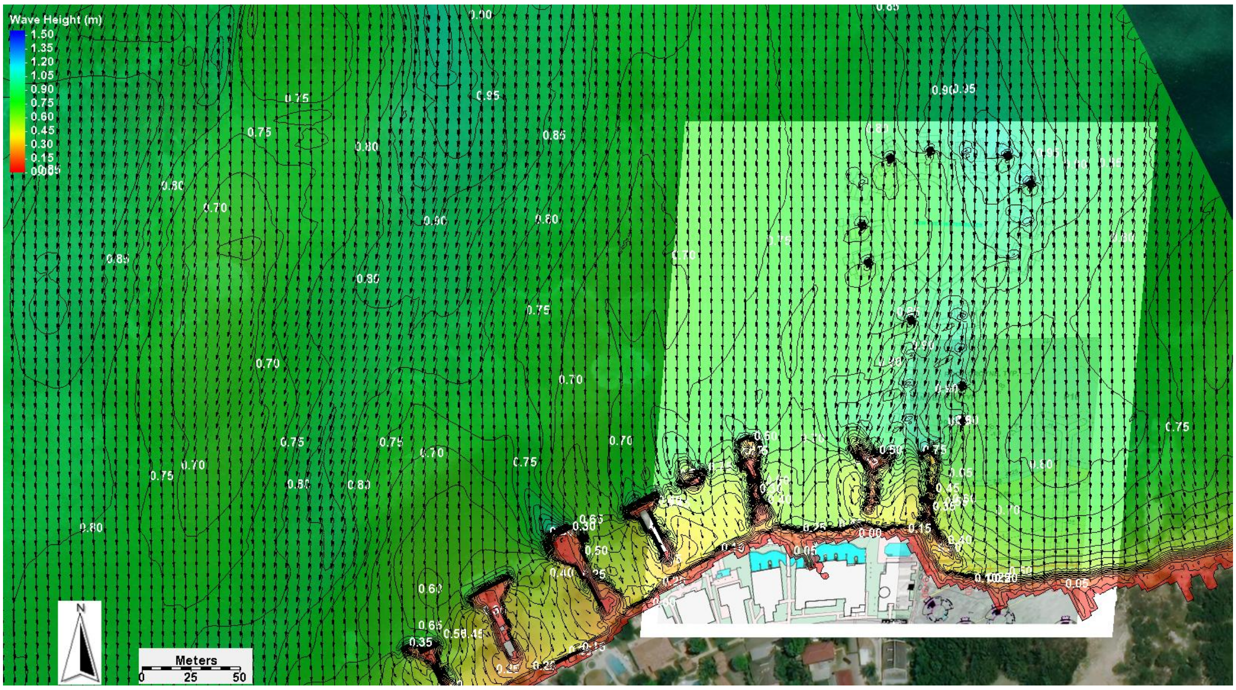


Figure 5-40: Modeled wave field for NE (45 deg) incident storm wave (Hsig = 1.16 m, Tp = 5.68 s) with a 0.7 m surge under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

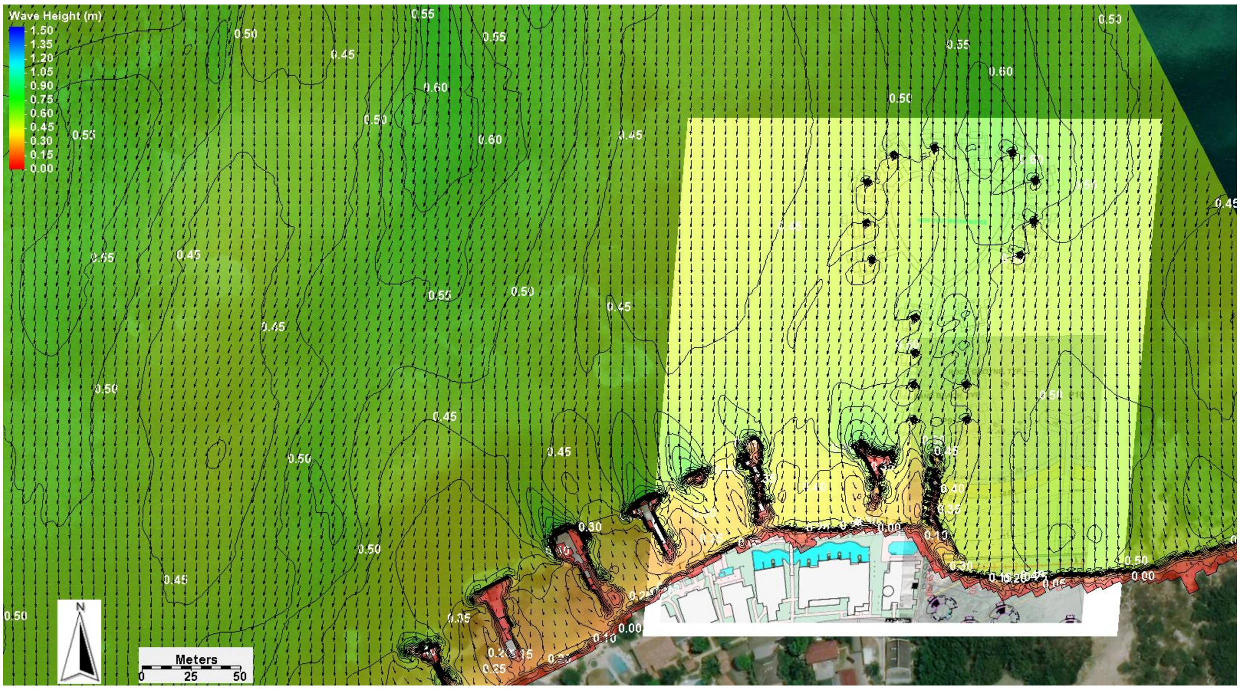


Figure 5-41: Modeled wave field for ENE (67.5 deg) incident storm wave (Hsig = 0.98 m, Tp = 6.99 s) with a 0.7 m surge under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

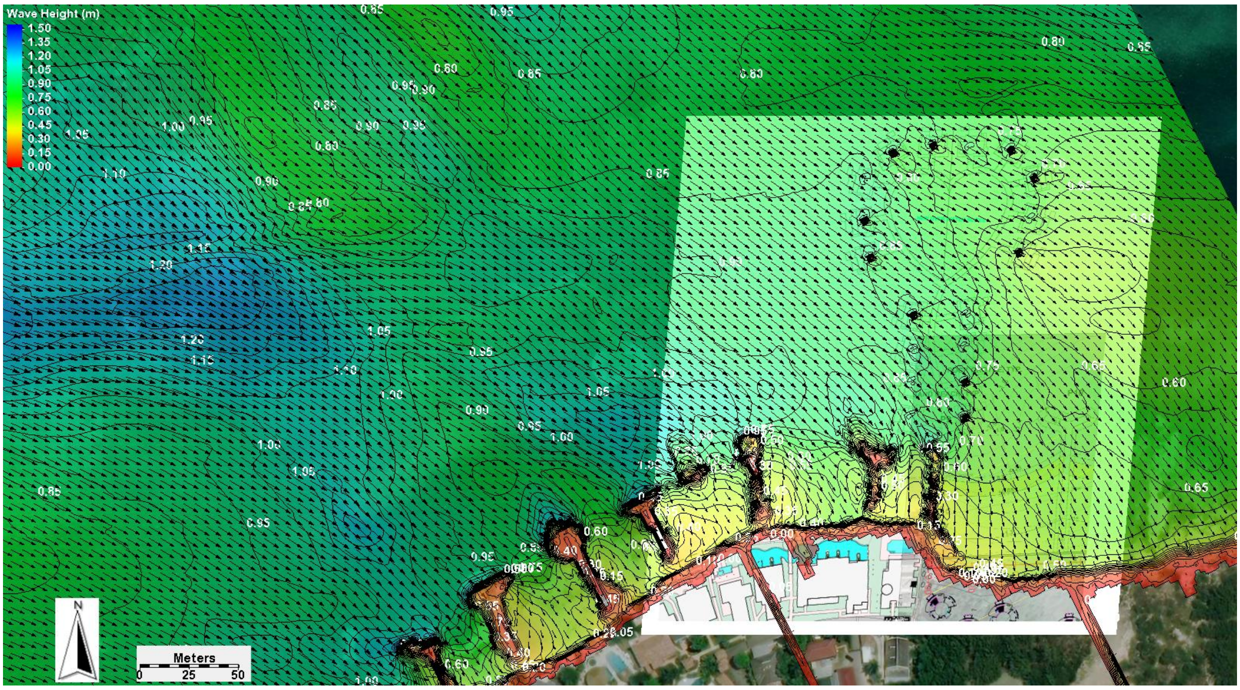


Figure 5-42: Modeled wave field for WSW (247.5 deg) incident storm wave (Hsig = 1.68 m, Tp = 8.25 s) with a 0.7 m surge under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

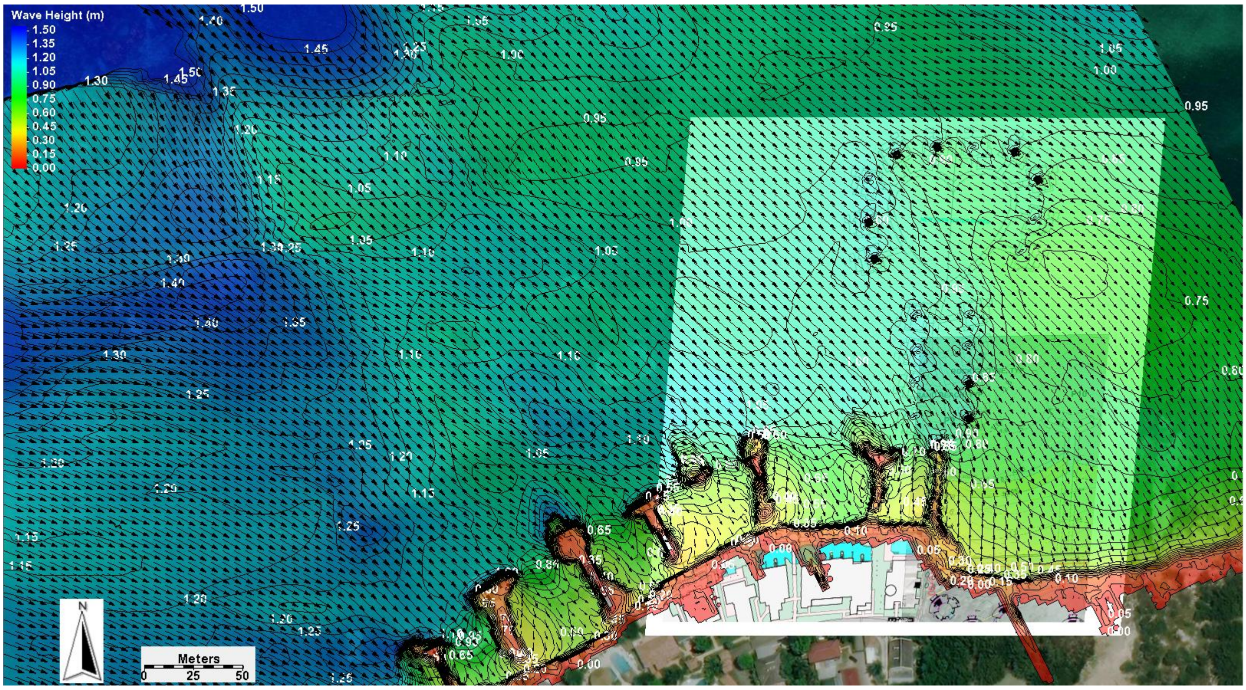


FIGURE 5-43: MODELED WAVE FIELD FOR W (270 DEG) INCIDENT STORM WAVE (HSIG = 2.13 M, TP = 7.89 S) WITH A 0.7 M SURGE UNDER PROPOSED CONDITIONS. NOTE THE COLOR SCHEME AT THE OVERWATER UNITS' LOCATION WAS CHANGED BY THE BACKGROUND IMAGE. THE WAVE HEIGHT VALUES CAN BE OBTAINED FROM THE CONTOUR LINES. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

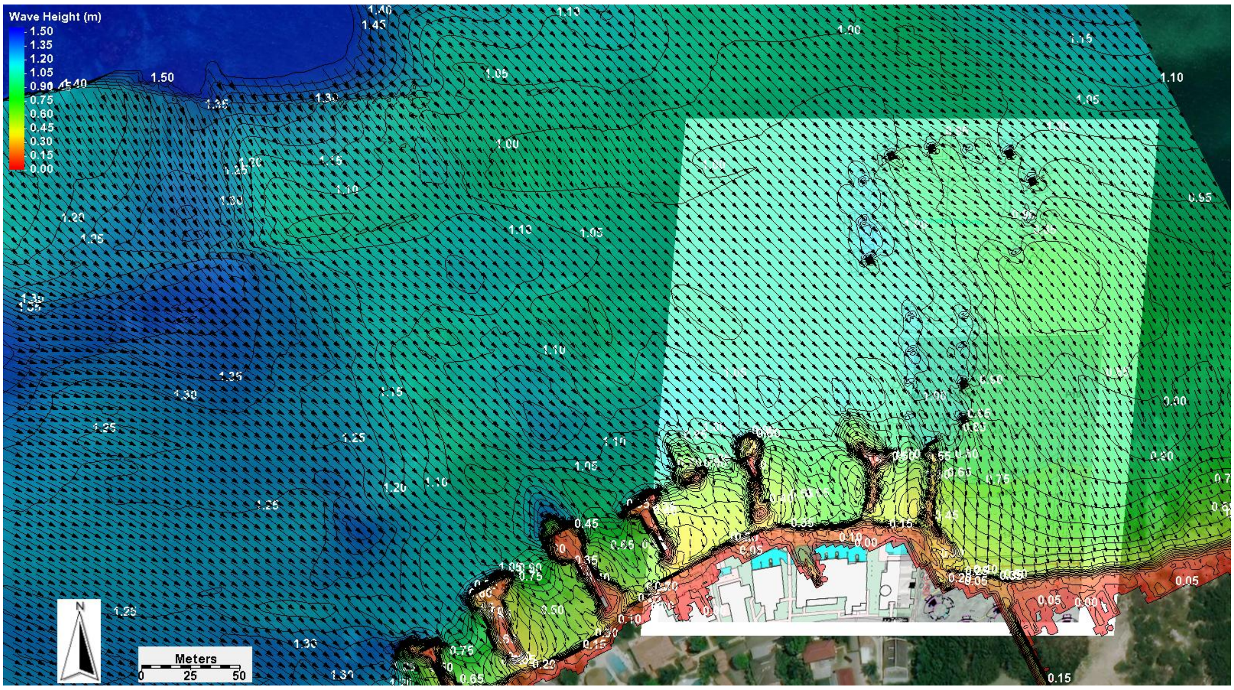


FIGURE 5-44: MODELED WAVE FIELD FOR WNW (292.5 DEG) INCIDENT STORM WAVE (HSIG = 1.92 M, TP = 7.53 S) WITH A 0.7 M SURGE UNDER PROPOSED CONDITIONS. NOTE THE COLOR SCHEME AT THE OVERWATER UNITS' LOCATION WAS CHANGED BY THE BACKGROUND IMAGE. THE WAVE HEIGHT VALUES CAN BE OBTAINED FROM THE CONTOUR LINES. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

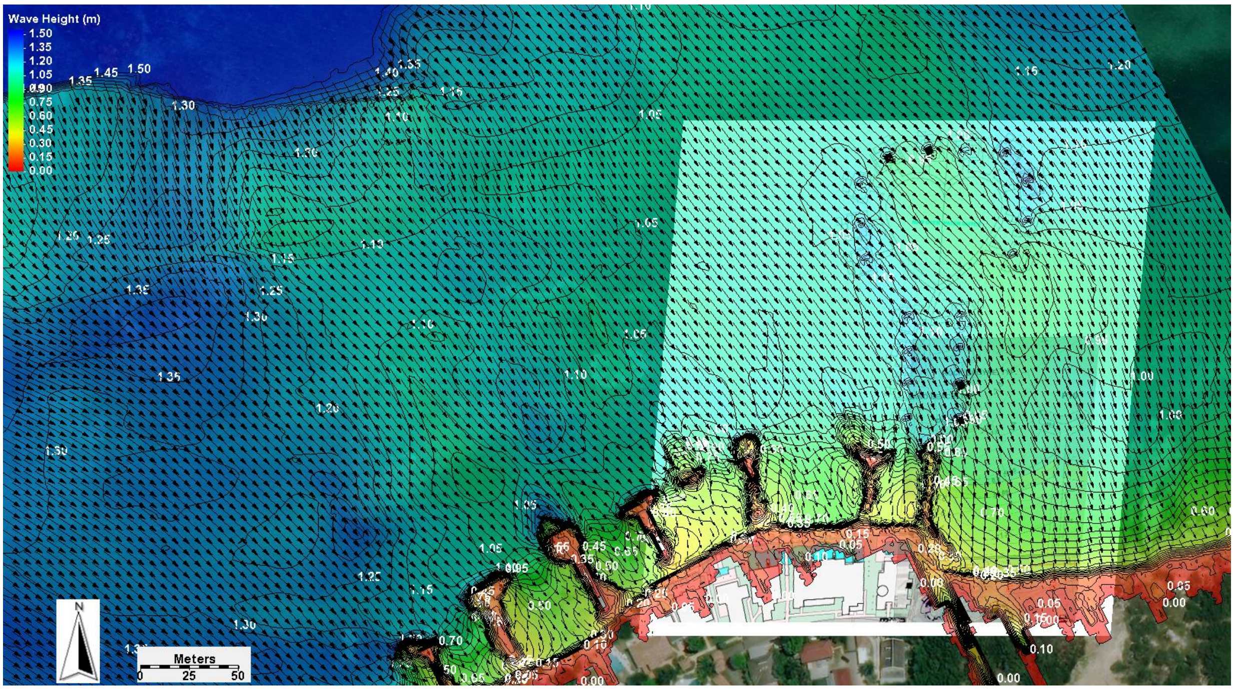


Figure 5-45: Modeled wave field for NW (315 deg) incident storm wave (Hsig = 2.29 m, Tp = 7.53 s) with a 0.7 m surge under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

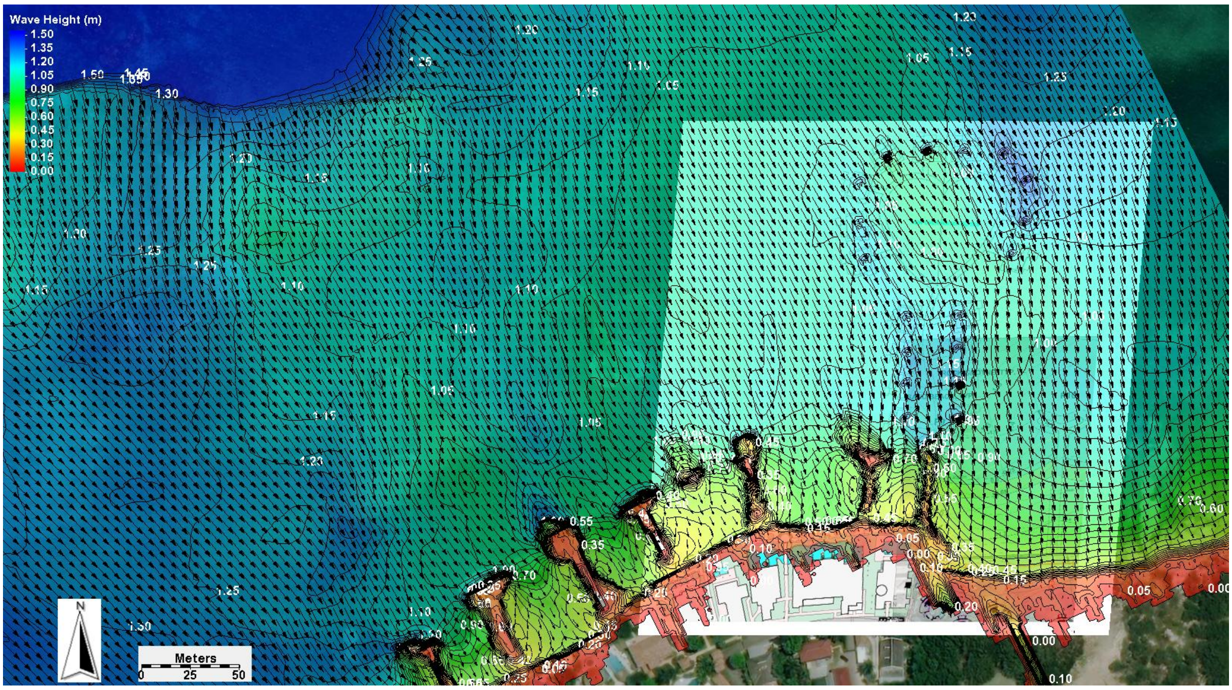


Figure 5-46: Modeled wave field for NNW (337.5 deg) incident storm wave (Hsig = 2.28 m, Tp = 6.87 s) with a 0.7 m surge under proposed conditions. Note the color scheme at the overwater units' location was changed by the background image. The wave height values can be obtained from the contour lines. Zooming in to, e.g., 200%, to view details of the wave fields.

In summary, the wave modeling results illustrate that the barrier reef provides significant protection against open Caribbean waves at the project site. However, since the barrier reef is not continuous, some wave energy propagates through the gaps causing some spatial variations at the project site. The eastern portion of the Sandal's resort is better protected by the barrier reef, resulting in lower wave height under most incident wave conditions, as compared to the western portion. Therefore, the recommended locations of the overwater units are in the eastern portion of the resort. The small pilings supporting the overwater units have minimal influence on the overall wave conditions at the project site and along the shoreline. Minor and highly localised interactions between the pilings and the waves occur.

Simulated Flow Field

The CMS-FLOW model was applied to simulate tide and wind-driven flow at the project site. The main goal of the flow simulation is to examine if the proposed overwater units, specifically the support pilings, would have significant influence on the flow field at the project site, as well as along the beach. An energetic flow condition is used here as an example. The flow field as discussed in the following is driven by a spring tide superimposed with a strong 15 m/s easterly wind. The easterly trade wind is by far the most dominant wind condition in the greater study area. The 15 m/s wind speed represents a very strong wind, which should occur only during stormy conditions. The strong easterly wind drives an east-to-west flow, as shown in **Figure 5-47**. It is worth noting that the CMS-FLOW computes depth-average current velocities. Because the project area is relatively shallow, the depth-averaged velocity should provide a reasonable representation of the flow field. Wind-driven current velocities at the water surface may be slightly greater than the depth-averaged ones. However, spatial patterns should be quite similar.

Figure 5-47 illustrates the simulated flow field at the project site under existing conditions. Overall, the eastward-directed depth-averaged flow is stronger at the western portion of the resort than that at the eastern portion where the overwater units are proposed. This is partly influenced by the deeper water on the depth-averaged velocities at the eastern portion. Therefore, the simulated flow field supports the eastern location based on the wave modeling results.

The shore-perpendicular groyne field extending from the shoreline has significant influence on the flow field by blocking the eastward flow. For the closely spaced groynes, e.g., the easternmost compartment, the flow is largely blocked, while for wider compartments, e.g., the third from the east, a gyre forms within the compartment.

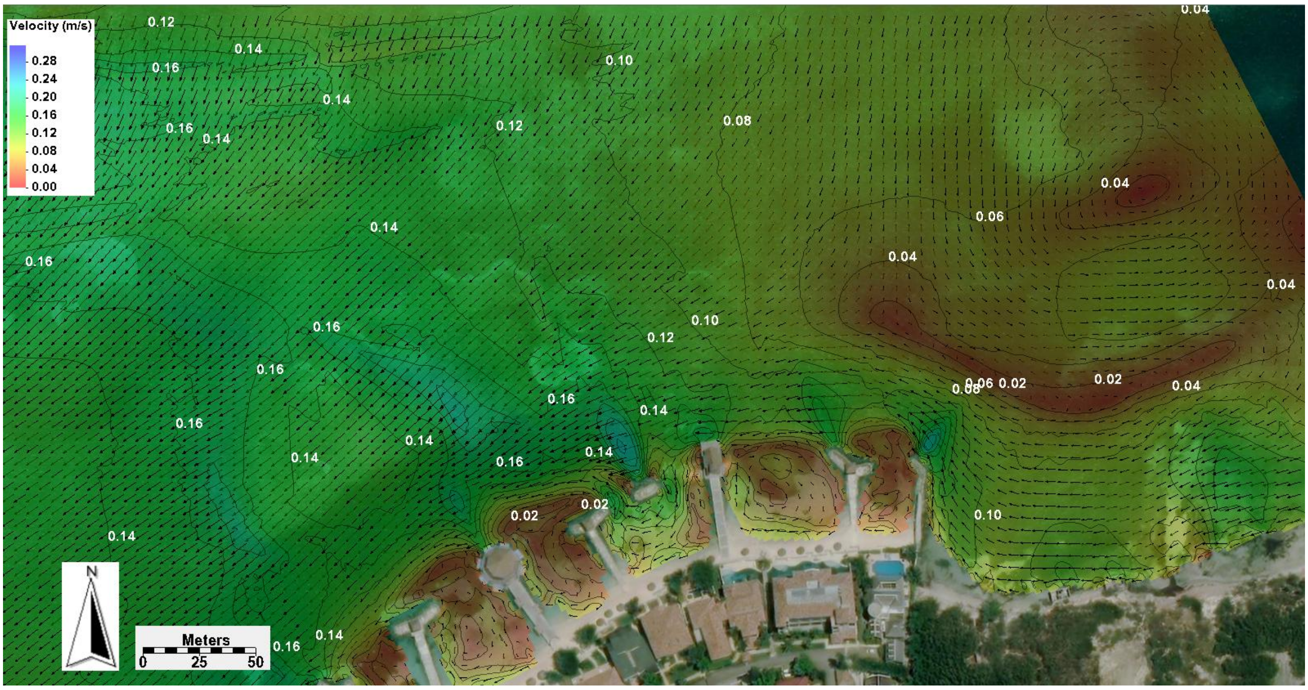


FIGURE 5-47: MODELED FLOW FIELD UNDER EXISTING CONDITION. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE FLOW FIELDS.

Similar to the wave-modeling case, the pilings supporting each overwater unit were represented collectively by one 2x2 m grid cell. **Figure 5-48** illustrates the simulated flow field at the recommended overwater unit locations. The flow field at the overall project site is not influenced by the small pilings. However, localised interactions between the individual piling and the flow field occur and are illustrated by the flow-shadow zones to the west of the piling. The localised flow shadow zones have minor influence on the overall flow field, as well as the flow pattern along the shoreline. This localised influence should have a negligible influence on the circulation in the project area and along the shoreline. The pilings should not have any negative impact on the water quality in the project area.

In summary, the results of the flow modeling indicate that the pilings supporting the proposed overwater units would not have any negative impact on the overall circulation at the project area, and therefore, should have negligible influence on water quality.

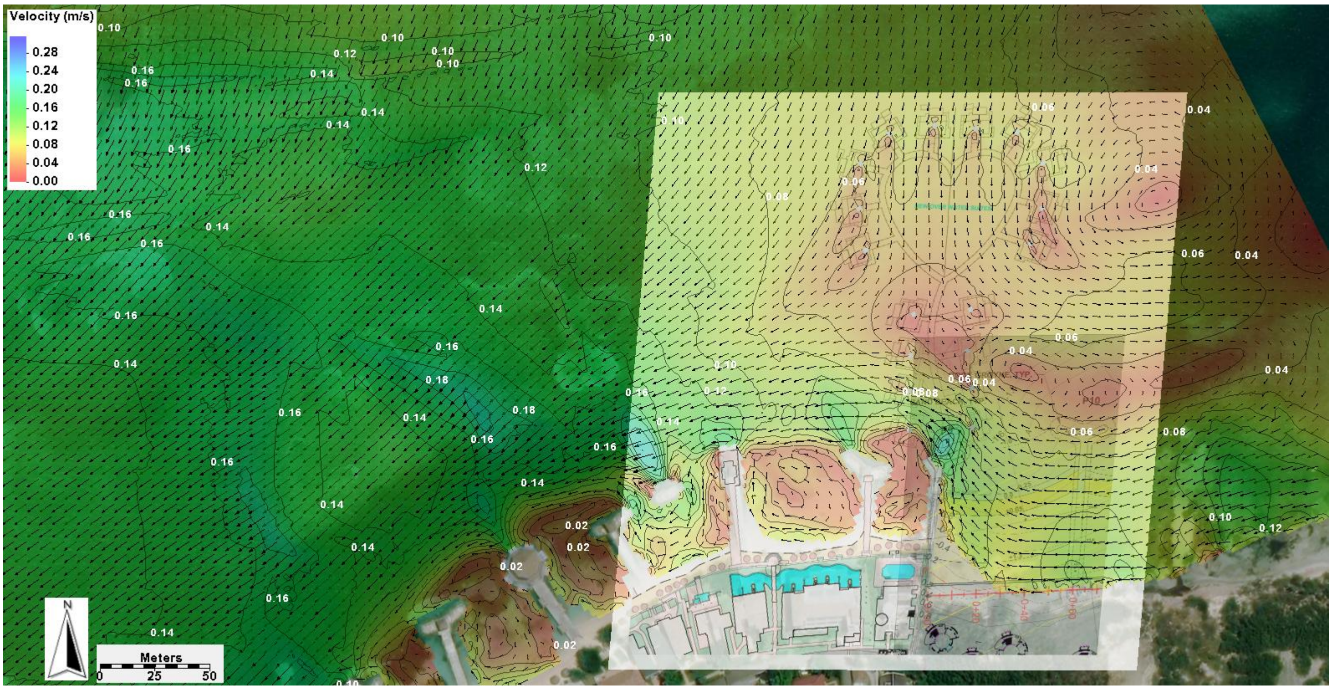


FIGURE 5-48: MODELED FLOW FIELD UNDER THE RECOMMENDED DESIGN. NOTE THE COLOUR SCHEME AT THE OVERWATER UNITS' LOCATION WAS CHANGED BY THE BACKGROUND IMAGE. THE FLOW VELOCITY VALUES CAN BE OBTAINED FROM THE CONTOUR LINES. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

5.1.1.8 *Sediment Plume Dispersal Modeling for the Construction Phase*

A field investigation and bottom sediment sampling and analysis were conducted on February 11-13 at the site of the proposed overwater units at Sandals Montego Bay Resort. A severe winter storm impacted the Island of Jamaica about 5 days before the field investigation. Widespread beach erosion and infrastructure damage were caused by this rather rare storm. Taking advantage of the opportunity offered by the very energetic event, this study examined moderate structure damage along the shoreline. The information is used here to evaluate the proposed design of the overwater units under storm conditions. Some recommendations were provided.

The main goals of this portion of the study are 1) to analyse the potential suspension and dispersion of sediment plumes during the construction of the overwater units, and 2) to recommend measures to limit plume dispersion and impact to surrounding environment during construction of the overwater units. In order to achieve these goals, *in situ* sediment samples were collected and analysed. Settling and dispersion of the sediment of different sizes were computed using well-established formulas.

Project Site and Lessons Learned from the Impact of a Severe Winter Storm on February 6, 2024

The Sandals Montego Bay Resort and the proposed overwater units are illustrated in **Figure 5-10**. A shallow and relatively wide barrier reef extends alongshore at about 400 m from the shoreline. As shown in **Figure 5-49**, extensive wave breaking occurs over the barrier reef, resulting in significant wave-energy reduction landward along the Sandals Resort shoreline and at the site of the proposed overwater units (**Figure 5-49,** white box). It is likely that the Google Earth photo shown in **Figure 5-49** was taken during an energetic condition as indicated by the active wave breaking over the barrier reef. Despite the protection by the barrier reef, some wave energy reached the shoreline and induced suspension of bottom sediment, as illustrated by the yellowish water color in the nearshore area (**Figure 5-49**). However, sediment suspension at the proposed overwater bungalows site was not as significant as suggested by the blue water color.

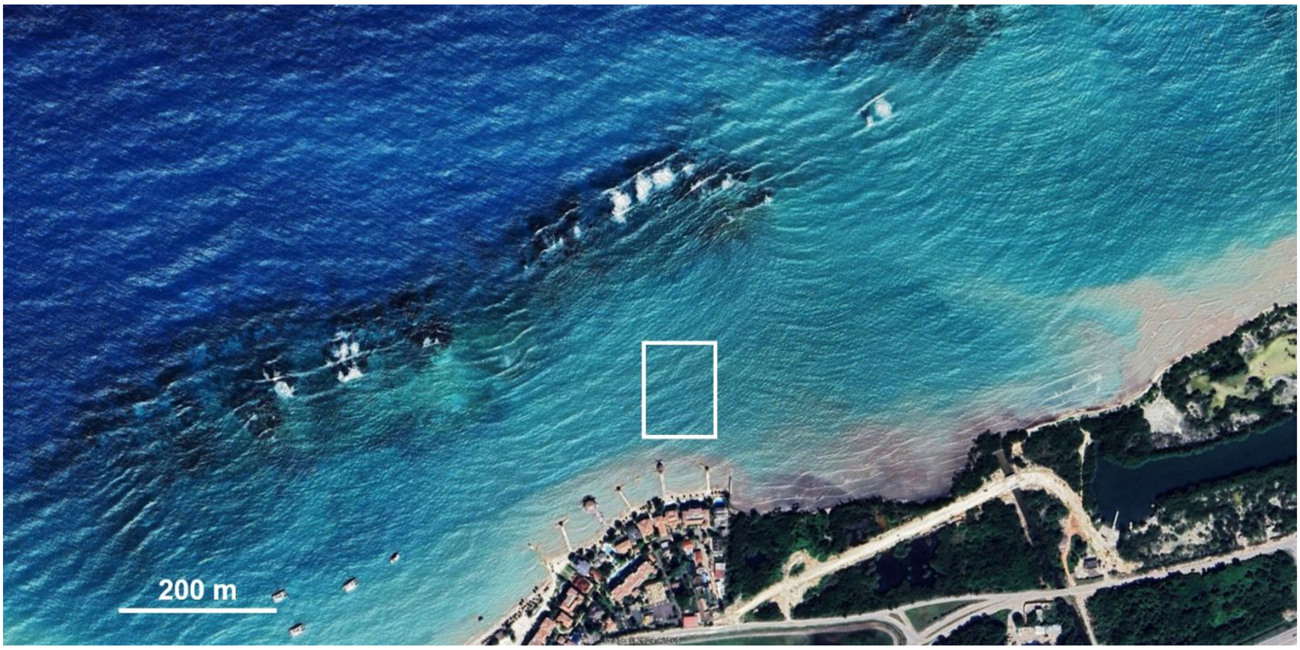


FIGURE 5-49: AERIAL VIEW OF THE PROJECT SITE FROM GOOGLE EARTH. NOTE ACTIVE WAVE BREAKING OVER THE SHALLOW OFFSHORE BARRIER REEF. THE PROJECT SITE (WHITE BOX) IS WELL PROTECTED BY THE SHALLOW OFFSHORE BARRIER REEF. ACTIVE SEDIMENT SUSPENSION OCCURRED IN THE NEARSHORE ZONE AS ILLUSTRATED BY THE YELLOW WATER COLOUR

A very energetic winter storm impacted the Sandals Montego Bay Resort on February 6, 2024. Damage along the sandy beach was observed during the field investigation on February 11, 2024. Here, we focus on the infrastructure damage with the goal of using this information to evaluate the proposed design of the overwater units. **Figure 5-50** illustrates the condition of a shore-perpendicular wood pier serving as a boardwalk. This pier is the 3rd from the east as shown in **Figure 5-49**. Several pieces of the board were detached from the frame, likely caused by the strong upward forcing generated by waves crashing from underneath overcoming the nails. The housing structure, likely used for party gathering, was also damaged

(**Figure 5-51** and **Figure 5-52**). The broken door (**Figure 5-50**) was likely caused by strong wind. The glass bottom inside the house was lifted from the floor, likely by the strong wave forcing from underneath. Similar types of damage were observed at other nearby structures installed on pilings (**Figure 5-50** lower panel).

Figure 5-50: upper panel: the wood pier (3rd from the east) was damaged by the severe winter storm impacted Jamaica on February 6, 2024. The wood board was detached by the wave impact from underneath. The deck is roughly 1.3 m from mean sea level. Lower panel: side view of the wood pier. Photo was taken on February 11, 2024 about 5 days after the storm.

FIGURE 5-51: THE HOUSE OVER THE WOOD PIER (2ND FROM THE EAST) WAS DAMAGED BY THE SEVERE WINTER STORM IMPACTED JAMAICA ON FEBRUARY 6, 2024. THE GLASS BOTTOM WAS DETACHED BY THE WAVE IMPACT FROM UNDERNEATH. THE DECK IS ROUGHLY 1.3 M FROM MEAN SEA LEVEL. PHOTO WAS TAKEN FEBRUARY 11, 2024 ABOUT 5 DAYS AFTER THE STORM.

Since the proposed overwater units will be installed on pilings, the observed damage can provide a case study to evaluate the integrity under very energetic conditions at the project site, particularly the upper limit of damaging wave forcing from underneath. Widespread damage to the wood deck was observed at several of the piers. The elevation of the deck to the water level was measured during the field investigation. Little to no damage was observed at decks that are more than 1.5 m above sea level. On the other hand, widespread damage was observed at decks that are lower than 1.5 m above sea level, with the degree of damage increasing with lower elevation. These observations suggest that high waves directly crashed under the decks that are lower than 1.5 m from sea level during this storm. Forcing from underneath can detach deck boards.

Little to no damage to the vertical pilings and frames was observed although the inspection was mostly conducted from on top of the deck. Since the overwater units will be supported by pilings similar to the decks shown in **Figure 5-50**, **Figure 5-51** and **Figure 5-52**, the following recommendations are provided based on the above observations:

1) The deck for the overwater units should be at least 2 m above the mean sea level. A deck elevation of 2.2 m above the mean sea level is strongly recommended to account for tidal fluctuations. This elevation will ensure that the overwater units can sustain energetic storms such as the one that impacted the project area on February 6, 2024.
2) The high deck of 2.2 m above sea level will also accommodate projected sea level rise of up to 0.4 m in the next 40 years.
3) Although no obvious damage to the pilings was observed, a modest amount of sand was washed onto the deck and the groynes suggesting active sediment transport under the storm conditions. It is, therefore, recommended that rock armor be installed around the pilings to prevent potential scour.
4) The above recommendations should not fundamentally change the design of the overwater units, except that the deck elevation be raised to 2.2 m above mean sea level, or 2.0 m above high tide.

FIGURE 5-52: A CLOSER VIEWER OF THE DETACHED GLASS BOTTOM.

Sediment Sampling and Analysis at the Project Site

Suspension of sediment plume and subsequent plume dispersion are strongly controlled by the size of the bed sediment. Finer sediments would stay in suspension longer than coarser sediments and can be dispersed over a larger area. Therefore, information on the bottom sediment grain size composition is necessary to quantify plume generation and dispersion. The plume analysis method developed by Wang and Beck (2017) was used in this study.

Bottom sediment samples were collected on February 11 2024 during the field investigation (**Figure 5-53** and **Figure 5-54**). An approximately 5-cm long core sample was collected from the bed to ensure a representative bottom sediment. A plastic cup was used by divers to collect the bottom sediment.

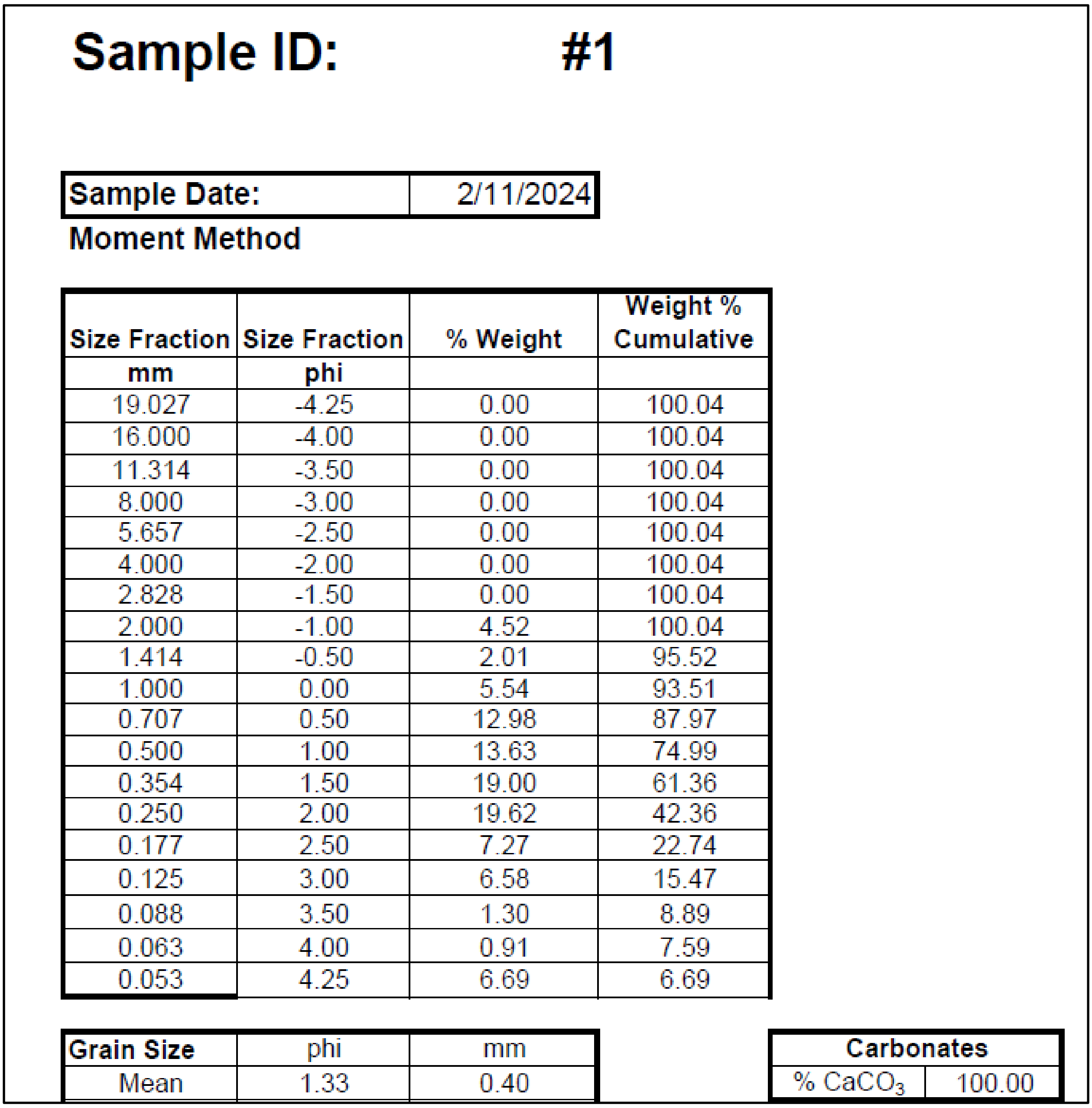
FIGURE 5-53: SEDIMENT SAMPLING IN THE NEARSHORE AREA. THE BOTTOM SEDIMENT IN THIS AREA IS QUITE MUDDY.

FIGURE 5-54: SEDIMENT SAMPLING AT THE OVERWATER UNIT SITE. THE BOTTOM SEDIMENT IN THIS AREA IS MOSTLY SANDY. THE BARRIER REEF IS VISIBLE SEAWARD OF THE SAMPLING SITE.

A total of 8 bottom sediment samples were collected (**Figure 5-55**). Six bottom sediment samples were collected along a shore-perpendicular transect extending from the sandy beach to the overwater units' site. In addition, two sediment samples were collected in the nearshore area to the east of the project site. These samples should provide an adequate representation of the bottom sediment characteristics.

FIGURE 5-55: LOCATIONS OF THE FIELD SEDIMENT SAMPLING

Standard sieves were used to analyse the sediment grain-size composition. For sediment grains that are finer than 0.063 mm, i.e., mud sized grains, wet sieving was conducted since these small grains need to be washed through the sieve openings. For sand sized grains, the standard method of shaking the sieve stack was used. Detailed grain-size compositions of the 8 bottom sediment samples are shown in **Figure 5-56**, **Figure 5-57**, **Figure 5-58**, **Figure 5-59**, **Figure 5-60**, **Figure 5-61**, **Figure 5-62**, and **Figure 5-63**.



Sample ID: **#1**

Sample Date:	2/11/2024

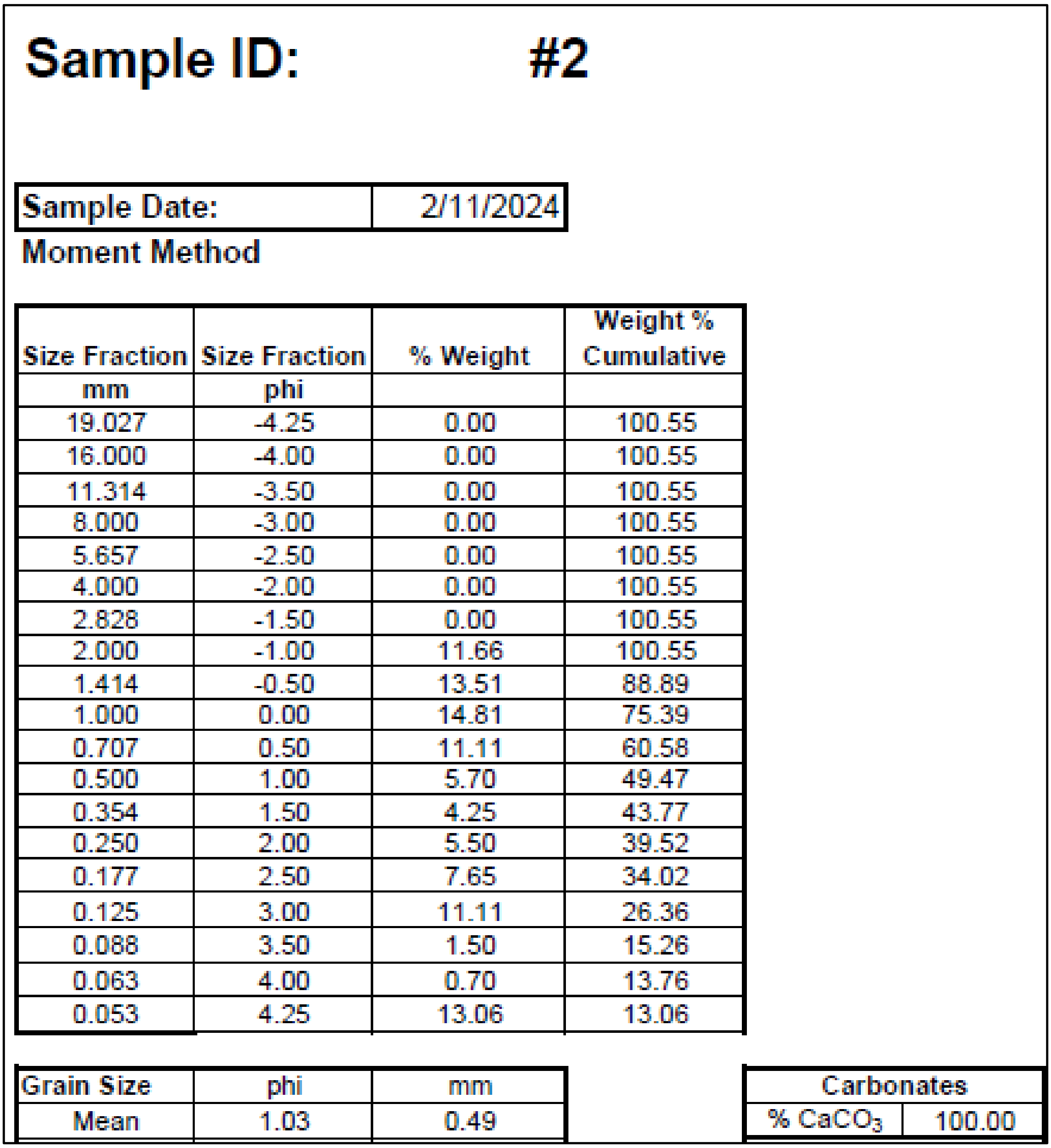
Moment Method

Size Fraction	**Size Fraction**	**% Weight**	**Weight % Cumulative**
mm	**phi**		
19.027	-4.25	0.00	100.04
16.000	-4.00	0.00	100.04
11.314	-3.50	0.00	100.04
8.000	-3.00	0.00	100.04
5.657	-2.50	0.00	100.04
4.000	-2.00	0.00	100.04
2.828	-1.50	0.00	100.04
2.000	-1.00	4.52	100.04
1.414	-0.50	2.01	95.52
1.000	0.00	5.54	93.51
0.707	0.50	12.98	87.97
0.500	1.00	13.63	74.99
0.354	1.50	19.00	61.36
0.250	2.00	19.62	42.36
0.177	2.50	7.27	22.74
0.125	3.00	6.58	15.47
0.088	3.50	1.30	8.89
0.063	4.00	0.91	7.59
0.053	4.25	6.69	6.69

Grain Size	phi	mm
Mean	1.33	0.40

Carbonates	
% $CaCO_3$	100.00

Figure 5-56: sediment grain size composition of sample #1.



Sample ID: #2

Sample Date:	2/11/2024

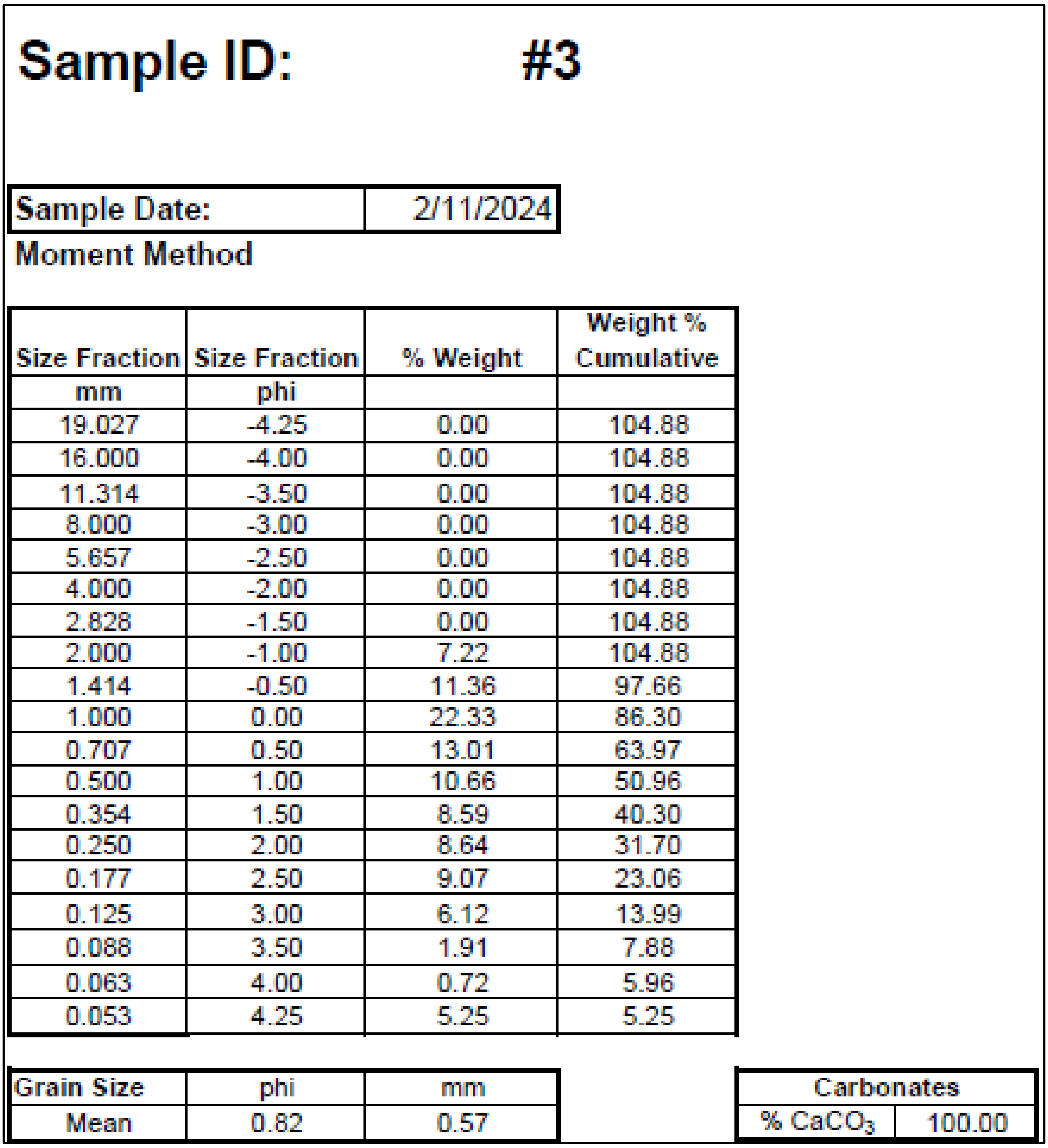
Moment Method

Size Fraction mm	Size Fraction phi	% Weight	Weight % Cumulative
19.027	-4.25	0.00	100.55
16.000	-4.00	0.00	100.55
11.314	-3.50	0.00	100.55
8.000	-3.00	0.00	100.55
5.657	-2.50	0.00	100.55
4.000	-2.00	0.00	100.55
2.828	-1.50	0.00	100.55
2.000	-1.00	11.66	100.55
1.414	-0.50	13.51	88.89
1.000	0.00	14.81	75.39
0.707	0.50	11.11	60.58
0.500	1.00	5.70	49.47
0.354	1.50	4.25	43.77
0.250	2.00	5.50	39.52
0.177	2.50	7.65	34.02
0.125	3.00	11.11	26.36
0.088	3.50	1.50	15.26
0.063	4.00	0.70	13.76
0.053	4.25	13.06	13.06

Grain Size	phi	mm
Mean	1.03	0.49

Carbonates	
% $CaCO_3$	100.00

FIGURE 5-57: SEDIMENT GRAIN SIZE COMPOSITION OF SAMPLE #2.



Sample ID: #3

Sample Date:	2/11/2024

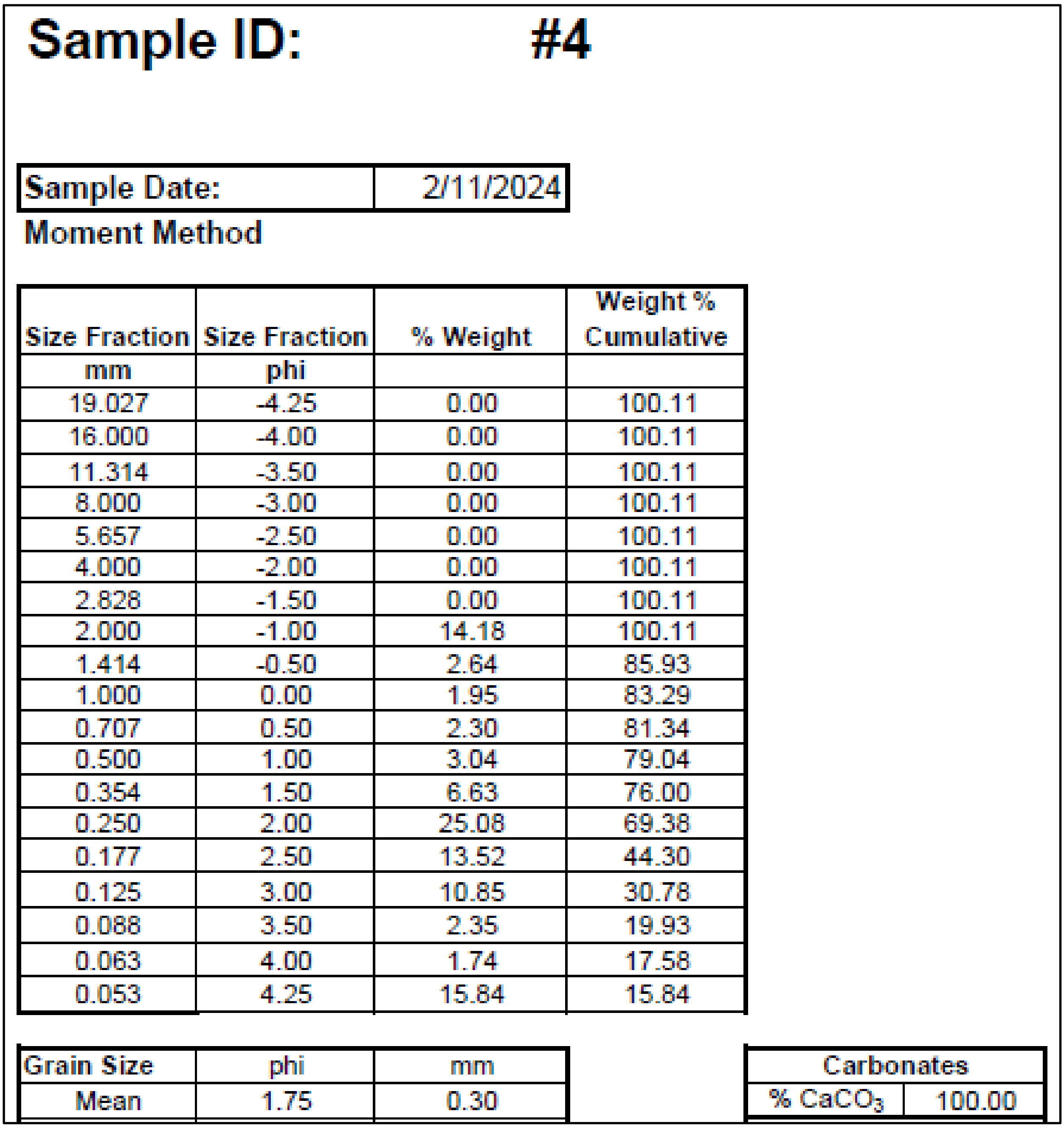
Moment Method

Size Fraction	Size Fraction	% Weight	Weight % Cumulative
mm	phi		
19.027	-4.25	0.00	104.88
16.000	-4.00	0.00	104.88
11.314	-3.50	0.00	104.88
8.000	-3.00	0.00	104.88
5.657	-2.50	0.00	104.88
4.000	-2.00	0.00	104.88
2.828	-1.50	0.00	104.88
2.000	-1.00	7.22	104.88
1.414	-0.50	11.36	97.66
1.000	0.00	22.33	86.30
0.707	0.50	13.01	63.97
0.500	1.00	10.66	50.96
0.354	1.50	8.59	40.30
0.250	2.00	8.64	31.70
0.177	2.50	9.07	23.06
0.125	3.00	6.12	13.99
0.088	3.50	1.91	7.88
0.063	4.00	0.72	5.96
0.053	4.25	5.25	5.25

Grain Size	phi	mm
Mean	0.82	0.57

Carbonates	
% $CaCO_3$	100.00

Figure 5-58: sediment grain size composition of sample #3.



Sample ID: #4

Sample Date:	2/11/2024

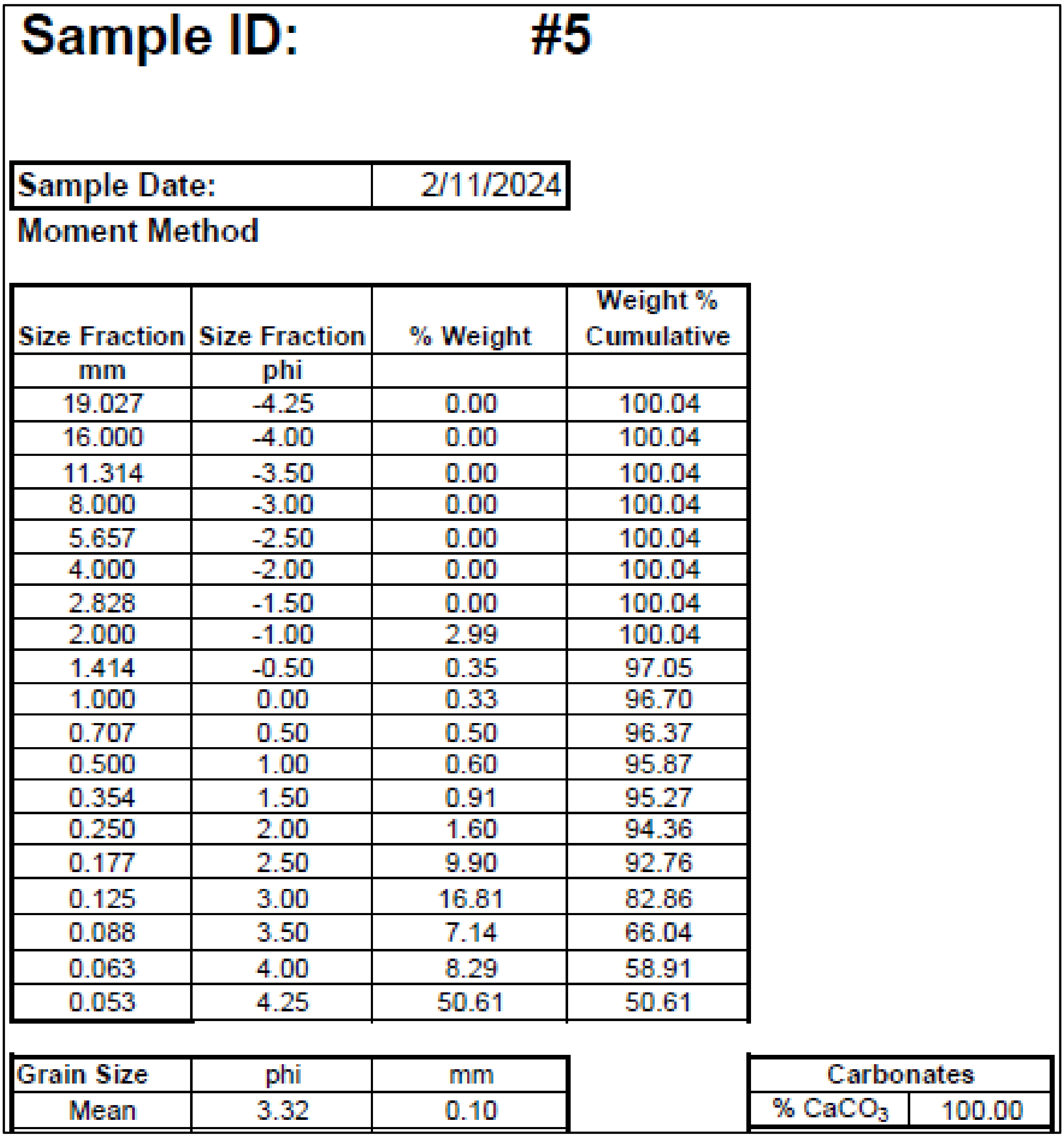
Moment Method

Size Fraction	Size Fraction	% Weight	Weight % Cumulative
mm	phi		
19.027	-4.25	0.00	100.11
16.000	-4.00	0.00	100.11
11.314	-3.50	0.00	100.11
8.000	-3.00	0.00	100.11
5.657	-2.50	0.00	100.11
4.000	-2.00	0.00	100.11
2.828	-1.50	0.00	100.11
2.000	-1.00	14.18	100.11
1.414	-0.50	2.64	85.93
1.000	0.00	1.95	83.29
0.707	0.50	2.30	81.34
0.500	1.00	3.04	79.04
0.354	1.50	6.63	76.00
0.250	2.00	25.08	69.38
0.177	2.50	13.52	44.30
0.125	3.00	10.85	30.78
0.088	3.50	2.35	19.93
0.063	4.00	1.74	17.58
0.053	4.25	15.84	15.84

Grain Size	phi	mm
Mean	1.75	0.30

Carbonates	
% $CaCO_3$	100.00

Figure 5-59: sediment grain size composition of sample #4.



Sample ID: #5

Sample Date:	2/11/2024

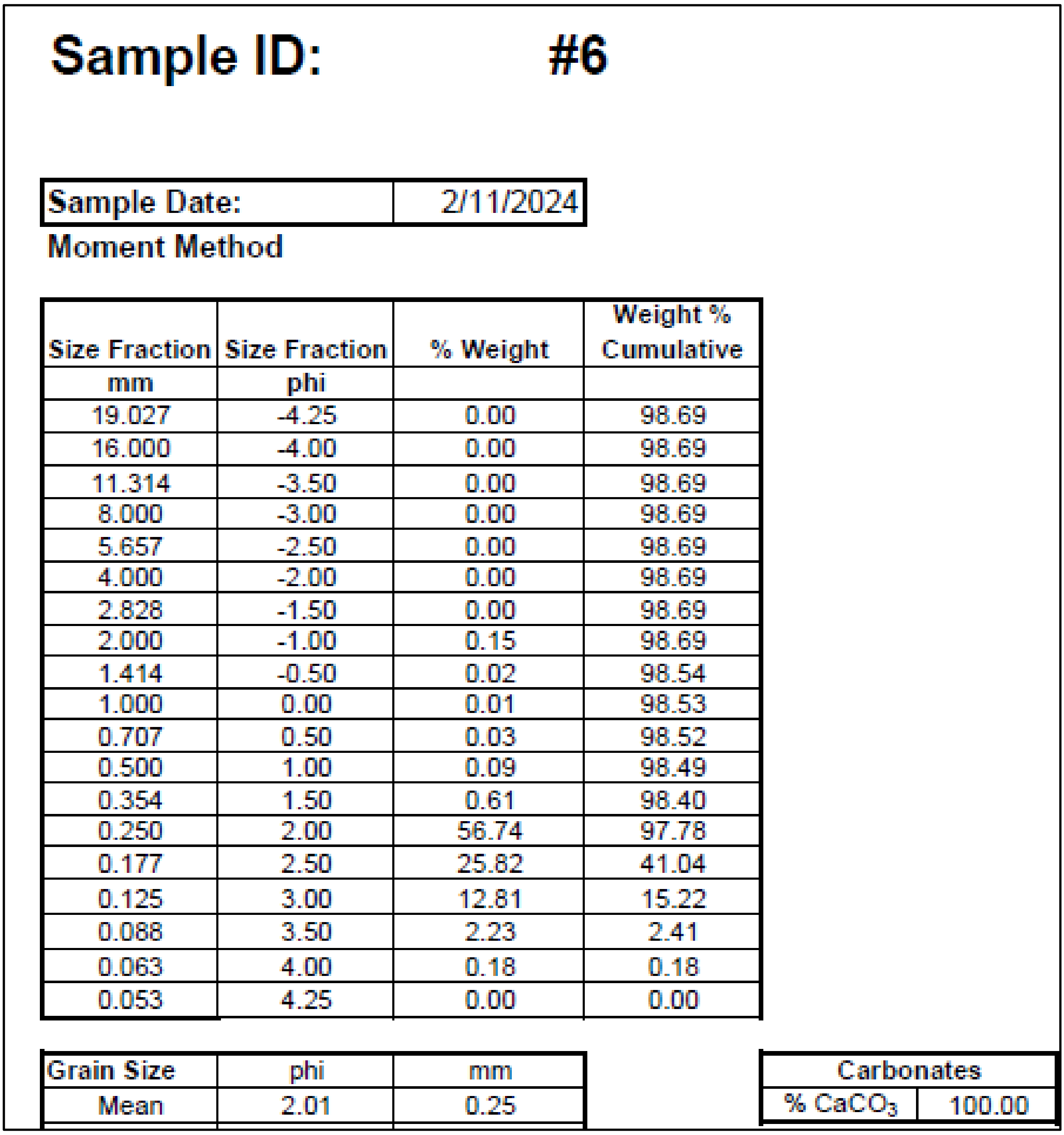
Moment Method

Size Fraction	Size Fraction	% Weight	Weight % Cumulative
mm	phi		
19.027	-4.25	0.00	100.04
16.000	-4.00	0.00	100.04
11.314	-3.50	0.00	100.04
8.000	-3.00	0.00	100.04
5.657	-2.50	0.00	100.04
4.000	-2.00	0.00	100.04
2.828	-1.50	0.00	100.04
2.000	-1.00	2.99	100.04
1.414	-0.50	0.35	97.05
1.000	0.00	0.33	96.70
0.707	0.50	0.50	96.37
0.500	1.00	0.60	95.87
0.354	1.50	0.91	95.27
0.250	2.00	1.60	94.36
0.177	2.50	9.90	92.76
0.125	3.00	16.81	82.86
0.088	3.50	7.14	66.04
0.063	4.00	8.29	58.91
0.053	4.25	50.61	50.61

Grain Size	phi	mm
Mean	3.32	0.10

Carbonates	
% $CaCO_3$	100.00

FIGURE 5-60: SEDIMENT GRAIN SIZE COMPOSITION OF SAMPLE #5.



Sample ID: #6

Sample Date:	2/11/2024

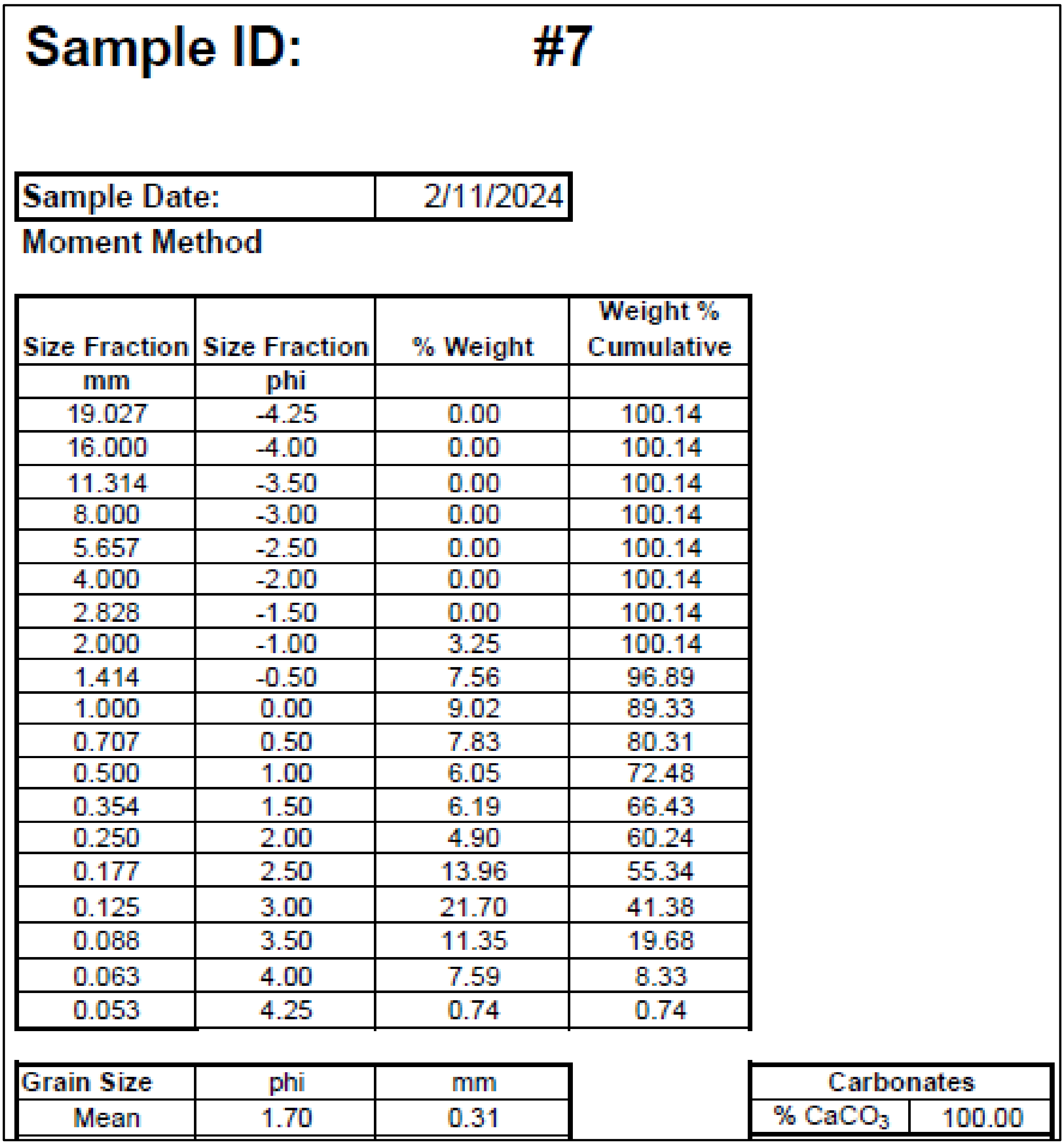
Moment Method

Size Fraction	Size Fraction	% Weight	Weight % Cumulative
mm	phi		
19.027	-4.25	0.00	98.69
16.000	-4.00	0.00	98.69
11.314	-3.50	0.00	98.69
8.000	-3.00	0.00	98.69
5.657	-2.50	0.00	98.69
4.000	-2.00	0.00	98.69
2.828	-1.50	0.00	98.69
2.000	-1.00	0.15	98.69
1.414	-0.50	0.02	98.54
1.000	0.00	0.01	98.53
0.707	0.50	0.03	98.52
0.500	1.00	0.09	98.49
0.354	1.50	0.61	98.40
0.250	2.00	56.74	97.78
0.177	2.50	25.82	41.04
0.125	3.00	12.81	15.22
0.088	3.50	2.23	2.41
0.063	4.00	0.18	0.18
0.053	4.25	0.00	0.00

Grain Size	phi	mm
Mean	2.01	0.25

Carbonates	
% $CaCO_3$	100.00

Figure 5-61: sediment grain size composition of sample #6.



Sample ID: **#7**

Sample Date:	2/11/2024

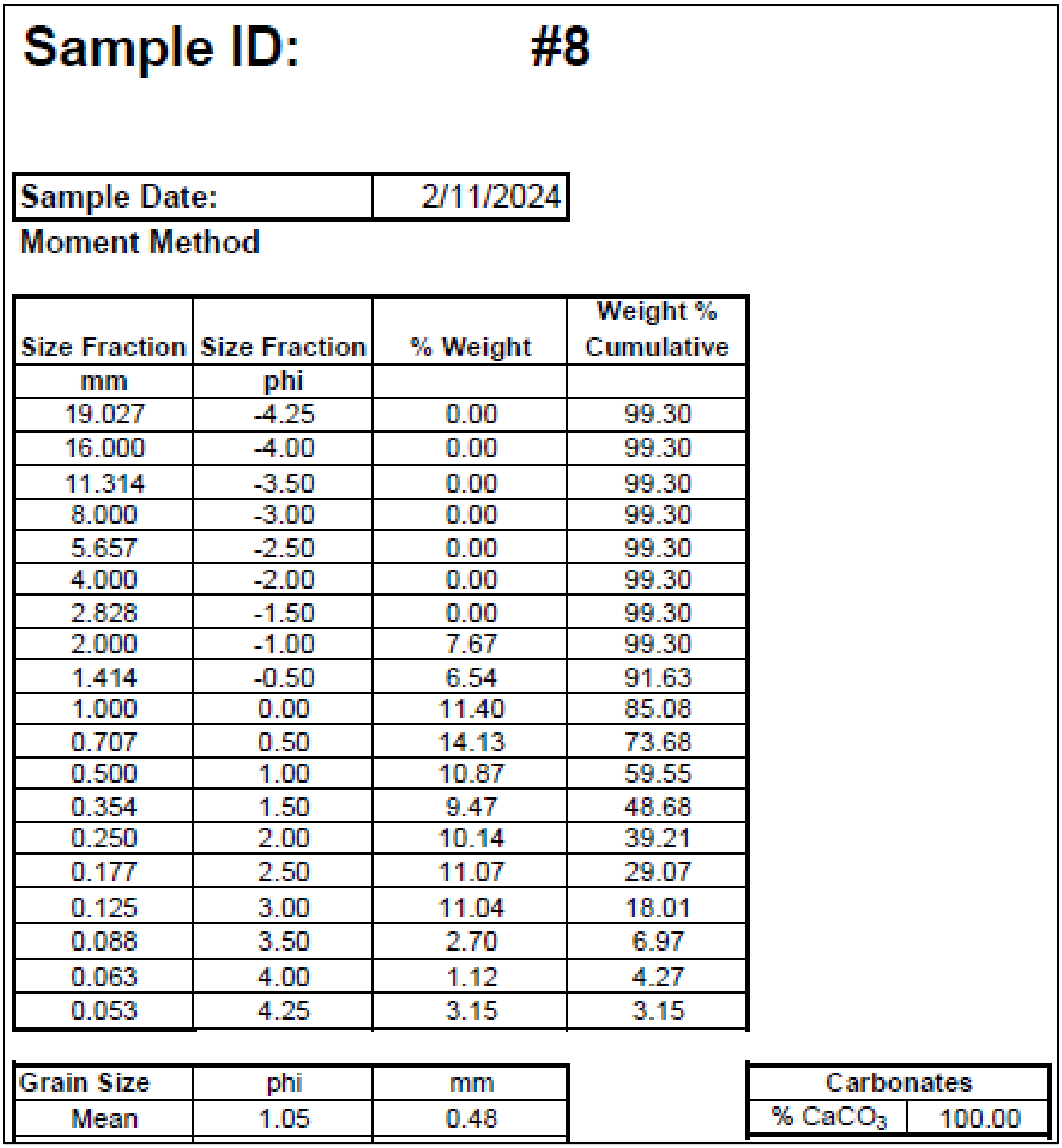
Moment Method

Size Fraction mm	Size Fraction phi	% Weight	Weight % Cumulative
19.027	-4.25	0.00	100.14
16.000	-4.00	0.00	100.14
11.314	-3.50	0.00	100.14
8.000	-3.00	0.00	100.14
5.657	-2.50	0.00	100.14
4.000	-2.00	0.00	100.14
2.828	-1.50	0.00	100.14
2.000	-1.00	3.25	100.14
1.414	-0.50	7.56	96.89
1.000	0.00	9.02	89.33
0.707	0.50	7.83	80.31
0.500	1.00	6.05	72.48
0.354	1.50	6.19	66.43
0.250	2.00	4.90	60.24
0.177	2.50	13.96	55.34
0.125	3.00	21.70	41.38
0.088	3.50	11.35	19.68
0.063	4.00	7.59	8.33
0.053	4.25	0.74	0.74

Grain Size	phi	mm
Mean	1.70	0.31

Carbonates	
% $CaCO_3$	100.00

FIGURE 5-62: SEDIMENT GRAIN SIZE COMPOSITION OF SAMPLE #7.



Sample ID: #8

Sample Date:	2/11/2024

Moment Method

Size Fraction	Size Fraction	% Weight	Weight % Cumulative
mm	phi		
19.027	-4.25	0.00	99.30
16.000	-4.00	0.00	99.30
11.314	-3.50	0.00	99.30
8.000	-3.00	0.00	99.30
5.657	-2.50	0.00	99.30
4.000	-2.00	0.00	99.30
2.828	-1.50	0.00	99.30
2.000	-1.00	7.67	99.30
1.414	-0.50	6.54	91.63
1.000	0.00	11.40	85.08
0.707	0.50	14.13	73.68
0.500	1.00	10.87	59.55
0.354	1.50	9.47	48.68
0.250	2.00	10.14	39.21
0.177	2.50	11.07	29.07
0.125	3.00	11.04	18.01
0.088	3.50	2.70	6.97
0.063	4.00	1.12	4.27
0.053	4.25	3.15	3.15

Grain Size	phi	mm
Mean	1.05	0.48

Carbonates	
% $CaCO_3$	100.00

FIGURE 5-63: SEDIMENT GRAIN SIZE COMPOSITION OF SAMPLE #8.

Considerable grain-size variation was measured in the cross-shore direction. From landward to seaward, the sandy beach (Sample #6, **Figure 5-61**, with sample location shown in **Figure 5-55**) is composed of clean well-sorted medium sand, as expected, with minimal muddy sediment. A patch of muddy sediment was identified seaward of the wave-breaking zone at sample locations #4 and #5. Location #5 has the highest mud content of nearly 51%. The mud content decreases seaward to slightly less than 16% at location #4. Further seaward at the location of the overwater units, the mud content decreased to 5.3% at location #3, 13.1% at location #2, and 6.7% at location #1. The two samples to the east of the project site had mud content of less than 4%.

Sediment plume suspension, settling, and dispersion are controlled by the above sediment grain-size compositions. Finer sediments, e.g., mud-sized grains, settle much slower and, therefore, can be dispersed much farther and influence larger areas than coarser sediments. The high mud content at sample location #5 and #4 is consistent with the distinctive plume observed during energetic days as shown in **Figure 5-49**. In the following section, sediment plume settling and dispersion are quantified.

Settling and Dispersion of Potential Sediment Plume during Construction

Dispersion of the sediment plume is mostly driven by currents, i.e., convective mechanisms. At the project site, the current is mainly driven by tides and winds. The dominant easterly trade wind can drive a longshore current directed toward the west. Since the goal here is to evaluate the maximum extent of plume dispersion, an energetic wind condition was applied in the computation. It is assumed that construction would not be feasible if the wind speed is faster than 15 m/s (or about 34 miles per hour). Current velocity calculated based on this wind speed from the east should represent an upper limit and was used in the plume evaluation. The CMS model used in the earlier design study is applied here to provide an estimate of depth-averaged current velocity for the plume dispersion calculation. It is worth emphasising that the CMS model calculates depth-averaged velocity, as opposed to surface water velocity. Depth-averaged velocity provides a more representative value for plume dispersion analysis, as compared to surface water velocity.

The most up to date version (2022) of the Coastal Modeling System, the CMS, (http://cirpwiki.info/wiki/CMS), specifically the CMS-Wave and CMS-Flow models, was used in this portion of the study. Detailed modeling results were discussed in the previous sections. An example of flow modeling result is shown in **Figure 5-64**. This example illustrates the peak flow field associated with a rising tide with a 15-m/s easterly wind. A velocity of 0.12 m/s was estimated to be representative of the overwater units' site. It is worth noting that flow velocities at other locations can be faster than that at the overwater units' site. The flow velocity applied here for the computation of plume dispersion was not the fastest velocity computed for the modeling domain. Rather, it is representative of the overwater units' site.

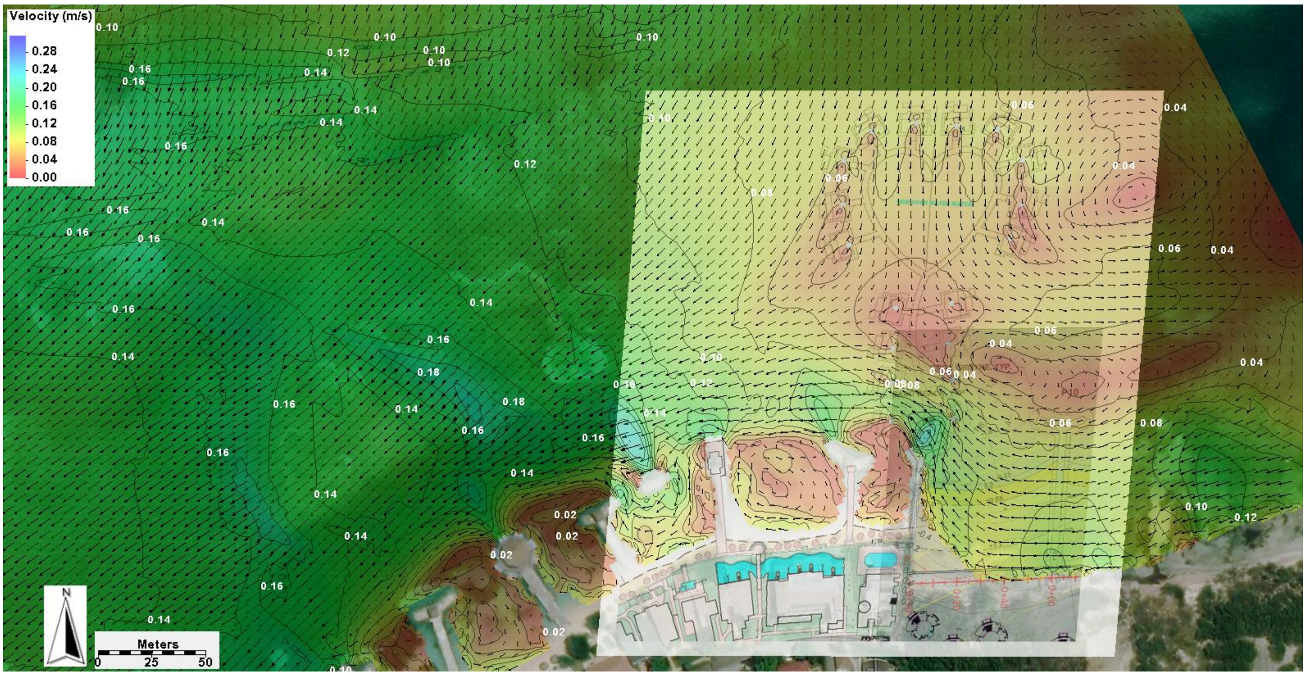


FIGURE 5-64: AN EXAMPLE OF MODELED FLOW FIELD UNDER THE RECOMMENDED DESIGN. NOTE THE COLOR SCHEME AT THE OVERWATER UNITS' LOCATION WAS CHANGED BY THE BACKGROUND IMAGE. THE FLOW VELOCITY VALUES CAN BE OBTAINED FROM THE CONTOUR LINES. ZOOMING IN TO, E.G., 200%, TO VIEW DETAILS OF THE WAVE FIELDS.

The time of plume settling is a function of *in situ* water depth and the settling velocity associated with a particular size of sediment (Wang and Beck, 2017). The water depth at the eight (8) sampling sites is listed in **Table 5-2**. Overall, the water depth at the project site ranges from 2.4 m at the overwater units' site to 0 m at the beach. This range of water depth was used to calculate the time needed for a particular sized sediment grain to settle to the bottom.

TABLE 5-2: WATER DEPTH AT SAMPLE SITES

Sample #1	2.4 m
Sample #2	2.2 m
Sample #3	1.8 m
Sample #4	1.4 m
Sample #5	1.1 m
Sample #6	beach, above water
Sample #7	1.3 m
Sample #8	0.8 m

Various formulas were developed to calculate settling velocities of sediment particles (Wang and Beck, 2022). Two of the most commonly used ones were applied in this study. Hallermeier (1981) proposed a set of empirical formulas for calculating settling velocities assuming that the sediments are non-cohesive:

$$w_s = \frac{\nu D_*^3}{18d} \qquad \text{for} \qquad D_*^3 \leq 39 \tag{1}$$

$$w_s = \frac{\nu D_*^{2.1}}{6d} \qquad \text{for} \qquad 39 < D_*^3 < 10^4 \tag{2}$$

$$w_s = \frac{1.05\nu D_*^{1.5}}{d} \qquad \text{for} \qquad 10^4 \leq D_*^3 < 3\times10^6 \tag{3}$$

where w_s is the settling velocity (m/s), ν denotes dynamic viscosity (kgm^{-1}s^{-1}), and D_* is the dimensionless grain size, defined as

$$\boldsymbol{D_*} = \left[\frac{(s-1)gd^3}{\nu^2}\right]^{\frac{1}{3}} \tag{4}$$

Soulsby (1997) re-analysed a large amount of existing data on settling velocities and developed a formula for calculating settling velocity, as

$$\boldsymbol{w_s} = \frac{\nu}{d}\left[\left(10.36^2 + 1.049D_*^3\right)^{\frac{1}{2}} - 10.36\right] \tag{5}$$

Equation (5) was verified over a large range of sediment grain sizes assuming that the sediment is non-cohesive (Soulsby, 1997). Cohesive sediments and associated flocculation are not considered by the Hallermeier (1981) and Soulsby (1997) formulas. It is assumed here that the settling of the mud-sized sediment in the project site would not be significantly influenced by flocculation, and the Hallermeier (1981) and Soulsby (1997) formulas are applicable.

Figure 5-65 compares the computed settling velocities using the two formulas. Overall, the Hallermeier (1981) and Soulsby (1997) formulas yielded similar settling velocities. The Soulsby (1997) formula was applied in this study for the plume dispersion analyses, as discussed in the following.

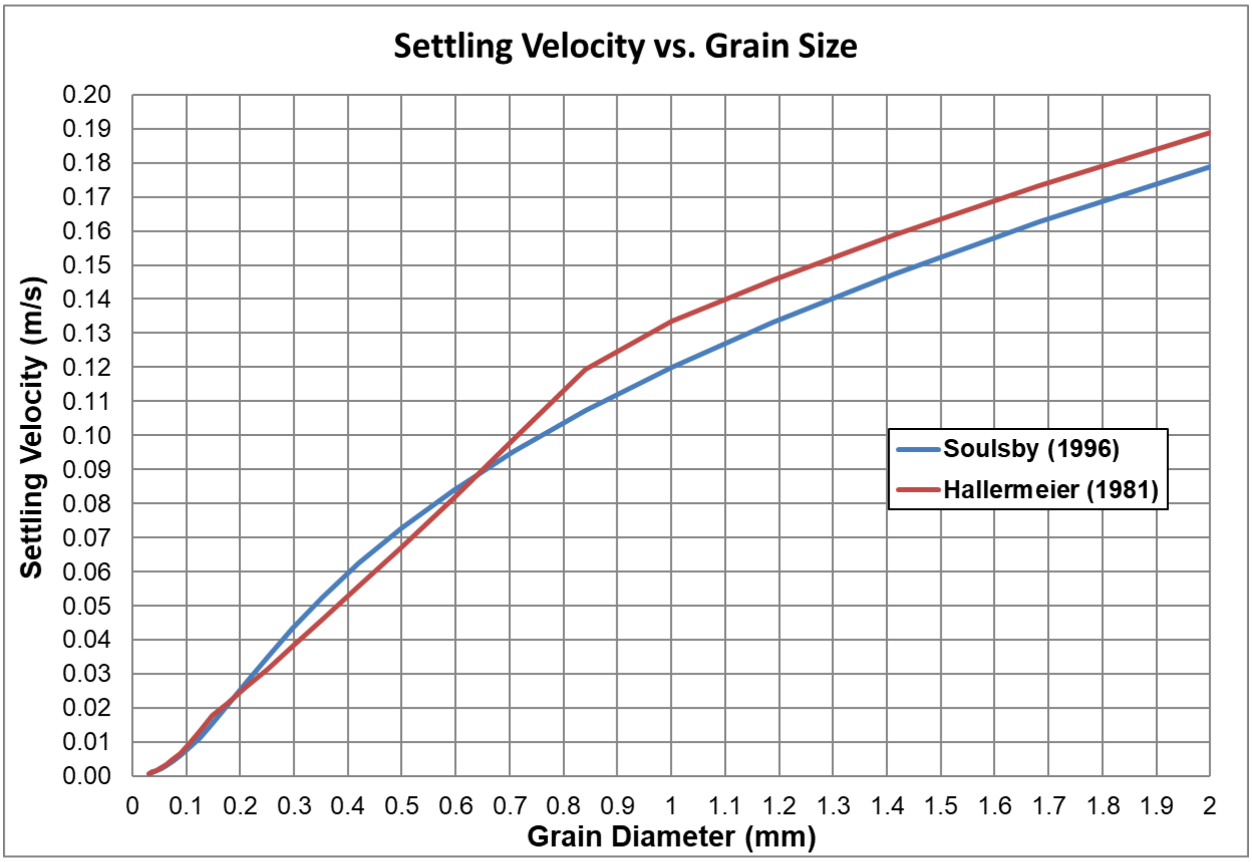


FIGURE 5-65: COMPARISON OF THE SOULSBY (1997) FORMULAE.

Based on Equations (1) through (5) and as illustrated in **Figure 5-65**, particle settling velocity is a strong function of grain size. Smaller grains, particularly the mud-sized grains, settle much slower than larger sand-sized grains. Based on the water depth at the project site, the time a specific sized particle needs to settle through the water column is calculated and illustrated in Figure 5-67. For particles that are larger than 0.5 mm, it takes less than 1 minute for them to settle through the typical water depth at the project site. However, based on the grain-size composition (**Figure 5-56**, **Figure 5-57**, **Figure 5-58**, **Figure 5-59**, **Figure 5-60**, **Figure 5-61**, **Figure 5-62**, and **Figure 5-63)**, a substantial portion of the sediment is smaller than 0.5 m and can therefore takes substantial time of up to 50 minutes for mud-sized grains to settle through the water column.

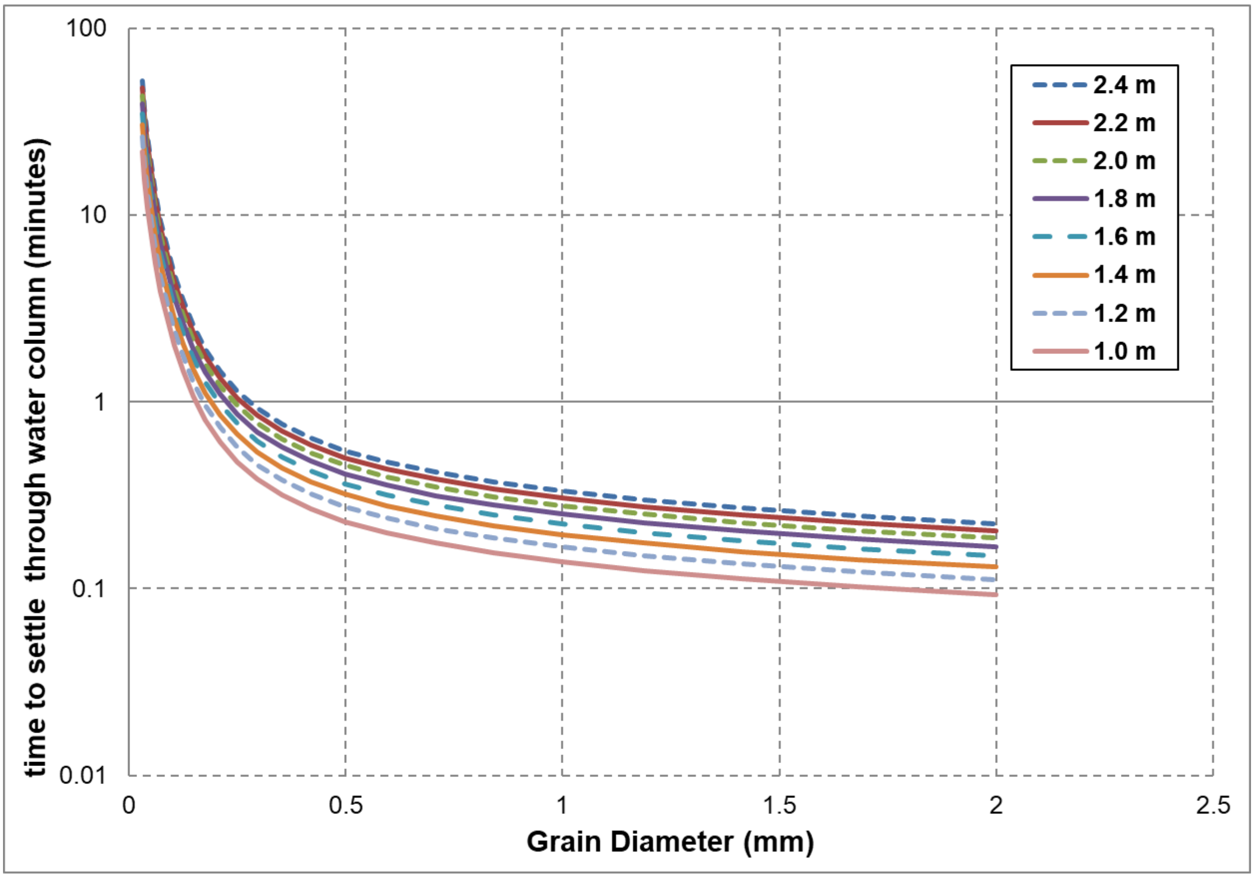


FIGURE 5-66: COMPUTED TIME FOR SEDIMENT GRAIN OF DIFFERENT SIZES TO SETTLE THROUGH 8 WATER DEPTHS.

Figure 5-66 shows that for mud sized sediment, it takes over 10 minutes to settle through the water column. For samples #4 and #5, mud sized grains can be up to 50% of the bottom sediment. Based on **Figure 5-67**, these fine-grained sediments can stay in the water column for over 10 minutes. Further offshore, samples #1, #2, and #3 have much less mud content, most of the sediments will settle down within 5 minutes (**Figure 5-66** and **Figure 5-67**).

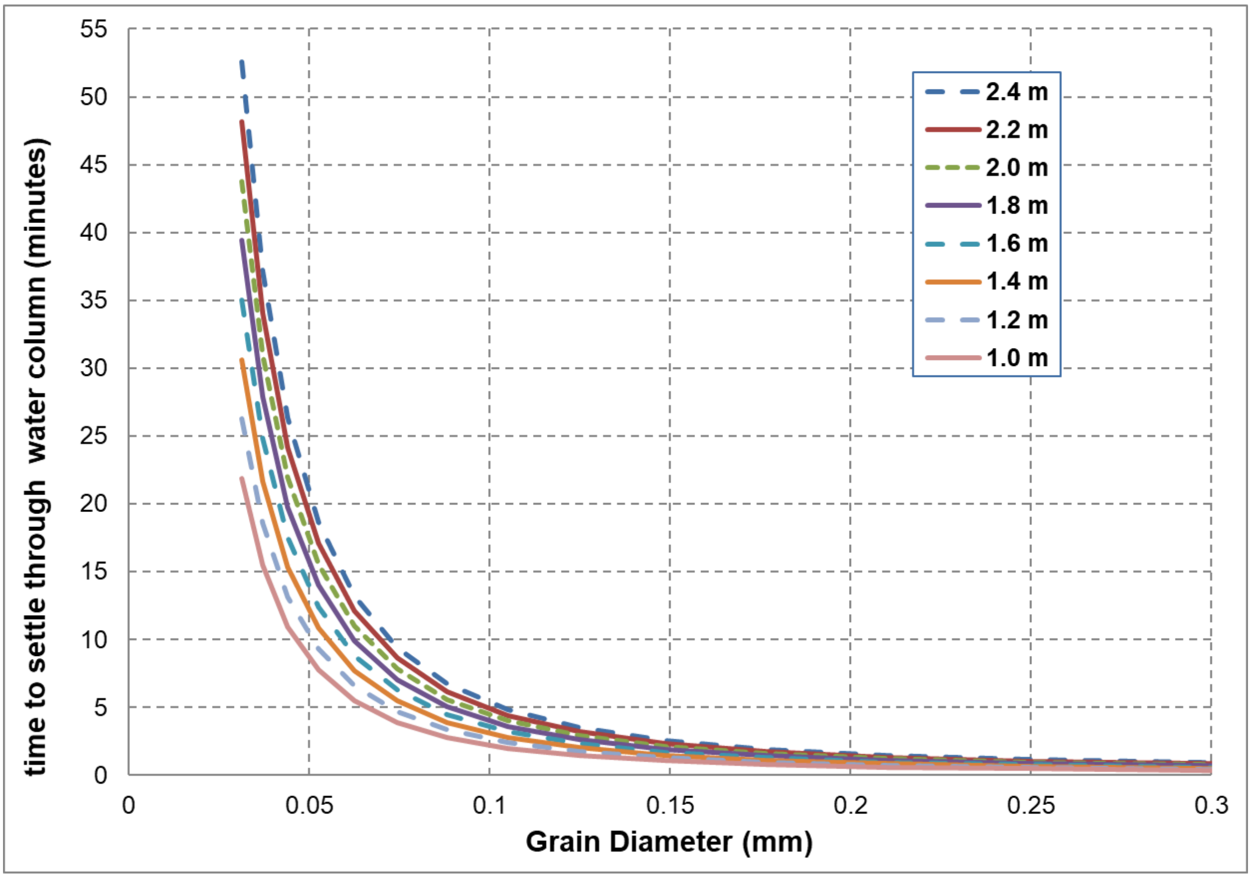


FIGURE 5-67: COMPUTED TIME FOR SEDIMENT GRAIN OF DIFFERENT SIZES TO SETTLE THROUGH 8 WATER DEPTHS, EMPHASISING SMALL GRAINS.

The numerical modeling shows that current at the project site can be up to 0.12 m/s, directly to the west, under windy conditions. The distance that the suspended sediment, i.e., the plume, can travel can be calculated by multiplying the settling time (**Figure 5-66** and **Figure 5-67**) by the current velocity. Since the settling time shown in **Figure 5-66** and **Figure 5-67** was calculated assuming that the particle was suspended to the surface of the water, it represents the maximum value of the settling time. Therefore, the travel distance obtained by multiplying this time with the velocity of 0.12 m/s represents the maximum distance the suspended particle can travel. This distance is used to represent the maximum extent that suspended particle, i.e., the plume, can travel under the energetic condition, and is illustrated in **Figure 5-68** and **Figure 5-69.**

For grains that are larger than 0.5 mm, they would travel less than 5 m before settling down to the bottom (**Figure 5-68**). However, for mud-sized grains, they can travel up to 400 m from the source (**Figure 5-69**). Since the current is mostly directed to the west as driven by the easterly trade wind, the plume dispersion is mainly directed toward the west and not likely to reach the barrier reef seaward. However, at sites with high mud content, i.e., sample locations #4 and #5, the plume can extend considerably alongshore.

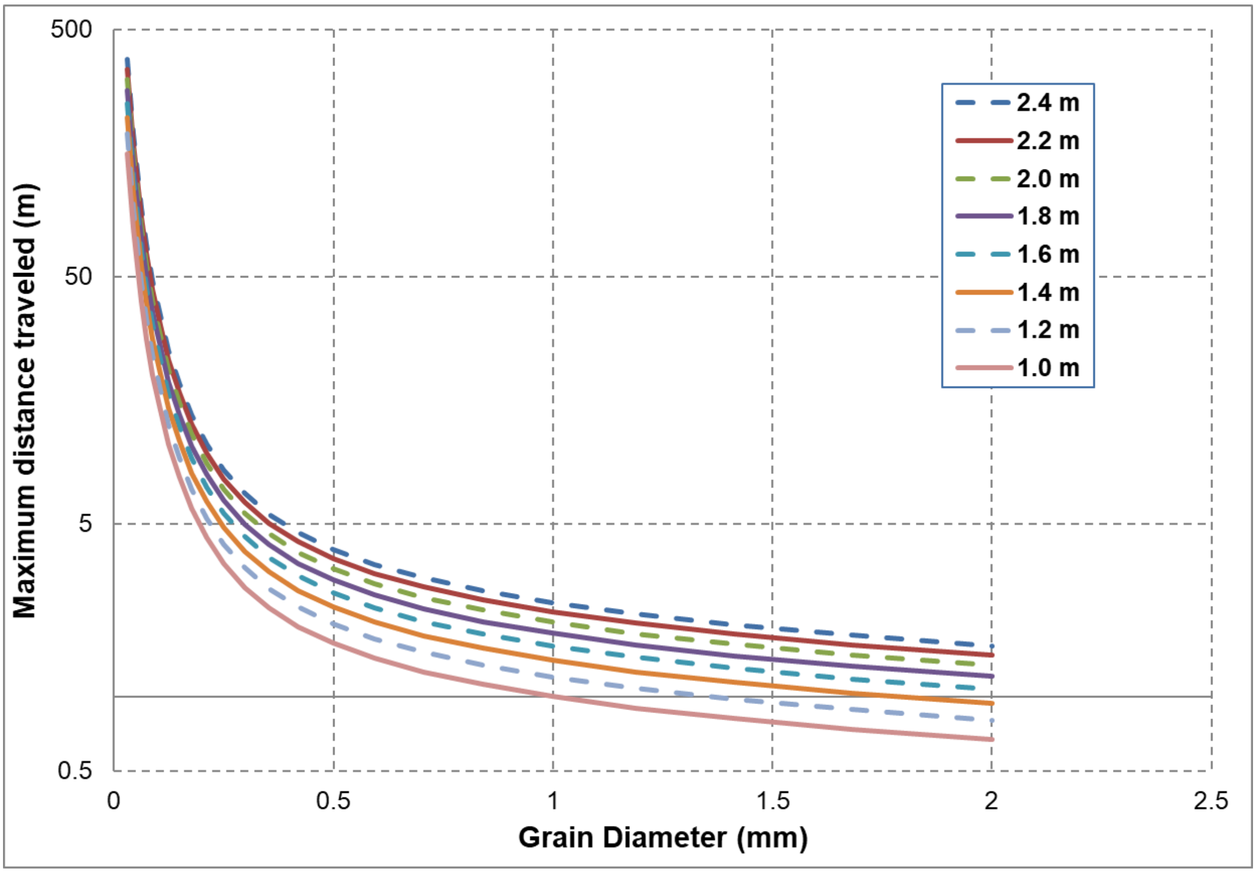


FIGURE 5-68: COMPUTED MAXIMUM DISPERSION DISTANCE OF DIFFERENT SIZES IN 8 WATER DEPTHS.

Based on the above analysis of plume suspension and dispersion, the following measures are recommended to control potential plume dispersion during construction:

4) The overwater unit construction, particular operations that may induce suspension of bottom sediments such as installation of pilings, should be conducted under calm conditions when the wind-driven current is much weaker than the velocity predicted for energetic conditions. This would significantly reduce the dispersion of suspended sediments.
5) At sites #4 and #5 with high mud content in the bottom sediment, plume barriers should be used to limit the dispersion of the suspended sediment. If feasible, plume barriers should be applied for the entire area.
6) Since the current tends to be directed to the west as driven by the easterly trade wind, the plume barriers should be deployed to the west of the construction operations.

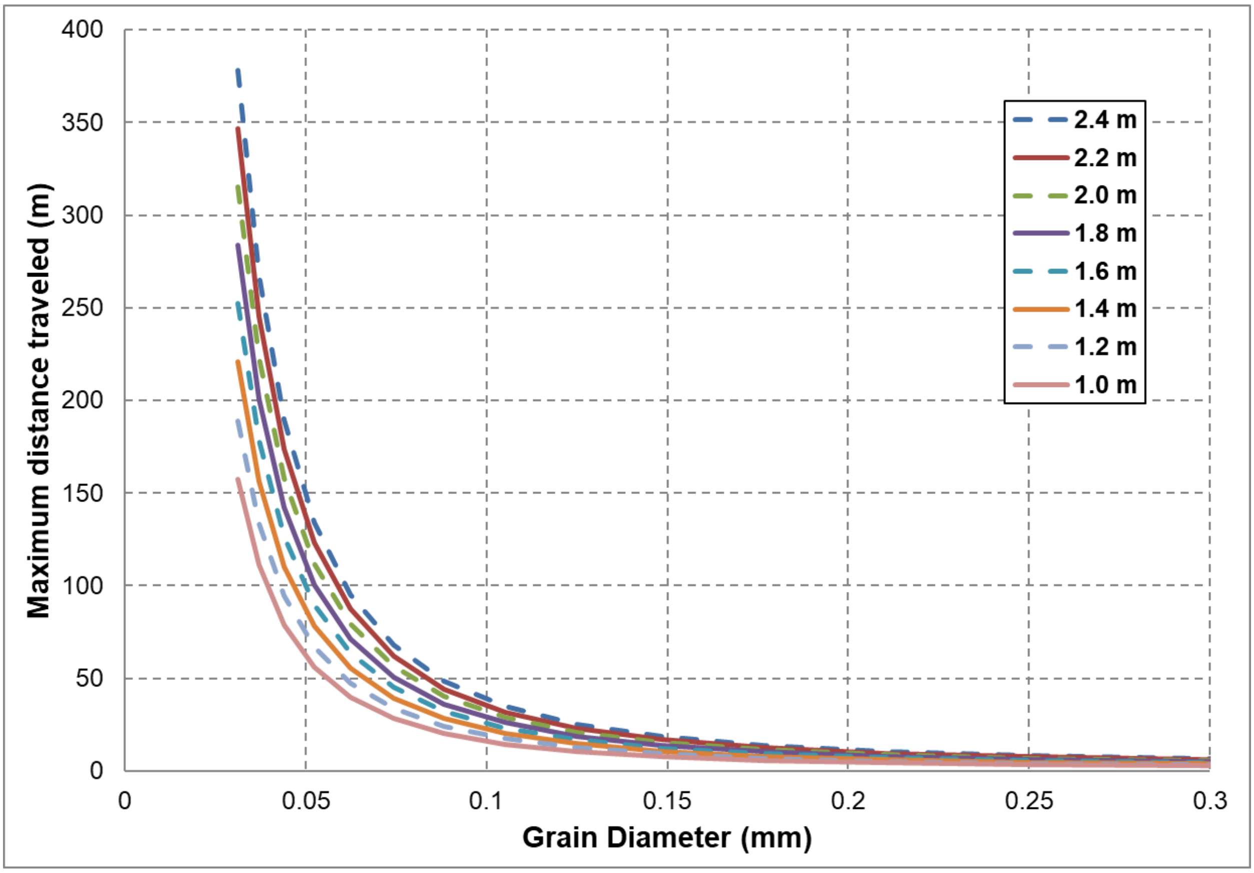


FIGURE 5-69: COMPUTED MAXIMUM DISPERSION DISTANCE OF DIFFERENT SIZES IN 8 WATER DEPTHS, EMPHASISING SMALL GRAINS.

Overall, the suspended sediments, even the mud-sized ones that may be induced by the construction operations would remain in the water column for less than one hour even under worst case scenarios. Its impact to the barrier reefs, which is located over 200 m seaward, should therefore not be significant. Plume barriers are recommended in the nearshore area where bottom sediments are quite muddy to further reduce the potential impact of plume dispersion.

5.1.2 Water Quality

5.1.2.1 Methodology

Baseline water quality was evaluated by a combination of field and laboratory analyses to determine the following parameters:

- Turbidity
- Dissolved Oxygen
- pH
- Temperature
- Total Dissolved Solids (TDS)
- Salinity
- Conductivity
- Nutrients (Nitrates and Phosphates)
- Faecal Coliform
- Biological Oxygen Demand (BOD)
- Total Suspended Solids (TSS)

Sample analyses were carried out by the National Water Commission Laboratory, Montego Bay. Water quality methods are summarised in **Table 5-3**.

TABLE 5-3: SUMMARY OF WATER QUALITY ANALYSES

Parameter	Method
Field Analysis *(in situ)*	
Dissolved Oxygen	YSI Meter/ YSI ProDSS Meter
Turbidity	Horiba Water Quality Checker U-10/ YSI ProDSS Meter
pH	Horiba Water Quality Checker U-10 (Glass Electrode)/ YSI ProDSS Meter
Depth	Speedtech Portable Depth Sounder/ YSI ProDSS Meter
Temperature, TDS, Salinity, Conductivity	YSI ProDSS Meter
Lab Analysis	
Faecal Coliform	9222 D. Fecal Coliform Membrane Filter Procedure
Nitrates	Colourimetric Automated Cadmium Reduction 353.2
Ortho-phosphate	Colourimetric Automated Ascorbic Acid Method 365.1

Samples were collected from five sampling sites (**Figure 5-70**) during the wet season on October 10, 2022, October 18, 2023 and October 25, 2023 and dry season on January 31, 2023, February 11, 2024 and March 11, 2024 to reflect background conditions (outside the reef) and baseline conditions within the footprint of the proposed development. Coordinates are shown in **Table 5-4**. These data sets are considered to be representative of wet and dry season baseline.

FIGURE 5-70: WATER QUALITY SAMPLING SITES

TABLE 5-4: WATER SAMPLING SITES

Station ID	Coordinates (DD)	
	N	W
1	18.514782	-77.903406
2	18.511117	-77.904262
3	18.511784	-77.903295
4	18.512457	-77.902264
5	18.512715	-77.900687

Results from the water quality sampling are compared to local and international water quality standards.

There is no salinity standard, so the levels determined are compared to levels generated by NOAA using NASA's Soil Moisture Active Passive (SMAP) data (NOAA)[3]. The NOAA reference site is shown in **Figure 5-71**.

FIGURE 5-71: NOAA SMAP REFERENCE SITE FOR SALINITY.

5.1.2.2 *Results and Observations*

Wet Season

The summary of the wet season data is shown in **Table 5-5.** The data for all sampling occasions are presented in **Appendix 1.**

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[3] https://coastwatch.noaa.gov/cw_html/cwViewer.html?lat=27.00&lon=-80.80&z=3&date=20240501&layer0=basemapWI&layer1=goesTC&layer2=MESIb

Phosphate-P averaged .003mg/l at all sites. The range was .002mgl to .005mg/l. The highest average was determined for the background station outside the reef (SMB1) and just west of the easternmost site (SMB4). The lowest value was determined for the easternmost site within the footprint of the proposed overwater bungalows (SMB5). At all other sites, P levels were .003mg/l. These levels compare to the NEPA interim standard of .003mg/l.

Nitrate-N averaged .011mg/l at all sites with a range of .005mg/l to .031mg/l. N was highest at the background site outside the reef (SMB1) and lowest at the westernmost site within the footprint of the proposed overwater bungalows and also at the site just west of the easternmost site (SMB4). Notably, the NEPA interim standard was exceeded at the background site while at other sites N was within the standard.

Biological Oxygen Demand (BOD) averaged 1.21mg/l at all sites with a range of 0.72mg/l to 1.79m/l. BOD was highest at the background site and lowest at the easternmost site within the footprint of the proposed overwater bungalows (SMB5). BOD exceeded the NEPA interim standard at the background site, as well as at the site just west of the easternmost site (SMB3). At the other sites, BOD was within the interim standard.

Dissolved Oxygen (DO) averaged 5.0mg/l at all sites with a range of 4.4mg/l to 5.9mg/l. DO was lowest at the site just east of the westernmost site (SMB3) and highest at the background site (SMB1). At the easternmost site (SMB5) DO was 4.9mg/l while at the site just west of the easternmost site (SMB3) DO was 4.7mg/l. At the westernmost site (SMB2) DO was 5.0mg/l. With the exception of the background site all sites were near or slightly less than the EPA standard. Considering that these levels are daytime levels it is likely that levels could drop to below the standard during nocturnal hours when photosynthetic oxygen is absent.

Faecal Coliform (FC) averaged 2.7 MPN/100ml at all sites with a range of >2 to 8 MPN/100ml>2 to 4NTU. The highest level was determined for the sample taken at the background site (SMB1). These levels were within the NEPA interim standard.

pH was almost uniform at all sites averaging 8.0 and being in the range 8.0 to 8.1. The highest level was determined for the background station (SMB1) while at all other sites pH was 8.0.

Temperature (T°C) was in the narrow range 30.40C° to 30.55±.06°C. These levels are slightly higher than the reference value quoted by the UWI Mona, Climate Studies Group (2017, 2022).

Total Suspended Solids (TSS) averaged 5mg/l with a range of 0.3mg/l to 11.7mg/l. TSS was lowest at the background site and highest at the site just west of the easternmost site (SMB4). At the site just east of the westernmost site (SMB3), TSS was 7.3mg/l while at the westernmost site (SMB2) TSS was 3.7mg/l. At the easternmost site (SMB5) TSS was 3.3mg/l.

Turbidity levels averaged 7.8NTU with a range of 0.5NTU to 14.9NTU. Turbidity levels mirrored the TSS levels, with the lowest level measured at the background site (SMB1) and the highest level measured at the site just west of the easternmost site (SMB4). At the easternmost site turbidity was 8.9NTU at the westernmost site (SMB2) turbidity was 6.1NTU and at the site just east of the westernmost site (SMB3) turbidity was 8.5NTU. These data yielded turbidity to TSS ratio of 1.6.

Salinity was in the narrow range of 34.2ppt to 34.3ppt. The higher levels were determined for the background site (SMB1) and the easternmost site (SMB5). The other sites within the proposed project footprint (SMB2, SMB3, SMB4) had a slightly lower salinity (34.2ppt).

Conductivity was in the range 57483µS/cm to 57729µS/cm and averaged 57633 µS/cm. The highest level was determined at the easternmost site (SMB5) and the lowest at the background site (SMB1). At the westernmost site (SMB2) conductivity was 57694 µS/cm, while at the site to the east of the westernmost site (SMB3) conductivity was 57677 µS/cm. At the site just west of the easternmost site (SMB4) conductivity was 57583 µS/cm.

Table 5-5: Water quality data Average over the Three Sampling Occasions – Wet Season

STATION ID	**PO4-P (mg/l)**		**NO3-N (mg/l)**		**BOD (mg/l)**		**DO (mg/l)**		**FC (MPN/100ml)**		**pH**	
	T	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**T/B**	**T**	**B**
SMB 1	0.005	0.003	0.031	0.008	1.79	1.70	5.9	5.7	4	8	8.1	8.0
SMB 2	0.003		0.005		0.89		5.0	5.2	0	0	8.0	8.1
SMB 3	0.003		0.006		1.64		4.7	5.1	0	0	8.0	8.1
SMB 4	0.005		0.005		0.99		4.4	4.3	3	3	8.0	8.1
SMB 5	0.002		0.006		0.72		4.9	4.8	3	3	8.0	8.0
STD/REF	0.003(4)		0.014(4)		1.16(4)		4.8(4)		2-13 (4)		8.1(3)	
AVERAGE	0.003		0.011		1.21		5.0	5.015	2	2.733	8.0	8.0
MAX	0.005	0.003	0.031	0.008	1.79	1.700	5.9	5.747	4	8	8.1	8.1
MIN	0.002	0.003	0.005	0.008	0.72	1.700	4.4	4.310	0	0	8.0	8.0
std dev											0.0	0.0

STATION ID	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/L)		T (°C)	
	T	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**B**
SMB 1	0.3	3	0.5	0.5	34.3	34.3	57483	57865	36491	37014	30.56	30.55
SMB 2	3.7		6.1	5.3	34.2	34.2	57694	57315	39725		30.47	30.15
SMB 3	7.3		8.5	2.0	34.2	35.2	57677	58400	36217		30.46	29.80
SMB 4	11.7		14.9	2.0	34.2	35.2	57583	58400	43408		30.40	30.15
SMB 5	3.3		8.9	2.8	34.3	34.3	57729	56267	33148		30.47	30.2
STD/REF					35.6 (1)						29.6(2)	
AVERAGE	5.3		7.8	3	34.2	34.6	57633	57649	37798		30.47	30.16
MAX	11.7	3	14.9	5	34.3	35.2	57729	58400	43408	37014	30.56	30.55
MIN	0.3	3	0.5	0	34.2	34.2	57483	56267	33148	37014	30.40	29.80

T - Denotes sample taken at the surface (Top of the water column)

B - Denotes sample taken at the bottom of the water column

(1) – NOAA Coast Watch Sea Surface Salinity – Near Real Time – SMAP 2022

(2) – University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April 2020

(3) – https://www.noaa.gov/education/resource-collections/oceans-coats/ocean-acidification. Last updated April 1, 2020

(4) – Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009

Dry Season

The summary of the dry season data is shown in **Table 5-6.** The data for all sampling occasions are presented in **Appendix 2.**

Phosphate-P averaged .003mg/l at all sites. The range was .002mgl to .004mg/l. The highest average was determined for the background station outside the reef (SMB1) and just west of the easternmost site (SMB4). The lowest value was determined at the background site (SMB1), the westernmost site (SMB2) and east of the westernmost site (SMB 3). SMB4 and SMB5 had an average of .004, exceeding the NEPA interim standard of .003mg/l.

Nitrate-N averaged .005 mg/l at all sites with a range of .004 mg/l to .007 mg/l. Nitrate-N was highest at the background site outside the reef (SMB1B) and the eastern site within the footprint of the proposed development (SMB5). The lowest average Nitrate-N was determined for the sample taken just west of the easternmost site (SMB4). All sites were within the NEPA Interim standard of 0.014 mg/L.

Biological Oxygen Demand (BOD) averaged 1.07mg/l at all sites with a range of 0.37mg/l to 1.60 mg/l. Average BOD was highest at the background site and lowest at the westernmost site (SMB2). BOD exceeded the NEPA interim standard of 1.16 mg/L at the background site, east of the westernmost site (SMB3) and at the easternmost site SMB5. At the other sites (SMB2 and SMB4), BOD was within the interim standard.

Dissolved oxygen (DO) averaged 6.5mg/l at all sites with a range of 6.0mg/l to 6.8mg/l. DO was lowest at the easternmost site (SMB5) and highest at the site just east of the westernmost site (SMB3). At the background site (SMB1) DO was 6.4mg/l while at the westernmost site (SMB2) DO was 6.7mg/l. These values were all better than the USEPA criterion value for marine waters.

Faecal coliform (FC) average was generally <2 MPN/100ml at all sites. A level of 2 MPN/100ml was determined on one occasion at the westernmost site (SMB3). These levels were well within the Draft Jamaica National Ambient Water Quality Standard for Marine Water (13 MPN/100ml).

pH was almost uniform at all sites averaging 8.1 and being in the range 8.1 to 8.2. The highest level was determined for the westernmost site (SMB2) and the site just east of the westernmost site (SMB3).

Temperature (T°C) was in the narrow range 27.6°C (SMB1T) to 28.1°C (SMB5B). These levels are slightly higher than the reference value quoted by the UWI Mona, Climate Studies Group (2017,2022).

Total Suspended Solids (TSS) averaged 4.7mg/l with a range of 3.3mg/l to 6.7mg/l. TSS was lowest at the background site and highest at the site just east of the westernmost site (SMB3).

Turbidity levels averaged 5.3NTU at the top of the water column and 4.4NTU at the bottom of the water column. Turbidity ranged from 2.7NTU to 9.3NTU. The lowest level measured at the background site (SMB1) and the highest level measured at the site just east of the westernmost site (SMB3). At the westernmost site (SMB2) turbidity was 6.0NTU and west of the easternmost site (SMB4T) turbidity was 2.7NTU at the surface and 3.0NTU at the bottom of the water column.

Salinity was in the narrow range of 35.8ppt to 36.4ppt. The higher levels were determined for the background site (SMB1). All the other sites (SMB2, SMB3, SMB4, SMB5) had a salinity of 35.9 ppt.

Conductivity was in the range 56114μS/cm to 57755μS/cm and averaged 57008 μS/cm at the top of the water column and 57384 μS/cm at the bottom of the water column. The highest level was determined at the easternmost site (SMB5B) and the lowest at the background site (SMB1T).

Table 5-6: Water quality data Average over the Three Sampling Occasions – dry season

STATION	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO (mg/l)		FC (MPN/100ml)		pH	
ID	T	B	T	B	T	B	T	B	T	B	T	B
SMB 1	0.002	0.004	0.005	0.007	1.50	1.19	6.4	6.4	0		8.1	8.1
SMB 2	0.002		0.005		0.37		6.7	7.0	0		8.2	8.2
SMB 3	0.002		0.006		1.31		6.8	6.8	1		8.2	8.2
SMB 4	0.004		0.004		0.57		6.6	6.8	0		8.1	8.1
SMB 5	0.004		0.007	0.000	1.60	0.00	6.0	6.3	0		8.1	8.1
STD/REF	0.003(4)		0.014(4)		1.16(4)		4.8(4)		2-13(4)		8.1(3)	
AVERAGE	0.003	0.004	0.005	0.004	1.07	0.59	6.5	6.7	0		8.1	8.1
MAX	0.004	0.004	0.007	0.007	1.60	1.19	6.8	7.0	1	0	8.2	8.2
MIN	0.002	0.004	0.004	0.000	0.37	0.00	6.0	6.3	0	0	8.1	8.1

STATION	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)		T (°C)	
ID	T	B	T	B	T	B	T	B	T	B	T	B
SMB 1	3.3	1.7	2.7	2.7	36.4	35.8	56114	57480	34135	34341	27.6	28.0
SMB 2	4.0		6.0	6.0	35.9	35.9	57335	57503	34235	34216	27.8	27.8
SMB 3	6.7		9.3	6.2	35.9	35.9	57220	57051	34168	34156	27.7	27.6
SMB 4	5.0		2.7	3.0	35.9	35.9	57137	57131	35603	34147	27.7	27.6
SMB 5	4.7	0.0	6.1	4.3	35.9	35.8	57234	57755	34238	35873	27.8	28.1
STD/REF					35.6 (1)						29.6(2)	
AVERAGE	4.7	0.8	5.3	4.4	36.0	35.9	57008	57384	34476	34546	27.7	27.8
MAX	6.7	1.7	9.3	6.2	36.4	35.9	57335	57755	35603	35873	27.8	28.1
MIN	3.3	0.0	2.7	2.7	35.9	35.8	56114	57051	34135	34147	27.6	27.6

T - Denotes sample taken at the surface (Top of the water column)

B - Denotes sample taken at the bottom of the water column

(1) – NOA Coast Watch Sea Surface Salinity – Near Real Time – SMAP 2022

(2) – University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April 2020

(3) – https://www.noaa.gov/education/resource-collections/oceans-coats/ocean-acidification. Last updated April 1, 2020

(4) – Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009

Wet Season Dry Season Comparison

Levels of phosphorous in the wet season were similar to the dry season with the average being the same (.003mg/l) at all sites which is equivalent to the interim standard.

Levels of nitrogen in the wet season tended to be higher in the wet season (.011mg/l) than in the dry season (.005 mg/l). Levels in the wet and dry season were slightly lower than the interim standard (.014mg/l).

Dissolved oxygen (DO) levels in the wet season were distinctively lower in the wet season (5.0mg/l) than in the dry season (6.5mg/l). Both data sets are within the EPA standard (4.8mg/l) though oxygen levels are consistently better in the dry season.

BOD was slightly higher in the wet season (1.21mg/l) than in the dry season (1.07mg/l). This is consistent with the lower DO levels observed for the wet season compared to the dry season. The wet season levels slightly exceed the interim standard (1.16mg/l).

Faecal coliform levels were consistently within the interim standard (<13MPN) at all sites. The average faecal coliform was marginally higher in the wet season (2MPN) than in the dry season (0MPN).

Average pH was marginally lower in the wet season (8.0) than in the dry season (8.1). These levels are similar to levels from a previous study (**ESL 2018**).

Average surface turbidity was slightly higher in the wet season (7.8NTU) than in the dry season (5.3NTU). At the bottom of the water column average turbidity in the wet season was 3NTU and 4.4NTU for the dry season.

TSS levels reflected turbidity levels and were slightly higher in the wet season (5.3mg/l) than the dry season (4.7mg/l).

Salinity levels were slightly lower in the wet season (34.2psu) than in the dry season (36.0psu)

5.1.3 Noise Levels of undeveloped site and the ambient noise in the area of influence

Noise levels were measured at two sites: at Sandals Montego Bay just west of the site proposed for the construction of the overwater bungalows and another at the undeveloped site proposed for construction of the villa style units east of the present developed area (**Figure 5-72**). Noise levels for both occasions are summarised in **Table 5-7**

Noise Level at Sandals Montego Bay - Just West of Site Proposed for Overwater Bungalows

Average noise level (Leq) measured over a 30-minute period commencing 13:56 on January 31, 2023, was 70.5dbA, which was above the standard for a commercial zone. The maximum noise level over the period was 95.6 dBA while the L90 or value measured 90% of the time (also referred to as the background noise level) was 55.9dBA. The Peak was 111.7dBC. The source of the elevated noise level (111.7 dBA) was the airport, which was located nearby.

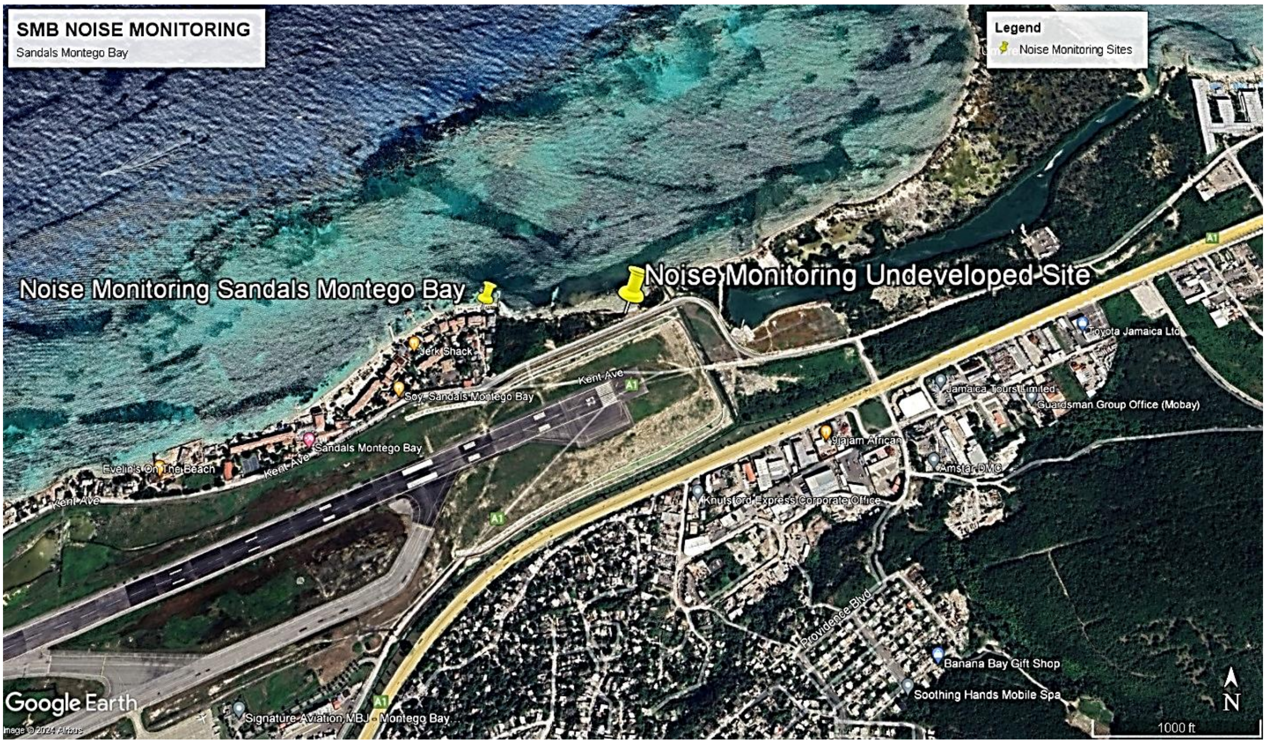


FIGURE 5-72: SANDALS MONTEGO BAY – NOISE MONITORING SITE. SANDALS MONTEGO BAY – NOISE MONITORING SITE.

TABLE 5-7: SUMMARY OF NOISE DATA

Date	Latitude (N)	Longitude (W)	Time	Total Run Time	Leq dBA	LAMax	L90	Peak	National Standard - Commercial Zone 7AM - 10 PM
31-Jan-23	18.511729	-77.901064	13:56	00:30:00	70.5	95.6	55.9	111.7	65
25-Oct-23	18.511672	-77.898247	9:39	00:30:01	55.3	77.3	49.4	92.6	

The time history (**Figure 5-73**) shows noise levels associated with aircraft take offs between approximately 85dBA and 90dBA.

Noise Level at Undeveloped Site East of Sandals Montego Bay

Average noise level (Leq) measured over a 30-minute period commencing 09:39 on October 25, 2023, was 55.3dbA, which was within the standard for a commercial zone. The maximum noise level over the period was 77.3 dBA while the L90 or value measured 90% of the time (also referred to as the background noise level) was 49.4dBA (**Figure 5-73**). The Peak was 92.6dBC. The generally lower levels on this occasion were consistent with lighter air traffic on this occasion.

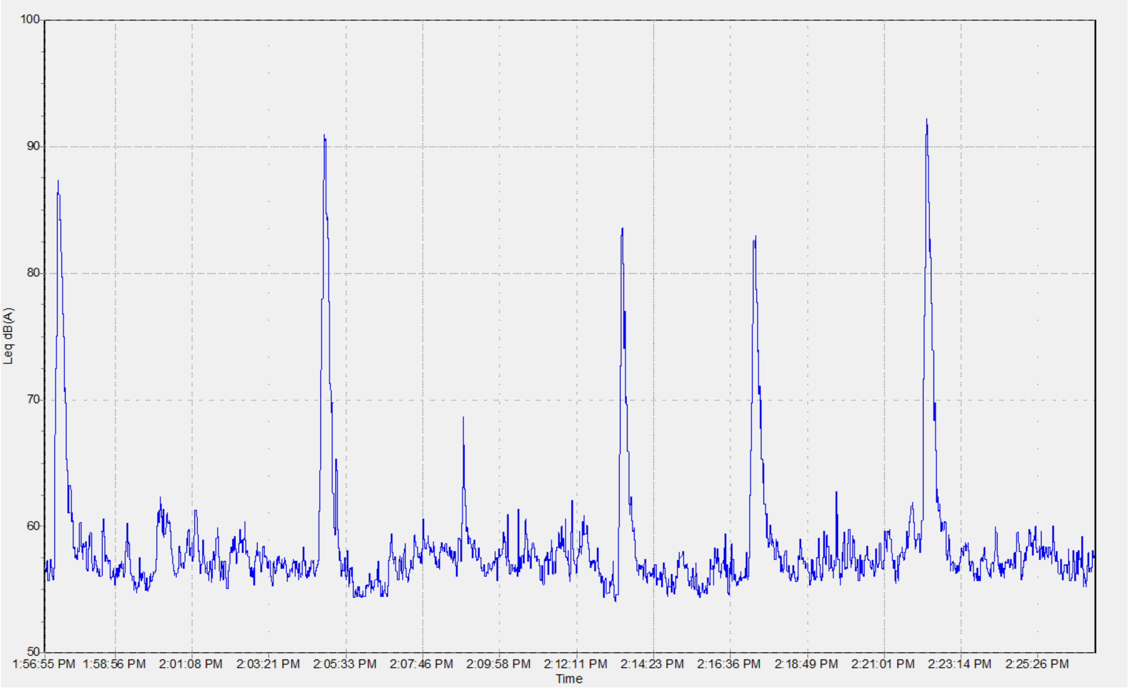


FIGURE 5-73: NOISE HISTORY – SHORT TERM MONITORING JANUARY 31, 2023

5.1.4 Sources of existing pollution

No obvious pollution sources were observed in the vicinity of the study area. There is a sewage treatment plant at the southern portion of the site (Figure 5-74) which is licensed as an oxidation ditch system with discharge to be used for irrigation. This STP is to be decommissioned and the hotel connected to Rose Hall sewage treatment plant.

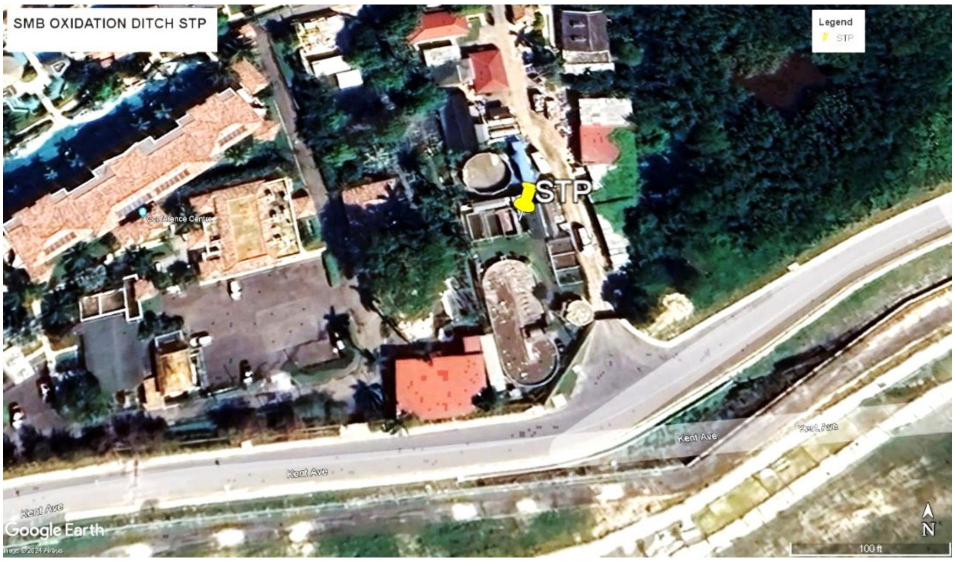


FIGURE 5-74: OXIDATION DITCH STP

A major drainage discharge outlet for surface water runoff approximately 320m east of the site boundary, takes storm water runoff to the sea. This is expected to seasonally affect turbidity levels in the study area.

5.1.5 Results of a Geotechnical Assessment for the site

The geotechnical investigation conducted at Sandals Overwater Bungalows, Montego Bay, St James includes a geological evaluation, subsurface soil description and classification, Standard Penetration Tests (SPT), soils laboratory and geotechnical analyses of the soils (13.3 Appendix 3).

The bungalows are to be erected in shallow water of the Caribbean Sea with depths ranging from 2.4m (8 ft) to 3.3m (11 ft). The geotechnical information gathered from the investigation indicates the soil in the seabed consists predominantly of 9.7m (32 ft) to 10.6m (35 ft) very loose/loose, to medium dense coarse grain soil which is comprised of calcareous sand and gravel with varying proportions of silt. Where the soil is described as silty, the soil will behave as a coarse grain soil, given that the combined proportion of sand and gravel in the soil is high. Below the calcareous sediment, is moderately weak reef limestone.

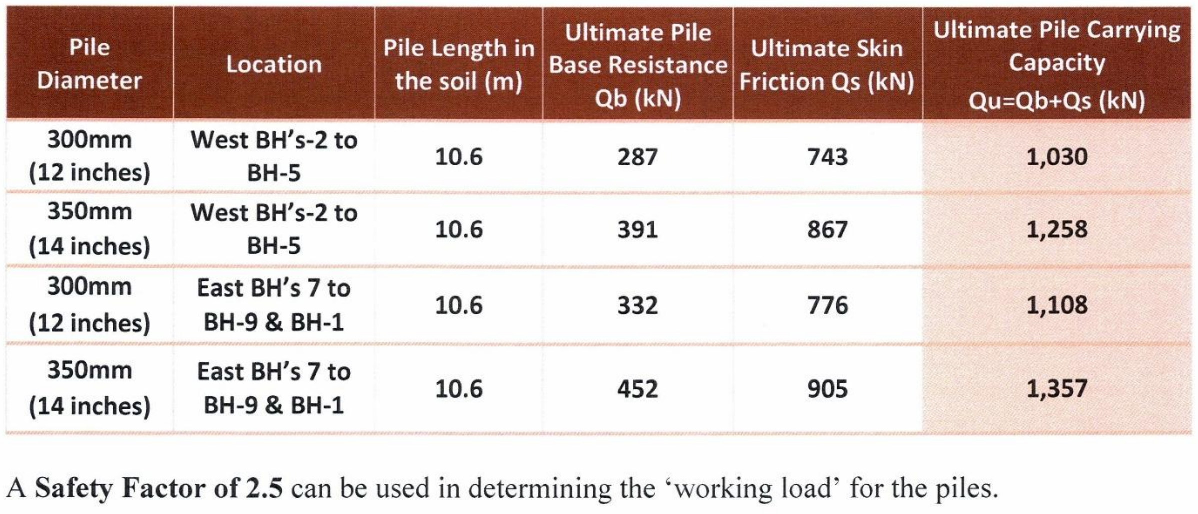
The type of foundation recommended is pile foundation with the pile tip embedded in the limestone bedrock. Driven or cast-in-place piles can be considered, however, the preferred option is for **cast-in-place piles**, given that there is likely to be weakening of the rock wall around the pile during the driving process which would reduce frictional resistance in the rock. It is important that the drilling process for the construction of the piles will create minimal disturbance of the rock around the tip of the pile.

Table 5-8 provides Ultimate Carrying Capacity of a single pile based on pile length of 10.6m in the soil and pile diameters of 300mm and 350mm (12 inches and 14 inches). The structural engineer will use the data in **Table 5-8** as a guide for design of the piles for the bungalows. However, actual pile length design will be based on the depth of pile in the soil and depth of water above the seabed which gives a pile length of approximately 13m-13.5m.

Given that the pile will largely depend on end bearing resistance into the bedrock and that the bungalows are designed to be lightly loaded structures, it is expected that settlement will be kept within a tolerable limit of 25mm, based on the working load to be determined by the structural engineer.

It is the opinion of the geotechnical engineer that the Sandals site in Montego Bay, St James, can be used for construction of the proposed overwater bungalows.

TABLE 5-8: ESTIMATED ULTIMATE PILE CARRYING CAPACITY FOR A SINGLE PILE IN NON-COHESIVE SOILS FOR SANDALS OVERWATER BUNGALOWS ON THE EASTERN AND WESTERN SECTIONS OF THE SITE, MONTEGO BAY, ST. JAMES.



Pile Diameter	Location	Pile Length in the soil (m)	Ultimate Pile Base Resistance Qb (kN)	Ultimate Skin Friction Qs (kN)	Ultimate Pile Carrying Capacity Qu=Qb+Qs (kN)
300mm (12 inches)	West BH's-2 to BH-5	10.6	287	743	1,030
350mm (14 inches)	West BH's-2 to BH-5	10.6	391	867	1,258
300mm (12 inches)	East BH's 7 to BH-9 & BH-1	10.6	332	776	1,108
350mm (14 inches)	East BH's 7 to BH-9 & BH-1	10.6	452	905	1,357

A **Safety Factor of 2.5** can be used in determining the 'working load' for the piles.

5.2 Biological Environment

5.2.1 Marine Survey

The marine survey was conducted in two phases. The first phase focused on the area of the overwater bungalows and the area of influence in front of Sandals Montego Bay (SMB). The second phase focused on the benthic environment along the coastline immediately east of the SMB resort boundary, the site of proposed groynes.

5.2.1.1 Methodology - Seagrass Survey Overwater Bungalows

A baseline survey of the marine flora and fauna was carried out on October 7 to10, 2022 for the overwater bungalows development site. The survey focused on the coastal ecosystem along the Sandals Montego Bay (MB) property, the spatial extent and condition of the seagrass beds, and the presence/absence of endemic, protected, and ecologically and commercially important species of flora and fauna in and immediately adjacent to the proposed project site.

The site survey encompassed a ~250m buffer around the area designated for developing overwater bungalows. Transect locations were selected in and adjacent to the project footprint. A total of ten (10) 100 m transects were surveyed **(Table 5-9)**, (**Figure 5-75**); 8 transects (T1-T8) were immediately within the project footprint, and two (T9, T10) were located near the reef crest ~350m from the shore.

TABLE 5-9: GPS COORDINATES OF TRANSECTS (100M) AND GROUND-TRUTHING SPOT-CHECKS AT THE SMB SITE.

Transect # (100m)	Latitude	Longitude
T1	18.510812	-77.903948
T2	18.511394	-77.903534
T3	18.51154	-77.90287
T4	18.512488	-77.901784
T5	18.512548	-77.901206
T6	18.512582	-77.900699
T7	18.513638	-77.902685
T8	18.512539	-77.904282
T9	18.513219	-77.905161
T10	18.51459	-77.90252
Ground truthing Site #	**Latitude**	**Longitude**
S1	18.510985	-77.905168
S2	18.510431	-77.904503
S3	18.510887	-77.903755
S4	18.511852	-77.902834
S5	18.512217	-77.902081
S6	18.512223	-77.901926
S7	18.512172	-77.901337
S8	18.512288	-77.900678
S9	18.513297	-77.901381
S10	18.514384	-77.90235
S11	18.514064	-77.903303
S12	18.512968	-77.904149

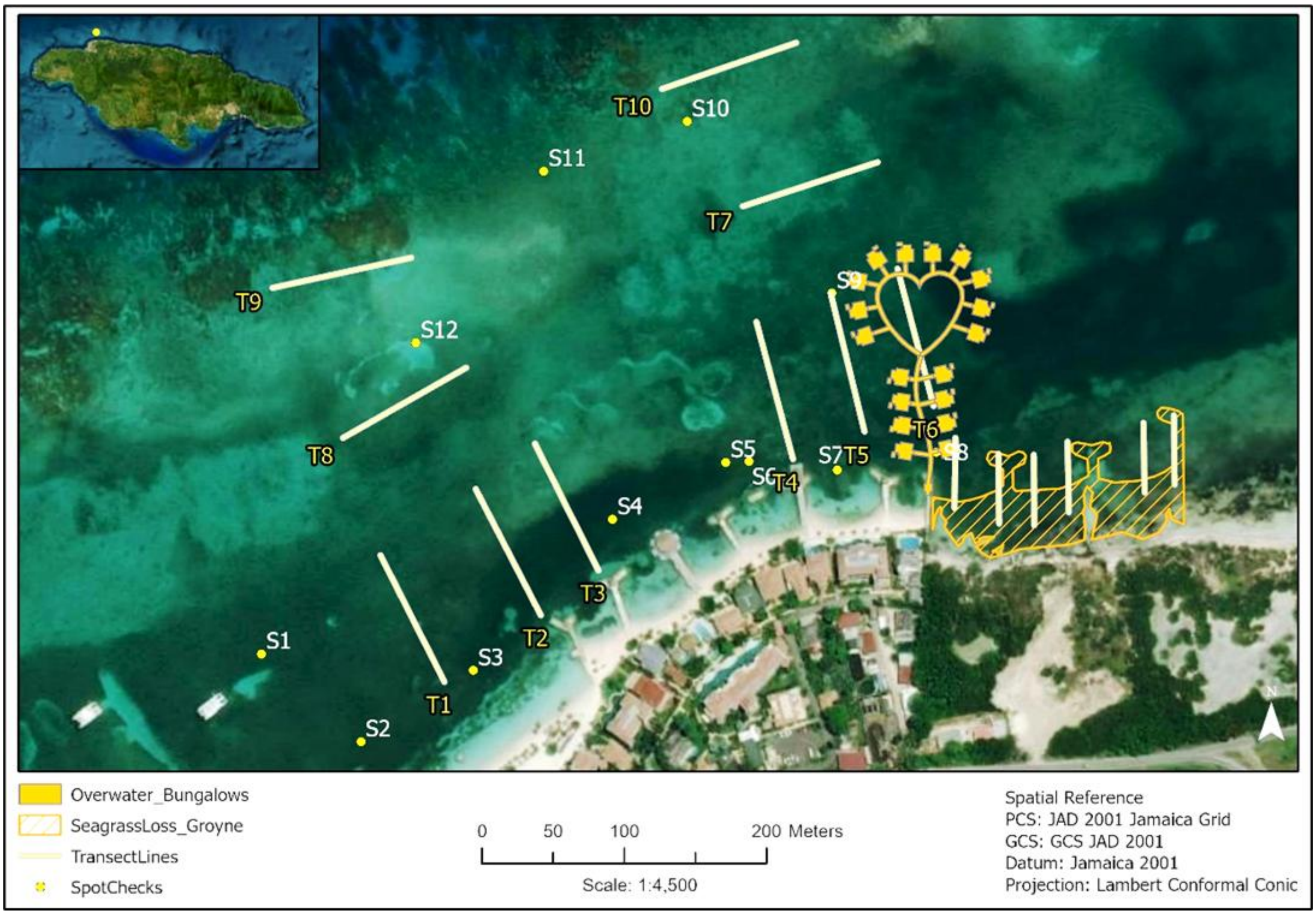


Figure 5-75: Location of the benthic surveys at the Sandals Montego Bay Site.

Seagrasses, Fishes, and Macroinvertebrates

Seagrass density was quantified using quadrats (0.25 m^2 and 1 m^2) placed at 5m intervals along the length of transects, alternating on the left and right sides of the tape. These quadrats were used to estimate the density (#/m^2) of fauna, including sea urchins, starfish, conch, and any other indicator species encountered.

A survey of the reef crest located ~350m from the shoreline (i.e., zone of influence) was carried out using the Atlantic and Gulf Rapid Reef Assessment (AGRRA[4]) protocol. The survey focused on characterising the benthic substrate composition, including the presence/absence, and condition (i.e., disease) of coral, alcyonaceans, macroalgae, and other substrate categories.

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[4] https://www.agrra.org/

The fish community was assessed using the AGRRA belt transect method at the reef crest (T9, T10) and Roving Diver Technique (RDT[5]) along the nearshore transects where the fish were less abundant. The RDT survey data provided species lists and frequency of occurrence for species encountered (i.e., **D**ominant, **A**bundant, **F**requent, **O**ccasional, **R**are).

A supplemental spot survey was carried out from the beach to the reef crest, seaward of the Sandal's MB property.

Estimating Seagrass Loss Due to the construction of Overwater Bungalows

The method for estimating seagrass loss and developing a relocation plan was based on *in-situ* surveys of seagrass boundaries and analysis of satellite imagery. Spatial analysis using ArcGIS was conducted to estimate the impact of the overwater bungalows on the seagrass ecosystem. The analysis incorporated the architectural footprint of the bungalows. ArcGIS tools, such as buffer analysis and overlay operations, were used to delineate the seagrass areas in the project footprint likely to be affected by construction activities. This analysis considered not only the direct footprint of the structures but also the shading effects, potential sediment disturbance, and the potential impact of the footings that will be used to stabilise the two Tank Weld barges (40' x 20' and 60' x 40') during construction of the overwater bungalows and walkways. The spatial analysis provided an estimated area of seagrass requiring relocation, allowing for a more accurate and targeted relocation plan tailored to the specific project parameters. Results and Observations -Overwater Bungalows

Backreef Ecosystem

Seagrass

The study area at Sandals Montego Bay is located on a narrow sandy terrace, 2-5m deep that extends ~ 350m seaward toward a shallow, submerged reef crest that gives way to a fringing reef, typical of the north coast of Jamaica. The sandy backreef (lagoon) is colonised by continuous seagrass meadows inshore that transition to a hardpan substrate covered with a thin layer of sand and sparse seagrass mixed with macroalgae, rubble, and small coral mounds near the reef crest.

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[5] Reef Environmental Education Foundation (http://www.reef.org)

Seagrass beds are essential to the health of coastal ecosystems by providing a variety of critical ecosystem functions including nursery grounds for fish and a variety of invertebrate species; stabilising sediments and improving water quality by trapping nutrient-laden runoff; dampening the impact of waves and storms, thereby providing coastal protection for the beach area from erosion; and mitigating effects of climate change through carbon sequestration (Guanell et al., 2016). Proper management and conservation of this vital ecosystem are essential to ensure its resilience in the face of various anthropogenic impacts.

Transects conducted in the backreef area (T1-T8) revealed dense *Thallasia testudinum* meadows interspersed with macroalgae, including green algal species such as *Halimeda, Penicillus*, and *Udotea* and brown algae (*Sargassum, Dictyota, and Padina*, spp.), typically found growing between seagrass shoots.

Seagrass cover ranges from ~100% inshore and tapers off to 38% near the crest (T10). On average, 86% of the seagrass cover is attributed to *T. testudinum,* and 14% to the variable distribution of *S. filiforme* (**Figure 5-76**).

Thalassia shoot densities range from 66 shoots/m^2 to 587 shoots/m^2, with grass blade lengths varying from 10-30 cm (**Table 5-10**). The shoot density, condition, and blade lengths indicate a generally healthy and mature seagrass habitat.

TABLE 5-10: SEAGRASS DENSITY (#/M2), BLADE LENGTH, AND RELATIVE % COVER OF SEAGRASS SPECIES FOUND WITHIN THE PROJECT AREA AT THE SANDALS MB LOCATION (TTES = *THALASSIA TESTUDINUM*; SAND A S FIL = *SYRINGODIUM FILIFORME*).

Date	**Transct #**	**Seagrass Sp.**	**Shoot/25cm²**	**Shoot/m²**	**Blade length (cm)**	**% Cover**
08-Oct-22	1	*T tes/S fil*	30-40	587	15-20	83
08-Oct-22	2	*T tes/S fil*	19	305	10-30	86
09-Oct-22	3	*T tes*	24	379	15-20	100
09-Oct-22	4	*T tes/S fil*	18	283	10-25	95
09-Oct-22	5	*T tes*	22	356	10-25	100
09-Oct-22	6	*T tes*	32	516	15-20	100
09-Oct-22	7	*T tes*	14	221	10-20	75
09-Oct-22	8	*Ttes*	30	482	10-15	100
10-Oct-22	9	*Ttes*	16	251	10-25	86
10-Oct-22	10	*Ttes*	4	66	10	38

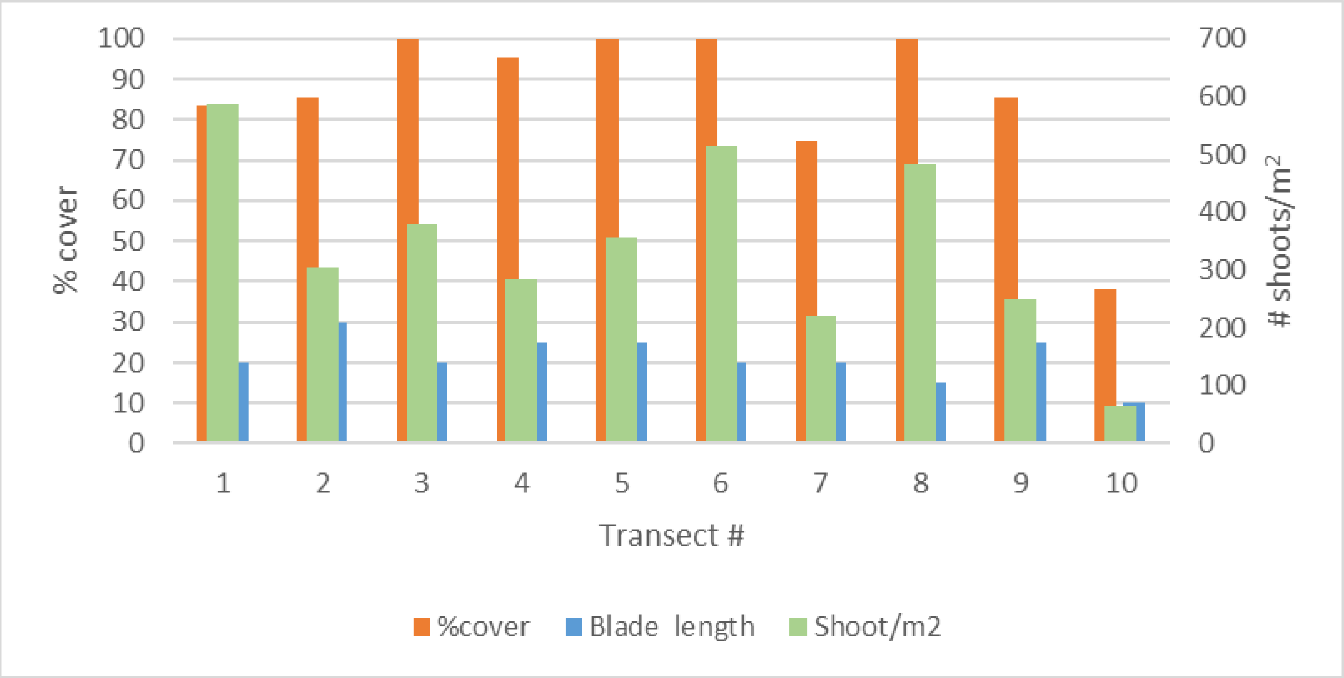

FIGURE 5-76: SHOOT DENSITY, % COVER AND DISTRIBUTION OF SEAGRASS FOUND ALONG THE TEN 100M TRANSECTS SURVEYED AT THE PROJECT SITE. (T TES=*THALASSIA TESTUDINUM*; S FIL= *SYRINGODIUM FILIFORME*).

Analysis of the satellite imagery and the subsequent ground-truthing revealed sparser and patchier seagrass distribution closer to the reef crest. Denuded patches along the seaward (northern) boundary of the dense *Thalassia* beds can be attributed to a combination of factors, including localised currents, intense wave action during storm events, heavy boat traffic, and bioturbation (e.g., feeding behavior of the stingrays *Hypanus americanus*).

Several crescent-shaped blowouts of variable size are apparent in the seagrass beds. Blowouts are bare or sparsely vegetated open areas in established seagrass beds (Patriquin 1975), caused by wave disturbances that erode the sandy sediment and expose a vertical edge of seagrass root matrix (i.e., rhizomes) (Macia and Robinson, 2005) (**Figure 5-77**). The resulting unvegetated area of the blowout is deeper than the surrounding seagrass bed. Over time and under favorable conditions, blowout scars can 'heal' through succession growth, whereby one species is replaced by another. Natural recovery (i.e., succession growth) was apparent in certain blowout areas where Manatee Grass (*Syringodium filiforme*), a pioneer species, has colonised the bare sandy substrate, which, over time, will contribute to trapping sand along the blowout edges and paving the way for recolonisation by *T. testudinum*.

Near the eastern boundary of the resort (T5 and T6), there is evidence of old scars (possibly propeller scars). A PVC pipe set in concrete blocks runs from the beach area toward the reef crest; it is assumed that this is an effluent pipe that has been decommissioned. If it is indeed decommissioned, it is recommended that the pipe be removed, but the concrete blocks can stay as they provide substrate for coral colonisation and a microhabitat for urchins and juvenile fish.

FIGURE 5-77: EDGES OF BLOWOUTS PROVIDE SHELTER FOR FISH AND DIADEMA ANTILLARUM.

Macroinvertebrates

Coastal seagrass beds provide habitat, feeding, breeding, and nursery grounds for many marine species that enhance local biodiversity[6]. Seagrass meadows are among the most productive marine habitats supporting juvenile fish, molluscs, polychaete worms, crabs, shrimp, and urchins that hide and forage among dense seagrass blades. The epiphytes that grow on the grass blades (e.g., algae, diatoms, and bacteria) serve as a food source for conch and many small invertebrates.

Turtles, some fish, and urchins feed on seagrass blades. No turtle nests were observed or reported by security personnel interviewed. However, the use of north coast beaches by sea turtles, especially the critically endangered hawksbill is well established.

The most frequently encountered fauna in the seagrass beds at the study site included the Variegated Sea Urchin (*Lytechinus variegatus*), West Indian Sea Egg (*Tripneustes ventricosus*), as well as the Long-spined Sea Urchin (*Diadema antillarum*), the occasional Cushion Sea Star (*Oreaster reticulatus)*, queen conch (*Aliger gigas*), giant golden anemone (*Condylactis gigantea)*, and various alcyonaceans (**Table 5-11, Figure 5-78**).

It is important to note the presence of *D. antillarum* in the seagrass beds at SMB. In the last year, there have been reports of high mortality rates of *D. antillarum*, and, more recently, other urchin species, sparking fears of a die-off similar to the one that occurred in 1983 which decimated an estimated 90% of *D. antillarum* across the Caribbean.

Cause for concern is real given that the coastal ecosystems are already under threat from rising sea surface temperatures, bleaching events, an outbreak of disease (e.g., Stony Coral Tissue Loss Disease [SCTLD]), and various deleterious anthropogenic activities (e.g., coastal development). The loss of *D. antillarum* and other urchin species would be catastrophic given the current fragile state of costal ecosystems. As such, the presence of *D. antillarum* juveniles in the seagrass beds at SMB indicates a healthy habitat for the species. These individuals should be protected from any harmful activities in coastal waters and relocated before any work related to the construction of overwater bungalows at SMB is contemplated.

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[6] United Nations Environment Programme (2020). Out of the blue: The value of seagrasses to the environment and to people. UNEP, Nairobi.

TABLE 5-11: INVENTORY OF MACROINVERTEBRATE FAUNA ENCOUNTERED IN THE BACKREEF AREA AT THE SANDALS MB PROJECT SITE.

Common name	Scientific Name	T1 *	T2	T3	T4	T5	T6	T7	T8	T9	T10	DAFOR
Variagated Sea Urchin	*Lytechinus variegatus*		✓	✓	✓	✓	✓	✓	✓	✓		D
West Indian Sea Egg	*Tripneustes ventricosus*		✓	✓	✓	✓		✓		✓		A
Long-spined Sea Urchin	*Diadema antillarum*				✓	✓		✓	✓	✓		F
Rock-boring Urchin	*Echinometra lucunter*							✓				O
Red Heart Urchin	*Meoma ventricosa*				✓	✓		✓				O
Sea Biscuit	*Clypeaster rosaceus*								✓			R
Three-rowed Seacucumber	*Isostichopus badionotus*				✓							O
Red Cushion Sea Star	*Oreaster reticulatus*											O
Giant Golden Anemone	*Strombus gigas*		✓				✓		✓	✓		A
Knobby Anemone	*Bartholomea lucida*											O
Sun Anemone	*Stichodactyla helianthus*											O
Tube-dwelling Anemone	*Arachnanthus nocturnus*							✓		✓		O
Queen Conch	*Aliger gigas*				✓							F
Black Sea Rod	*Plexaura homomalla*									✓		O
Common Sea Fan	*Gorgonia ventalina*									✓		O
Corallimorpharia	*Ricordea florida*									✓		O
Zoanthid	*Palythoa caribaeorum*									✓	✓	O
Hydrocorals	*Millepora sp.*									✓	✓	F
Scattered pore rope sponge	*Aplysina fulva*										✓	O
Encrusting sponge	*Cliona tenuis*									✓	✓	O
Chicken liver sponge	*Chondrilla nucula*									✓	✓	O

** Invertebrates may have been present; however, none was observed due to poor visibility.*

FIGURE 5-78: Seagrass Beds Support a Diversity Of Macroinvertebrate Fauna, Including Juvenile Fish, Urchins, Other Echinoderms (Holothurians), and Various Molluscs. (Clockwise: *Tripneustes Ventricosus, Diadema Antillarum, Lytechinus Variegatus*, and *Holothuroidea*).

Reef crest

The shallow reef crest separates the back reef from the fore reef slope. The substrate of the reef crest comprises old dead coral (old *A. palmata* stands and large boulder corals heads) that has been shaped over the years by exposure to intense wave action and storm surges.

In addition to providing coastal protection, the rugosity of the reef crest provides the three-dimensional habitat complexity for sea urchins, anemones, sea cucumbers, other reef-dwelling invertebrates, and juvenile reef fish. Despite the heavy macroalgal cover, the presence of CCA provides favorable conditions for coral recruitment.

A total of fifteen coral species were recorded on the reef crest (**Table 5-12**). Most prevalent coral species on the reef crest include *Siderastrea siderea*, *Siderastrea radians*, *Orbicella annularis, Orbicella faveolata, Pseudodiploria strigosa, and Pseudodiploria clivosa. Orbicella annularis and faveolata* (**Figure 5-79**) are listed as "Endangered" on the IUCN Red List of Threatened Species. *Manicina areolata colonies were frequently observed in the seagrass meadows.*

The coral colonies are predominantly healthy, although some vulnerable species show signs of infection by the Stony Coral Tissue Loss Disease (SCTLD) that has affected coral tracts throughout the Caribbean[7].

TABLE 5-12: THE PRESENCE AND ABUNDANCE OF CORAL SPECIES ENCOUNTERED ALONG THE REEF CREST USING THE DAFOR SCALE (DOMINANT, ABUNDANT, FREQUENT, OCCASIONAL, RARE).

Coral		**T1 ***	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**DAFOR**	**IUCN Status**
Boulder star coral	*Orbicella annularis*									✓		O	*Endangered*
Mountainous star coral	*Orbicella faveolata*									✓		O	*Endangered*
Massive starlet coral	*Siderastrea siderea*				✓	✓		✓		✓		A	*Least concern*
Lesser starlet coral	*Siderastrea radians*				✓			✓	✓	✓		A	*Least concern*
Symmetrical brain coral	*Pseudodiploria strigosa*									✓		O	*Least concern*
Knobby brain coral	*Pseudodiploria clivosa*									✓		O	*Least concern*
Grooved brain coral	*Diploria labyrinthiformis*									✓		O	*Least concern*
Mustard hill coral	*Porites astreoides*									✓	✓	F	*Least concern*
Finger coral	*Porites porites*									✓		O	*Least concern*
Thin finger coral	*Porites divericata*				✓	✓				✓		O	*Least concern*
Branched finger coral	*Porites furcata*							✓				O	*Least concern*
Blushing star coral	*Stephanocoenia intersepta*									✓		O	*Least concern*
Rose coral	*Manicina areolata*				✓	✓		✓				A	*Least concern*
Low relief lettuce coral	*Agaricia humilis*									✓		O	*Least concern*
Lettuce coral	*Agaricia agaricites*							✓		✓		A	*Least concern*

** Invertebrates may have been presnt , however, none were observed due to poor visibility*

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[7] Coral Disease Outbreak. https://www.agrra.org/coral-disease-outbreak/ Accessed Nov. 12, 2022.

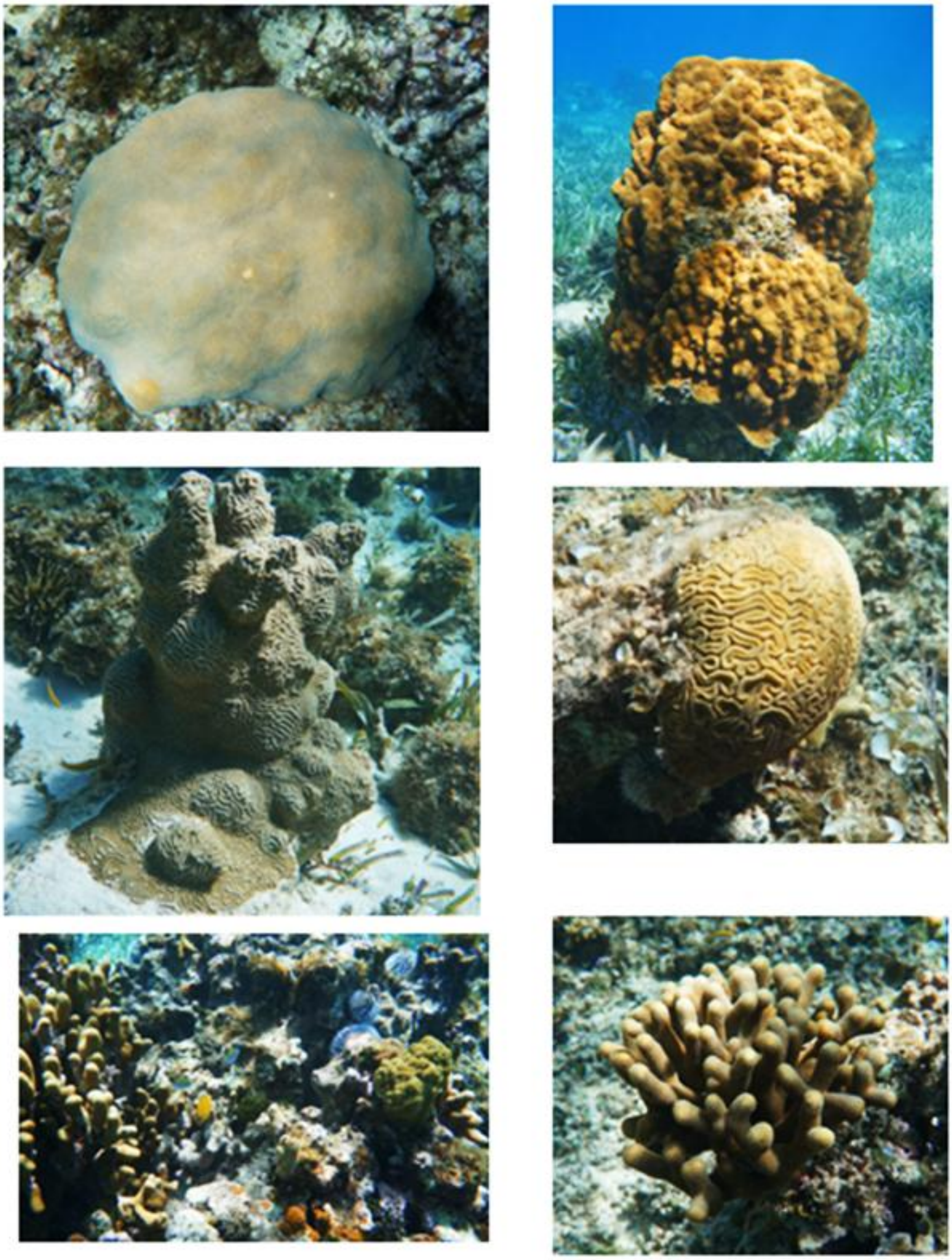


FIGURE 5-79: CORAL *SPECIES O. ANULARIS, O. FAVEOLATA, PSEUDODIPLORIA CLIVOSA, DIPLORIA LABYRINTHIFORMIS*, AND *PORITES* SPECIES.

FISHES

Thirty-one (31) fish species were observed during transect and roving surveys (**Table 5-13**), twelve (12) of which were observed in the seagrass meadows. By contrast, all 31 fish species were observed during the transect and roving surveys on the reef crest and surrounding areas. The fish were primarily juveniles, ranging from 5-15 cm in length. Parrotfish (Scaridae) and members of the wrasse family were the most abundant of these.

The scarcity of fish noted during the seagrass transects, and roving diver surveys can be attributed to poor visibility due to turbid conditions from runoff and the resuspension of fine sediments. It is likely that the number of fish, particularly juvenile fish associated with the seagrass beds at the study site, has been underestimated.

The backreef area, especially the seagrass beds, provides essential nursery grounds for juvenile fish and feeding grounds for the Southern stingray (*Hypanus americanus*), which has recently been listed as 'Near Threatened' on the IUCN Red List of Threatened Species (2024).

TABLE 5-13. FISH SPECIES ABUNDANCE OBSERVED DURING TRANSECT AND ROVING-DIVER SURVEYS AT THE SANDALS MB SITE.

		T9_1 (#/30m^2) (Reef Crest)		T9_2 (#/30m^2) (Reef Crest)		T9_3 (#/30m^2) (Reef Crest)		T9_4 (#/30m^2) (Reef Crest)		T10_1 (#/30m^2) (Reef Crest)		Roving Diver (Seagrass)
	Butterflyfish	10-15 cm	>15 cm	10-15 cm	>15 cm	10-15 cm	>15 cm	10-15 cm	>15 cm	10-15 cm	>15 cm	
Spotfin	*Chaetodon ocellatus*											R
Foureye	*Chaetodon capistratus*			1								
	Grunt											
French grunt	*Haemulon flavolineatum*					35		15	25			
Spanish grunt	*Haemulon macrostomum*					3		2				
Juvenile Grunts	*Haemulon / Anisotremus*											F
	Parrotfish											
Princess	*Scarus taeniopterus*	5										
Striped	*Scarus iseri*	60		38		27		15		16		D
Redband	*Sparisoma aurofrenatum*	6		2		3						
Redtail	*Sparisoma chrysopterum*											
Stoplight	*Sparisoma viride*											
Greenblotch	*Sparisoma atomarium*			2		6						
	Surgeonfish											
Blue Tang	*Acanthurus coeruleus*	4										
Ocean surgeonfish	*Acanthurus bahianus*	6		1								
	Wrasse											
Slippery Dick	*Halichoeres bivitattus*	8				3		1				O
Bluehead wrasse	*Thalassoma bifasciatum*			23		23		5		4		A
Clown wrasse	*Halichoeres maculipinna*											
Yellowhead Wrasse	*Halichoeres garnoti*	2		4								F
	Porcupinefish											
Ballonfish	*Diodon holocanthus*											
	Other Fishes											
Schoolmaster	*Lutjanus apodus*						2		2			
Lane snapper	*Lutjanus synagris*									2		
Harlequin bass	*Serranus tigrinus*	1										
Trumpet fish	*Aulostomus maculatus*		1									
Bar Jack	*Caranx ruber*		1									
Spotted Goatfish	*Pseudupeneus maculatus*				1							
Dusky damselfish	*Stegastes adustus*							2		9		
Threespot damselfish	*Stegastes planifrons*											R
Yellowtail damselfish	*Microspathodon chrysurus*											R
Sergeant major	*Abudefduf saxatilis*											R
Reef squirrelfish	*Sargocentron coruscum*					1						R
Squirrelfish	*Holocentrus adscensionis*	3				8		1				R
Sharptail eel	*Myrichthys breviceps*											R

Spot survey of the backreef was carried out at twelve (12) randomly selected sites within the study area to ground-truth the substrate throughout the project site (**Table 5-14).** Most of the spot surveys were confirmed *T. testudinum* (**Figure 5-80**). Sites closer to reef crest were sandy with variable seagrass cover (*T. testudinum* and *S. filiforme)* and interspersed with patch reef and coral mounds.

TABLE 5-14. GROUND TRUTHING SPOT SURVEY.

Site #	Lat	Long	Groundtruthing
S1	18.510985	-77.905168	Dense T*halassia testudinum*
S2	18.510431	-77.904503	Dense T*halassia testudinum*
S3	18.510887	-77.903755	Dense T*halassia testudinum*
S4	18.511852	-77.902834	Dense T*halassia testudinum*
S5	18.512217	-77.902081	Dense T*halassia testudinum*
S6	18.512223	-77.901926	Dense T*halassia testudinum* ; old prop scar
S7	18.512172	-77.901337	*T.testudinum* interspersed with old coral boulders with P.astreoides, P.furcata
S8	18.512288	-77.900678	Dense T*halassia testudinum*
S9	18.513297	-77.901381	*T.testudinum* ; pipe with concrete blocks; *P. astreoides; D. antillarum*
S10	18.514384	-77.90235	Hardpan with thin veneer of sand, sparse *T.testudinum, S.siderea, macroalgae; T. ventricosus*
S11	18.514064	-77.903303	Hardpan with thin veneer of sand, sparse *T.testudinum, macroalgae S.siderea, T. ventricosus*
S12	18.512968	-77.904149	Blowout with dense *T.testudinum* along the edges

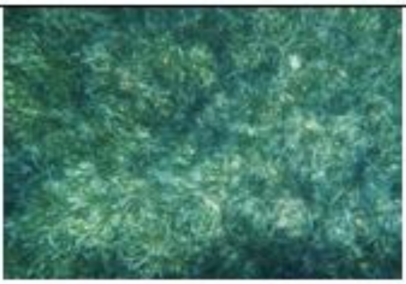
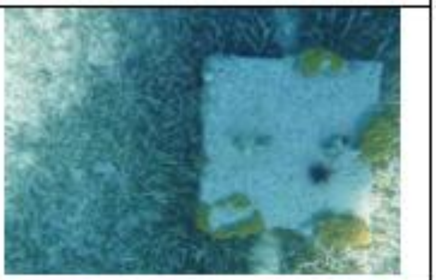
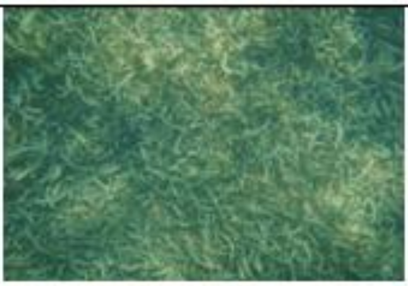
S1		S7	
S2		S8	
S3		S9	
S4		S10	
S5		S11	
S6		S12	

FIGURE 5-80: GROUND-TRUTHING REVEALED EXTENSIVE SEAGRASS MEADOWS AND A VIBRANT REEF CREST AREA.

5.2.1.1.1 Impacts of Overwater Bungalow Construction on Seagrass Beds

Seagrass and seagrass meadows play a crucial role in our ecosystem, serving as vital foraging and nursery grounds for juvenile fish, various invertebrates, and marine turtles (Jackson et al, 2001). The potential loss or physical harm to seagrass meadows, including degradation, changes in species composition, or nutrient level shifts, could significantly impact these species. Seagrasses also contribute to water quality by trapping silt, dirt, nutrients, and other suspended sediments, which then become part of the benthic substrate, stabilised by seagrass roots. This process is instrumental in stabilising beaches and coastlines and providing protection against storms.

Overwater structures could affect about 0.35 – 0.4 hectares (3,500 – 4,000 m^2)[8] of seagrass (**Figure 5-81**). The impacts would include direct impacts during construction (installation of piles and potential damage from barge and other heavy equipment) and indirect impacts during the operation of the overwater bungalows:

- Seagrass beds at and near the construction site will experience temporary increases in turbidity and sedimentation during the building of overwater bungalows.
- ~150-200 m^2 of seagrass will be directly impacted by the piling installation under the structure's footprint, necessitating seagrass relocation.
- > 3,300 m^2 of seagrass under the bungalows will be indirectly affected by shading during operational phases. These impacts are considered minimal and do not require mitigation. Although shading from overwater structures will reduce light intensity, light availability will vary throughout the day and with the seasons, reflecting the sun's changing position. In response to lower light levels, seagrasses like *Thalassia testudinum* may elongate their blades to increase their surface area for light absorption, optimising photosynthetic activity in shaded conditions.
- The use of barges and heavy machinery for installing pilings and overwater structures poses significant threats to seagrass beds through physical disturbances, including anchor damage,

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hull scraping, and equipment impacts. For the construction of overwater bungalows, two barges from Tank-Weld- Rio Bueno[9] (a smaller one measuring ~40 feet by 20 feet and a larger one ~60 feet by 40 feet) will be used, each equipped with stabilising footings at all four corners. While these footings aim to minimise movement and provide stability, the project must carefully consider the precise locations of barge footings, specific operational areas, deployment strategies, and safety measures to develop effective mitigation strategies. Although the use of barge footings doesn't necessarily require seagrass relocation, it is important to factor in any unforeseen seagrass loss into the final relocation plan. The contractor should confirm the area of concern to accurately assess the full extent of potential impact, ensuring that the project minimises damage to this vital marine ecosystem and that all appropriate mitigative measures are implemented.

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[9] http://tankweld.com/rio-bueno-2/ Accessed August 16, 2024

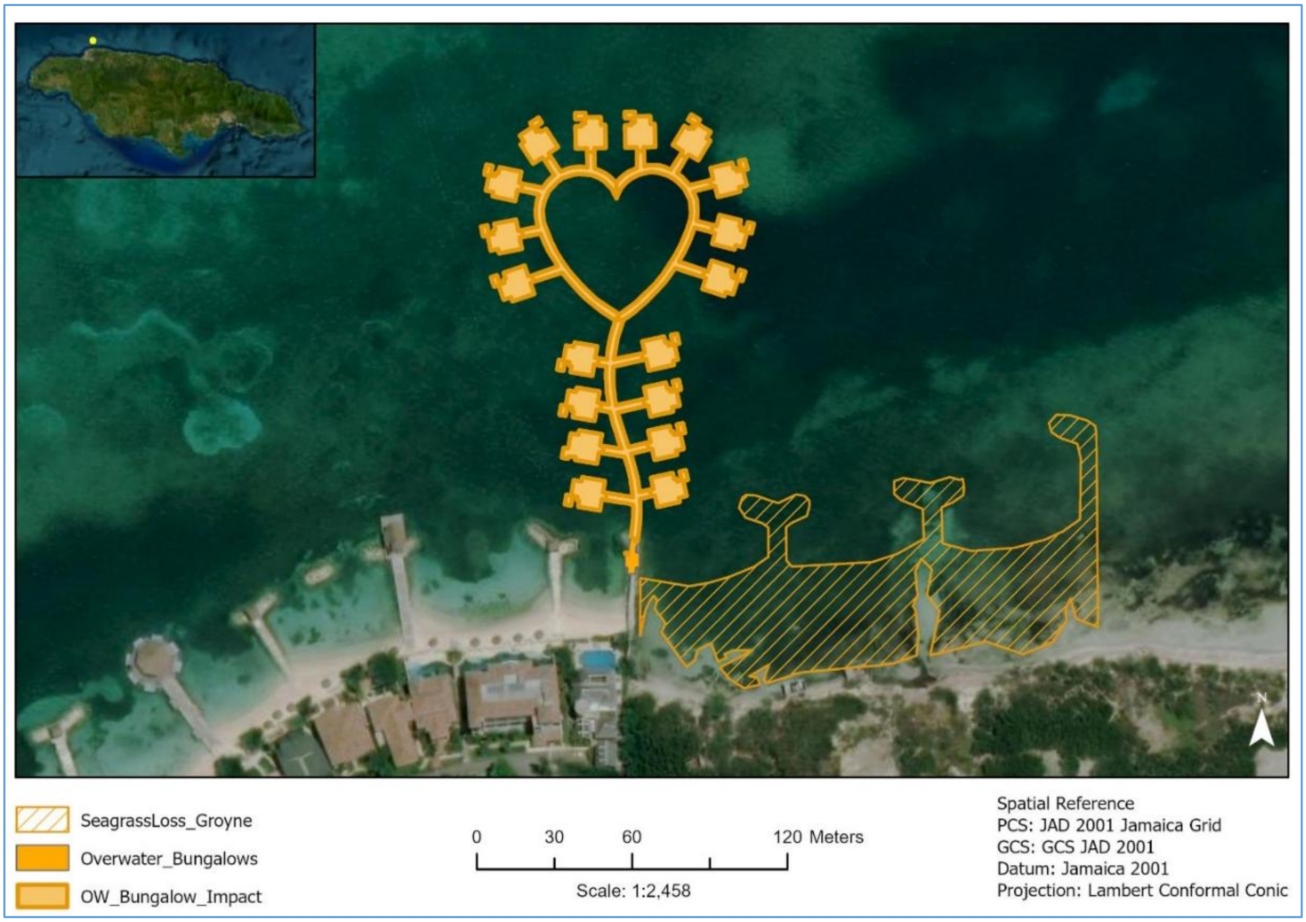

FIGURE 5-81: SEAGRASS COVER OF VARIABLE DENSITY WITHIN THE PROJECT FOOTPRINT. IT IS ESTIMATED THAT 100-200 M2 WILL BE IMPACTED DIRECTLY (SEAGRASS LOSS) DURING CONSTRUCTION OF THE OVERWATER STRUCTURES AND ~3,300 M2 WILL BE IMPACTED INDIRECTLY BY SHADING DURING THE OPERATION PHASE

5.2.1.2 Methodology - Seagrass Survey – SMB East (Groynes)

The benthic environment was surveyed along the coastline of the proposed project area (i.e., east of SMB, **Figure 5-82**), within the first 50 m from shore (**Figure 5-82).** Six (6) 50m transects were laid perpendicular to shore and a 1 m^2 quadrat was used to assess the benthos every 10 m in each transect,(see **Figure 5-83**). The following benthic community features were determined in each quadrat:

- Substrate type
- Species composition (seagrass and algal)
- Percentage cover (seagrass)
- Average (*Thalassia*) blade length
- Water depth
- Coral species
- Other faunal species

The immediate vicinity of the existing groynes was also surveyed using a roving, visual census survey which involved actively seeking out and identifying all marine benthic and pelagic species observed within the area.

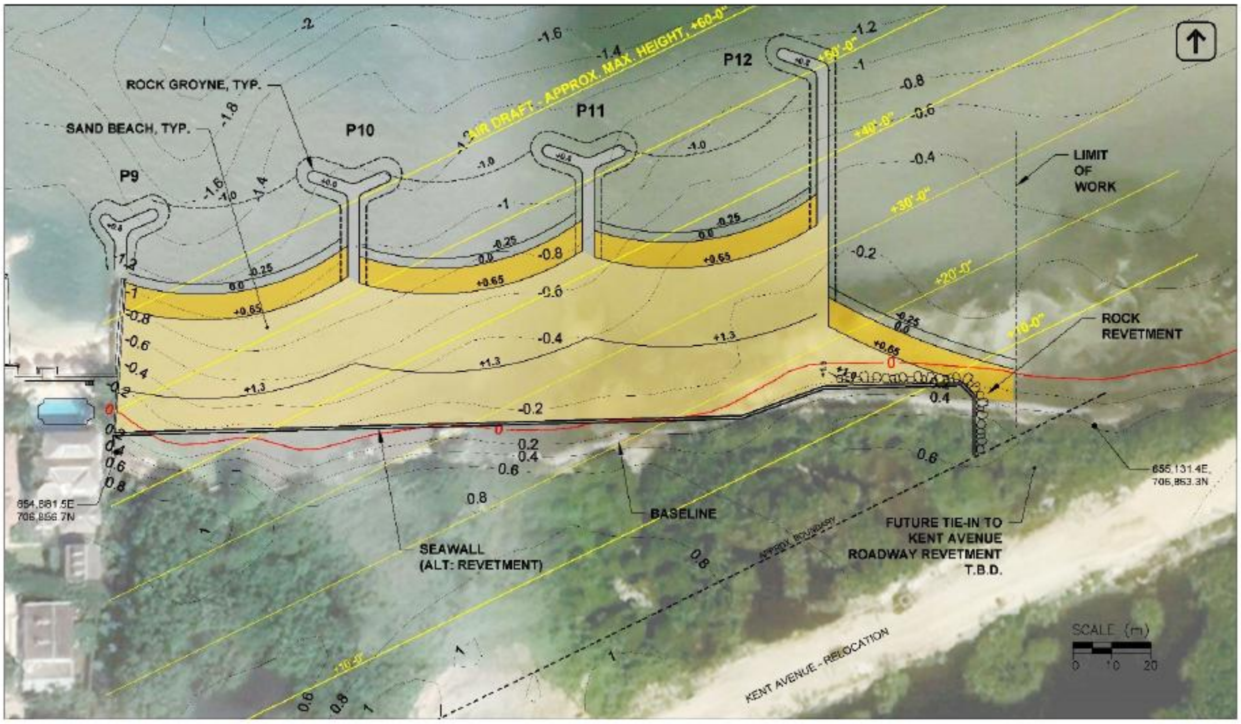

Figure 5-82: Section of the coastline in the project footprint included in the benthic survey.

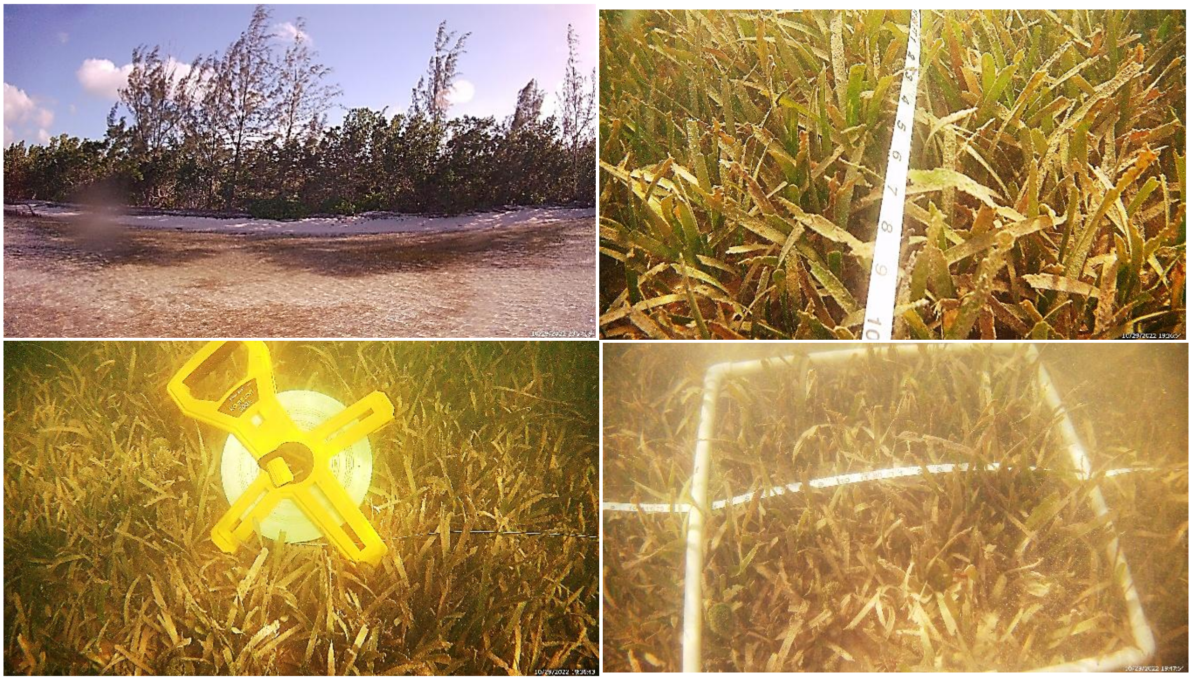

FIGURE 5-83: (A) EASTERN COASTLINE ADJACENT TO SMB (B) TRANSECT LAID PERPENDICULAR TO SHORE (C) 50 M TRANSECT (D) 1M2 QUADRAT LAID ALONG TRANSECT

5.2.1.3 Results and Observations - SMB East (Groynes)

Closer to the shore in the vicinity of the project area, the benthos consisted of tufts of macroalgae growing in muddy and sandy substrate as well as extensive seagrass beds with at least three seagrass species identified (described further below). **Table 5-15** lists the dominant seagrass species observed in each transect; the mean (%) cover of each species; the mean blade length (of *Thalassia* sp. only); the mean water depth; as well as other fauna (including coral spp.) observed in each transect over the surveyed area.

TABLE 5-15: SEAGRASS SUMMARY FOR SURVEYED AREA

Location	Substrate	Seagrass Species Present	Mean percentage (%) Cover	Mean blade length (cm)	Depth (m)	Fauna (incl. coral)
T1	Sand	*Thalassia sp.*	95.5	23.5	0.45	*Porites asteroides; Siderastrea siderea*
T2	Sand	*Thalassia sp.; Halodule sp.*	88.5; 0.75	27.1	0.42	Bluehead wrasse
T3	Sand, dead coral	*Thalassia sp.; Halodule sp.*	73.6; 0.8	8.9	0.55	*Porites asteroides*
T4	Sand	*Thalassia sp.; Syringodium sp.*	50; 0.68	11.7	0.39	Sea cucumber, sea urchin
T5	Sand	*Thalassia sp.; Syringodium sp.*	76.7; 0.21	18.5	0.41	*Acropora cervicornis*
T6	Muddy sand	*Syringodium sp.; Halodule sp.; Thalassia sp.*	3.6; 2.71; 0.97	4.3	0.52	

The entire area was dominated by turtle grass (*Thalassia testudinum*) however other seagrass species namely, manatee grass (*Syringodium* sp.) and needle grass *(Halodule* sp) were also observed, in some cases (e.g. T6) in relatively high abundances. The turtle grass beds appear healthy and is very extensive in some areas (see **Figure 5-84**). Evidence of seagrass associated fauna (e.g., Thalassinidean shrimp mounds, sea urchins and sea cucumbers) was also observed.

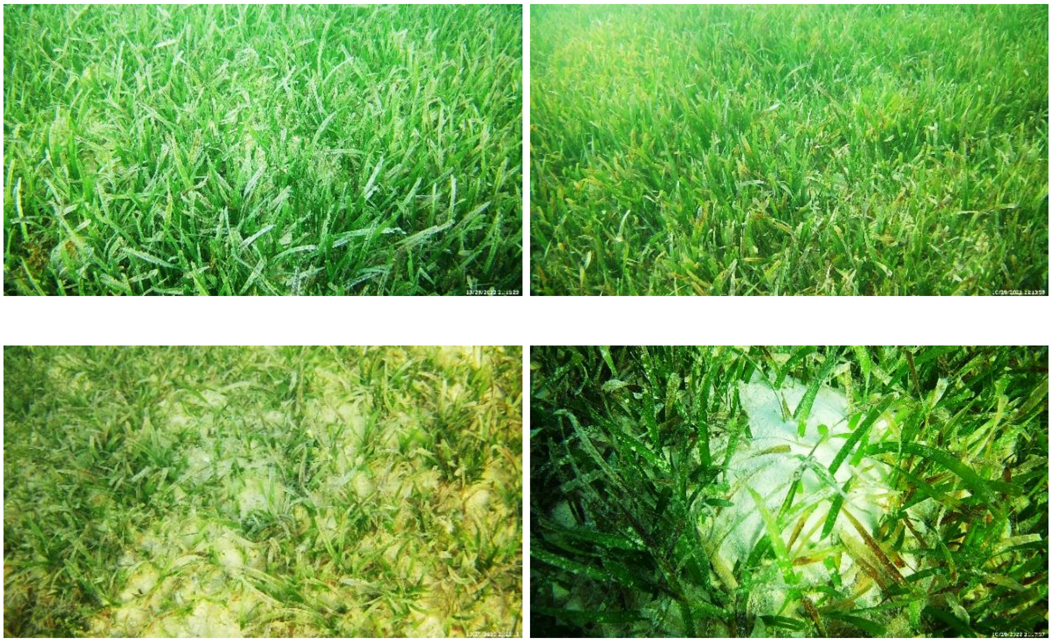

FIGURE 5-84: *THALASSIA TESTUDINUM* BEDS: VARIOUS STATES OF ABUNDANCE

The *Syringodium* sp. beds mostly dominated in muddy areas closer to shore. Their distribution was generally patchy however there were some areas where these beds were relatively extensive and considerably tall- in some cases protruding from the water during ebb and flow movements at low tides. The *Syringodium* beds in most areas were notably overladen by epiphytes and epifauna (see **Figure 5-85**), and further impacted by sedimentation in some nearshore areas.

FIGURE 5-85: *SYRINGODIUM* SP. BEDS OBSERVED IMPACTED BY SEDIMENTATION AND EPIFAUNA

Halodule sp. had lowest (%) cover throughout the surveyed area. Their distribution was generally patchy throughout the area, however relatively high abundance was observed in one area (T6) located nearshore in the vicinity of the two abandoned (sinking) buildings (**Figure 5-86**).

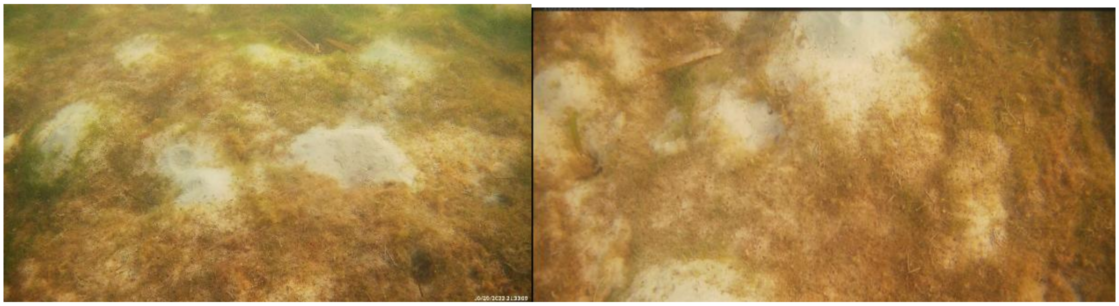

FIGURE 5-86: *HALODULE* SP. BEDS OBSERVED

Benthic and Pelagic community

The overall backreef zone is relatively shallow with most of the area ranging between depths of 0–5m. The substrate consisted of mainly sand, however the groyne and supporting stone structure have over time formed an integral part of the benthos providing hard substrate on which several corals, sponge and fan worms have settled. Several fin fish species were also observed almost exclusively near and within the groynes (see **Figure 5-87**). This however included the alien invasive lionfish (*Pterois volitans*) which was observed seeking refuge in the groyne crevices. **Table 5-16** below provides a summary of all finfish species observed during the roving survey of the area

FIGURE 5-87: FINFISH SPECIES OBSERVED NEAR AND WITHIN GROYNES

Coral Species

On the existing groynes, marine organisms identified included encrusting coral colonies such as *Siderstraea sidera* (Greater Starlet Coral), *Porites astreoides* (Mustard Hill Coral), *Porites porites* (Finger Coral) and *Acropora cervicornis* (Staghorn coral), most of which were smaller than 30 cm in size (see **Table 5-16, Figure 5-88**). These species were also less frequently observed throughout the surveyed area.

TABLE 5-16: SUMMARY OF BENTHIC (INCL. CORALS) AND PELAGIC SPECIES OBSERVED

No.	Species Name	Common Name
BENTHIC COMMUNITY		
1	*Porites asteroides*	Mustard Hill Coral
2	*Acropora cervicornis*	Staghorn Coral
3	*Siderstraea sidera*	Greater Starlet Coral
4	*Spirobranchus giganteus*	Christmas Tree Worm
5	*Branchiomma nigromaculata*	Spotted Feather Duster
6	*Acanthopleura granulata*	Chiton
7	*peysonnelia*	Peysonnelids
8	*Monanchora arbuscula*	Red Encrusting Sponge
9	*Holothuria mexicana*	Sea Cucumber
10	-	Anemone
11	*Thalassia testudinum*	Turtle grass
12	-	Thalassinidean Shrimps
13	*Dasyatis americana*	Sting Ray
14	*Strombus gigas*	Queen Conch
PELAGIC COMMUNITY		
1	*Holacanthus bermudensis*	Angelfish
2	*Abudefduf saxatilis*	Sergeant Major
3	*Gerres cinereus*	Mojarra
4	*Haemulon chrysargyreum*	Grunt
5	*Sphoeroides testudineus*	Checkered Pufferfish
6	*Lutjanus apodus*	Schoolmaster Snapper
7	*Pterois volitans*	Lionfish
8	*Holocentrus adscensionis*	Squirrelfish
9	*Microspathodon chrysurus,*	Yellowtail Damselfish
10	*Stegastes adustus*	Dusky Damselfish

FIGURE 5-88: CORAL SPECIES OBSERVED THROUGHOUT SURVEY AREA

Macroalgal Community

Table 5-17 provides a list of the algal species observed and positively identified in the area which included *Halimeda copiosa, Penicillus capitatus* (Mermaid's Shaving Brush), *Caulerpa taxifolia, Caulerpa racemosa, Udotea flabellum* (Mermaid Fan Algae), *Acetabularia caliculus* (Mermaid's Wine Glass) and *Ventricaria ventricosa* (Sea Pearl). **Figure 5-89** shows the commonly occurring species observed including brown algal species such as *Turbinaria turbinata, Padina jamaicensis, Sargassum sp.,* and *Dictyota* sp.

TABLE 5-17: ALGAL SPECIES OBSERVED

No.	Species Name	Common Name
ALGAL COMMUNITY		
1	*Halimeda copiosa*	Halimeda/Hanging Vine Algae
2	*Penicillus capitatus*	Mermaid's Shaving Brush
3	*Caulerpa taxifolia*	Feather Algae
4	*Caulerpa racemosa,*	Green Grape Algae
5	*Udotea flabellum*	Mermaid Fan Algae
6	*Acetabularia caliculus*	Mermaid's Wine Glass
7	*Ventricaria ventricosa*	Sea Pearl
8	*Turbinaria turbinata*	-
9	*Padina jamaicensis*	Peacock's tail
10	*Dictyota sp.*	Y-Branched Brown Algae
11	*Sargassum sp.*	

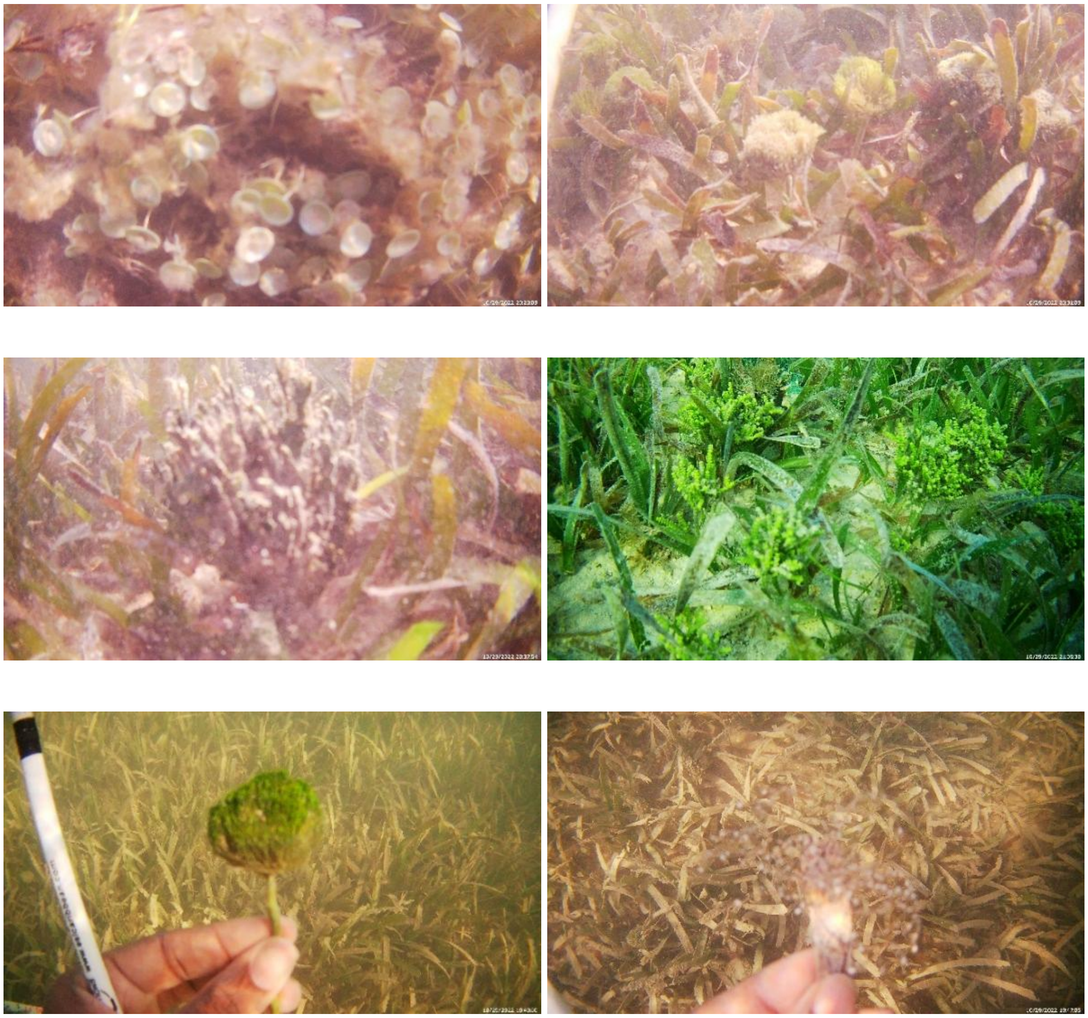

FIGURE 5-89: ALGAL SPECIES OBSERVED

Invertebrates

Other organisms such as *Spirobranchus giganteus* (Christmas Tree Worm), *Branchiomma nigromaculata* (Spotted Feather Duster), *Acanthopleura granulata* (Chiton), peysonnelids and the *Monanchora arbuscula* (Red Encrusting Sponge) were also observed. On substrate, Sea Cucumbers, and free-living Anemones were observed (**Figure 5-90**).

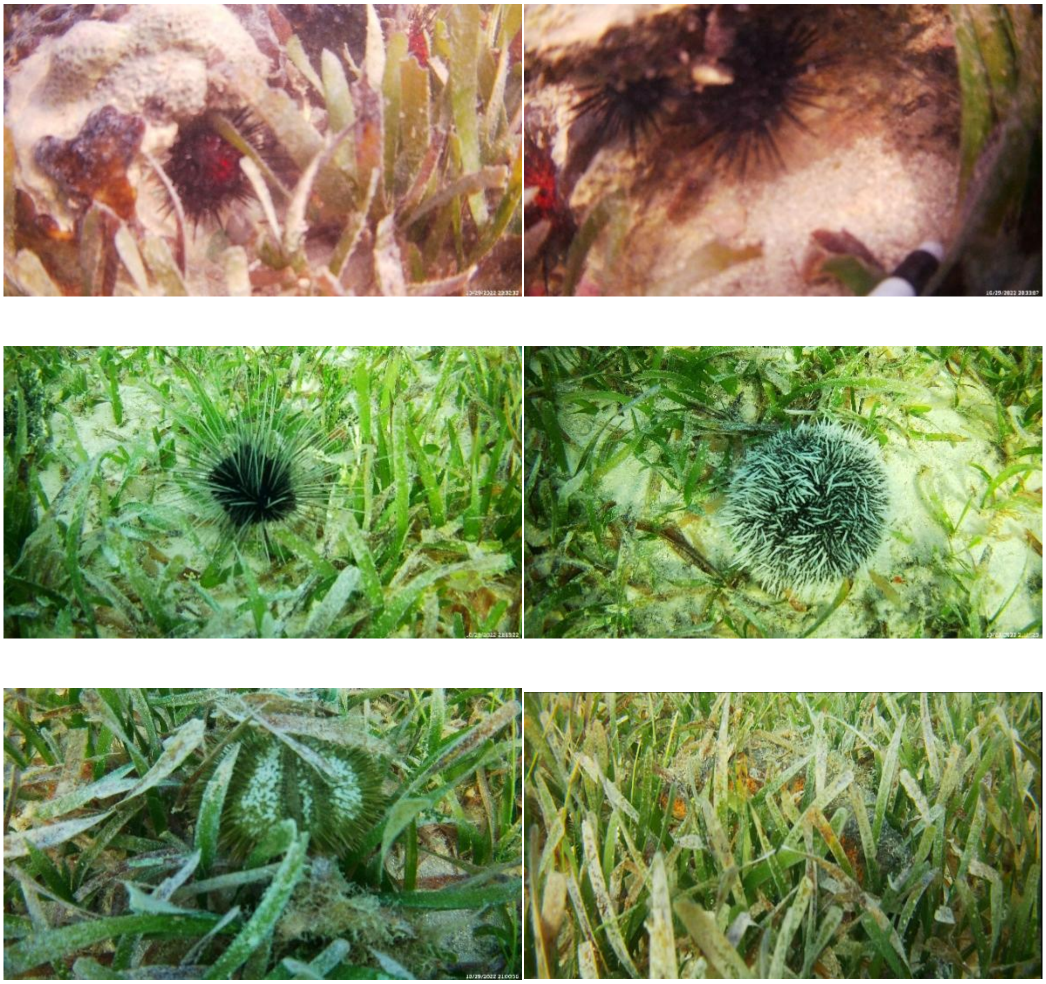

FIGURE 5-90: ECHINODERMS AND INVERTEBRATES

Rocky shore species

An abundance of snails- particularly *Littorina ziczac* (see **Figure 5-91**) was observed inhabiting the upper tidal areas of the existing groynes. Other species including chitons and other small gastropods were also observed in relatively high abundance.

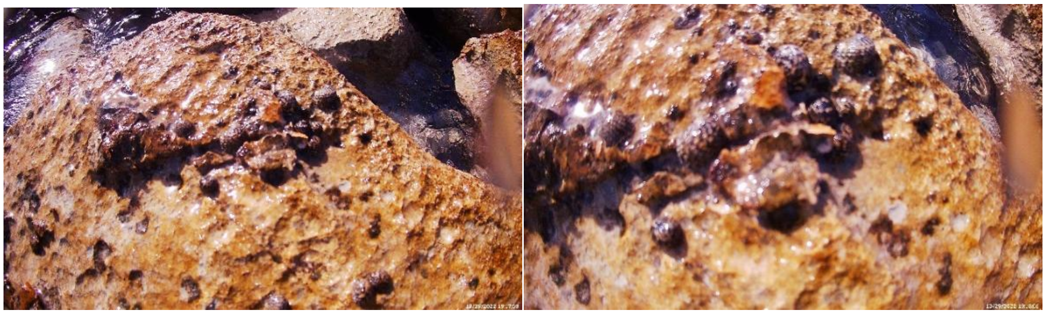

FIGURE 5-91: ROCKY SHORE SPECIES (LITTORINA ZICZAC) OBSERVED

Anthropogenic Impacts

Anthropogenic impacts observed in the marine areas included solid waste pollution (e.g., single-use and other plastics, discarded fishing gear etc.) and high sedimentation, especially in nearshore areas. **Figure 5-92** below shows examples of some anthropogenic impacts observed in the project area.

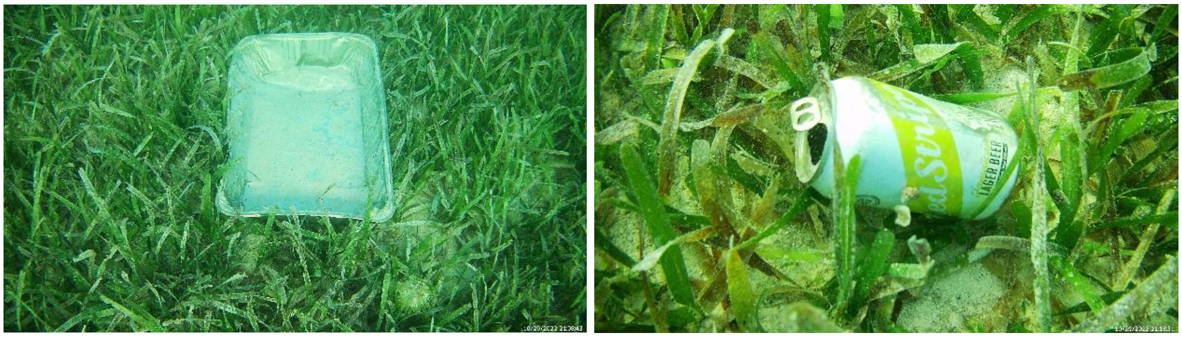

FIGURE 5-92: SOLID WASTE POLLUTION OBSERVED

5.2.1.3.1 Impacts of the Groyne Construction on Seagrass Beds

The project proposes installing a series of groynes along the eastern shoreline to stabilise the existing eroding shoreline. This involves constructing four new groynes (P9 to P12), to aid in the restoration and protection of the eroded shoreline. The proposed configuration is expected to provide essential shore protection while accommodating the planned expansion of the resort property and recreational amenities. In addition, the proposed plan calls for beach nourishment within the groyne cells. Collectively, the groyne installation and the groyne cells' filling will impact an estimated 0.7 -1.0 ha (7,000 – 10,000 m^2) of the seagrass habitat, primarily between P9, P10 and P11.

5.2.2 Terrestrial Survey

The terrestrial survey was conducted in two distinct phases. The first phase focused on the resort grounds and the nearby forested area proposed for staging and storage purposes. The second phase of the terrestrial survey focused on the wetland area located east of the SMB resort grounds.

5.2.2.1 Floral Assessment

5.2.2.1.1 Flora Assessment- Staging and Storage Areas

A walk-through method was employed to assess the terrestrial flora aspect of the broader biological characteristics of the proposed site. During this exercise all the property was walked through to capture as many plant species as possible at the site. The relative abundance of the various species was also observed, documented and ranked using a DAFOR scale. The identification of the plants observed were mainly done on site and those that were not identified on site were identified subsequently. This was done through the collection of samples or the capturing of digital images which were used to assist in the identification process.

The checklist of species (**Appendix 5** – Floral Species List (Staging and Storage Site) that were collated from the walk-throughs were then used to identify key species of significance to the specific environment, communities or ecosystems in which they were observed. The distribution status of the species was also checked, and this was added in a column to the checklist. This would include if the species were native, endemic, rare, threatened or introduced species. Other uses and notes on the species were also added to the collated checklist as a stand-alone column. Common names, where documented were also inserted as a column within the checklist.

Additional plates were organised at the end of the report containing images of some of the plants that were digitally captured to be used as a reference in some cases.

5.2.2.2 Results and Observations

From an ecological perspective, the study site can be characterised as disturbed with areas of native and non-native vegetation introduced over the years specifically for landscaping purposes. The eastern boundary of the property borders a disturbed woodland.

The results from the terrestrial flora surveys of the site identified as the proposed staging and storage area are as follows. A total of Eighty (80) species was observed in this area and these were from twenty-eight (29) plant families (**Appendix 5** – Floral Species List (Staging and Storage Site). The top five families represented in the proposed staging and storage site are Fabaceae, Malvaceae, Asteraceae, Poaceae and Convovulaceae and Euphorbiaceae, with 11, 10, 10, 7, 6 and 6 species respectively (**Figure 5-93**). The following charts break down the data specifics in terms of habit class, natural geographic distribution range (status), relative abundance using the DAFOR and IUCN (2024) status of the species.

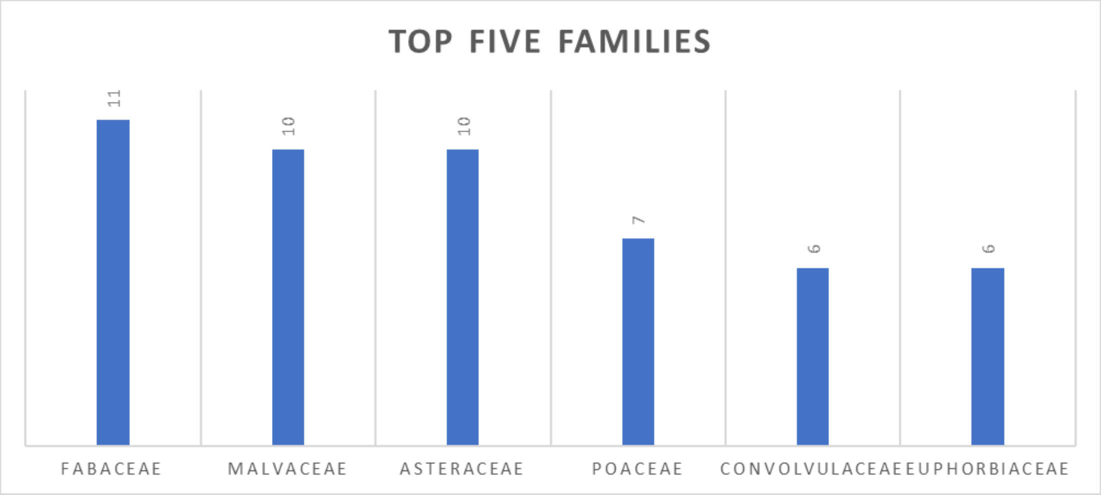

FIGURE 5-93: TOP FIVE FAMILIES REPRESENTED

The top five families represented within the proposed staging and storage area are common to disturbed areas. Some of the species can be considered as pioneer species which can quickly replace species that have been cleared or degraded as a result of anthropogenic or natural influences.

The habit classes of the observed species in the proposed staging and storage area were mostly herbs followed by trees, vines and shrubs respectively (**Figure 5-94**). The trees, however, occupy the majority of the area assessed.

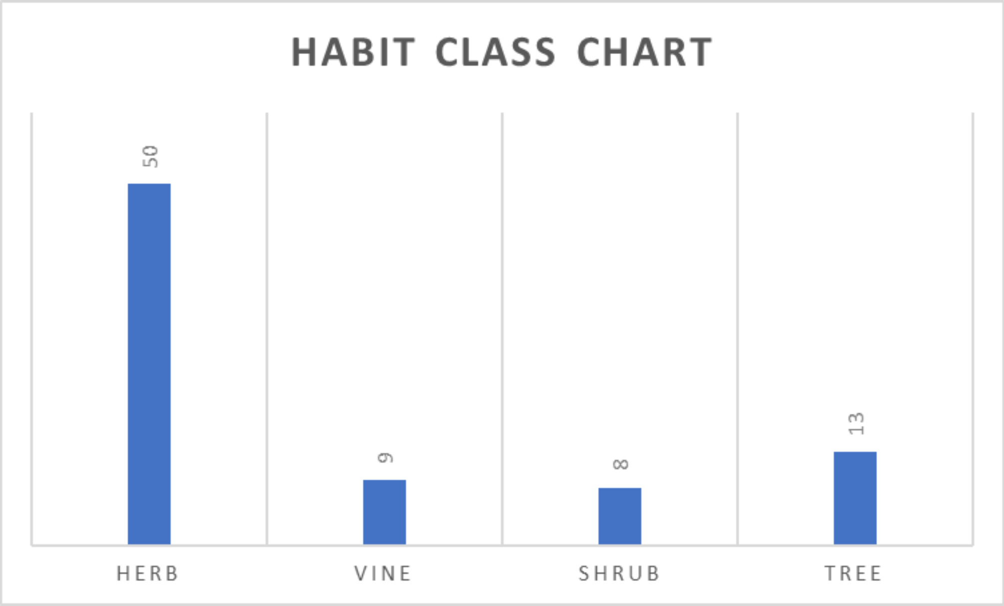

FIGURE 5-94: HABIT CLASS OF SPECIES OBSERVED

The species observed were mostly native. No endemic species documented. The natives represent approximately 75 percent of the species with exotic species representing the remaining 25 percent (**Figure 5-95**).

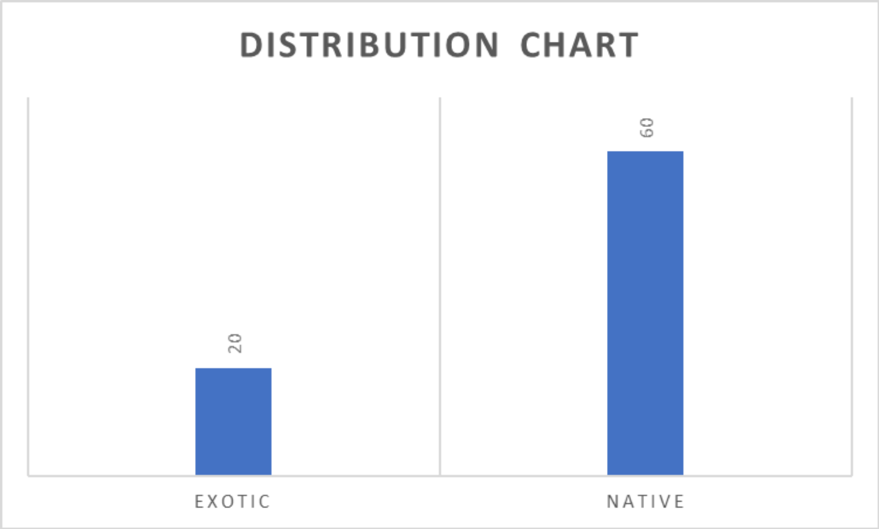

FIGURE 5-95: DISTRIBUTION/ GEOGRAPHIC RANGE

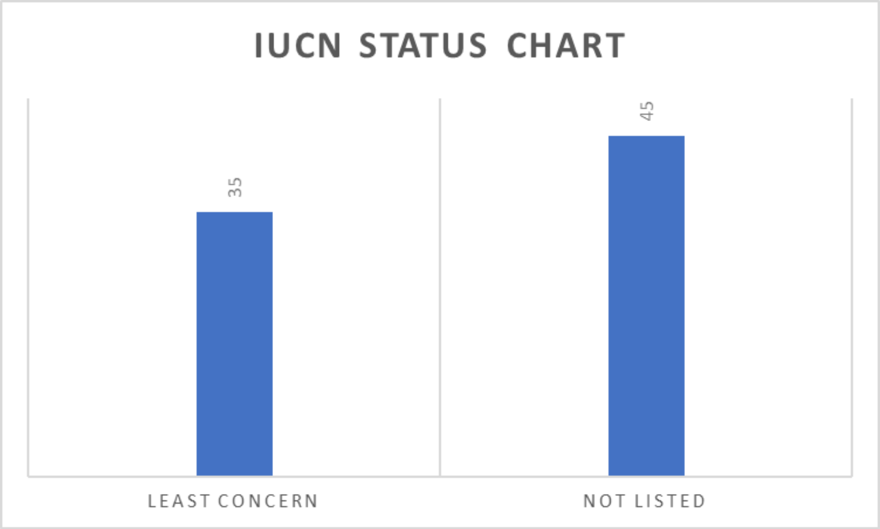

FIGURE 5-96: IUCN STATUS OF SPECIES OBSERVED

There were no species observed in the southern site that were listed on the IUCN Red List (2024) in the categories of vulnerable, endangered, or critically endangered. All the species observed that were assessed were listed as least concern and the remaining species were not listed/not assessed (**Figure 5-96**).

The proposed site is primarily characterised by two dominant species and three other abundant species that collectively cover most of the assessed area. (**Figure 5-97**).

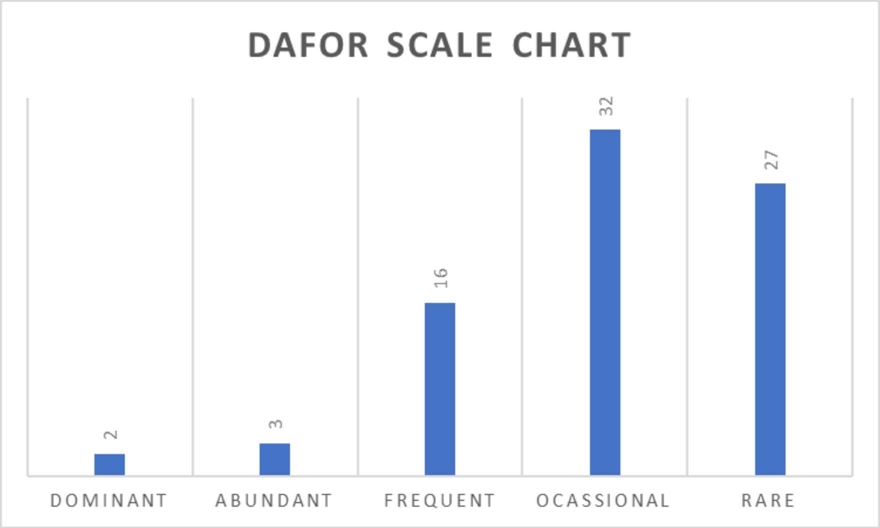

FIGURE 5-97: CHART DISPLAYING THE RELATIVE ABUNDANCE BASED ON THE DAFOR SCALE

5.2.2.2.1 *Floral Assessment - Wetland and Forested Area (East of SMB)*

The wetland boundary for the entire area was first determined using indicators such as soil type and saturation, presence/absence of wetland flora and fauna, as well as dominance of other (non-wetland) species. The extent of wetland areas was verified by a walk-through, while recording the GPS coordinates of boundaries and wetland/terrestrial transition areas. The coastal/wetland forest was subsequently surveyed using 10 x 10 m transects, which were set up randomly throughout the forest, at least 50 m apart. The following forest features were recorded within each transect:

- Species of trees (mangroves)
- Density of mangrove trees (number of each mangrove spp. present)
- Tree height (in meters, at least 5 trees in each transect)
- Diameter at breast height (DBH, in centimetres, at least 5 trees)
- Number of seedlings/saplings (<1.3 m, not including regenerative growth) per m ^{2}

A roving survey was also conducted within the proposed area to record other (non-wetland) vegetation observed. Non-wetland species were given a DAFOR ranking which describes their relative abundance throughout the entire site. The DAFOR ranking does not indicate whether a particular species has a high global population, nor does it provide an indication of its overall distribution. The ranks denote the following categories:

- **D – Dominant**: the species which have the most abundant in number and distribution across the site.
- **A – Abundant**: describes species that have a relatively high number of individuals but are not necessarily common in every part of the study area.
- **F – Frequent**: describes species that are less abundant on the site overall but occurs regularly around the site.
- **O – Occasional**: describes species that are not very common but have more than a few individual trees represented throughout the study area.
- **R – Rare**: denotes only those species with the lowest number of individuals and the low numbers usually mean they have the most restricted distribution.

Other general notes recorded include anthropogenic impacts observed (e.g., solid waste, evidence of cutting/clearing of trees, charcoal kilns, etc.), as well as the conservation status of any endemic/endangered/protected floral or faunal species present.

Habitat Classification

The proposed project area may be generally defined as a coastal forest, with areas of mangrove trees, which had been historically developed and impacted by dumping and disposal activities (over 30 years ago), and more recently impacted by the Airport Runway expansion works (see **Figure 5-98** and **Figure 5-99** below). The majority of the proposed project's footprint is therefore not wetland, but rather secondary coastal forest growing atop mounds of fill material and rubble. The forest is dominated by typical Caribbean coastal forest species such as Seaside Mahoe (*Thespesia sp.*) and Buttonwood/ Button mangroves (*Conocarpus erectus*) in lower areas, which is classified as a mangrove in Jamaica, but a 'mangrove associate' in other regions/locations.

FIGURE 5-98: PROPOSED PROJECT AREA IN 2018, SHOWING PROJECT AREA FOOTPRINT (BLUE POLYGON)

FIGURE 5-99: PROPOSED DEVELOPMENT SITE IN 2022, SHOWING PROJECT AREA FOOTPRINT (BLUE POLYGON)

A review of aerial images in conjunction with ground truthing of the property revealed that the project area has 2 wetland areas: one degraded mangrove/salina area to the east; and another buttonwood dominant wetland toward the west, with no standing water but surrounding a concrete pond. **Figure 5-100** below shows the outline of the pond (blue shaded region) and the approximate footprint of the 2 identified wetland areas (brown shaded regions). The remainder of the forested areas is considered coastal forest and disturbed secondary forest dominated by non-wetland species. The wetland areas that would potentially be impacted within the project area are the western buttonwood forest (approximately 2,543 m^2 area) and the eastern mangrove/salina (~1866 m^2).

FIGURE 5-100: BUTTONWOOD WETLAND (BROWN HIGHLIGHTED AREA ON LEFT) AND MANGROVE/SALINA WETLAND (AREA ON THE RIGHT); CONCRETE POND/POOL ALSO INDICATED (BLUE)

Forest Composition

The floristic parameters highlighted above (Section 5.2.2.1) were assessed within eight (8) transects throughout the proposed project area (**Figure 5-101**).

These data are summarised in **Table 5-18** and described further in the proceeding subsections below.

TABLE 5-18: FLORA SPECIES FOUND ON THE PROPOSED DEVELOPMENT SITE

Family	Scientific Name	Common Name	Range**	DAFOR Ranking

Mimosaceae	*Albizia lebbeck*	Woman's Tongue	Locally common, naturalised in open secondary woodlands, mostly on gravelly soils near habitations	R
Avicenniaceae	*Avicennia germinans*	Black Mangrove	Common in all saline and brackish communities around the coast and on the cays	R
Bataceae	*Batis marina*	Batis/salt wort	Dense colonies common in salt marshes, brackish marshes, and mangrove swamps	O

FIGURE 5-101: TRANSECT LOCATIONS SAMPLED (T1-T8)

Transect 1 (T1) – Coastal and Wetland Forest Boundaries

This area represented the transitional area/ ecotone between the wetland and coastal forests- that is, north of T1 was dominated by non-wetland flora and fauna, and had more compact, and drier soil; while within the transect and further south had moist/saturated soil and more wetland associated spp., see (**Figure 5-102**). Both mangrove (i.e., buttonwood) and other non-wetland secondary vegetation (e.g., *Thespecia sp.*) were observed in T1 and also noteworthy were the lack of standing water and new seedlings/saplings in the area; regenerative growth (of Buttonwood trees) was however observed.

Faunal species observed included love ants, Hermit crabs, spiders, termites, as well as avifauna such as ducks (unidentified), American redstart, mangrove warblers and sandpipers. **Figure 5-103** shows some of the (unidentified) non-wetland species encountered.

FIGURE 5-102: COASTAL/ NON-WETLAND VEGETATION OBSERVED OUTSIDE WETLAND BOUNDARY

FIGURE 5-103: UNIDENTIFIED NON-WETLAND SPECIES OBSERVED.

T2 –Coastal (Disturbed) Forest

This area can be considered as a coastal (as opposed to wetland), secondary forest- as indicated by the absence of mangroves in conjunction with the dominance of dry, compact soil and non-wetland flora such as lead trees (*Leucaena sp*.), seaside mahoe (*Thespecia sp.*) and morning glory (*Ipomea sp*.). Multiple mounds of construction/fill material, as well as other forms solid waste pollution (e.g. plastics) were observed in this area (**Figure 5-104**).

FIGURE 5-104: LARGE MOUNDS OF CONSTRUCTION AND POSSIBLY DREDGE/FILL MATERIAL OBSERVED IN SOME AREAS (E.G., T2)

T3 – Buttonwood Forest

T3 is a wetted area dominated by buttonwood trees, mixed with other mangrove associates such as coin vine (*Dalbergia ecastaphyllum*) and seaside mahoe. Like T1, this area is seemingly elevated above the central pond (**Figure 5-105**) to which water may drain into from these wetted areas. No mangrove seedlings were observed in T3; however, a large abundance of hermit crabs was observed (**Figure 5-106**), which could help explain the lack of seedlings (i.e., due to large abundance of hermit crabs feeding on seedlings).

FIGURE 5-105: ARTIFICIAL (CONCRETE) POND LOCATED NEAR T3 AND T4 (SALINITY READING= 4 PPT)

FIGURE 5-106: LARGE ABUNDANCE OF HERMIT CRABS OBSERVED IN T3

T4 – Disturbed Coastal Forest

This area can also be considered coastal forest as indicated by the dominance of species like seaside Mahoe and lead trees. Solid waste (mostly plastic pollution) was also observed in T4 (**Figure 5-107**) and there was evidence of forest clearing in the area (coal kilns observed). This area of the forest is likely used as a wood source for charcoal production and/or other uses. T4 was also located in relatively close proximity to the concrete pond (**Figure 5-105**), as well as two (abandoned) building structures (**Figure 5-108**).

FIGURE 5-107: SOLID WASTE (PLASTIC) POLLUTION OBSERVED IN T4

Figure 5-108: Abandoned, Sinking Buildings Ranging from Bathhouses with Soak-Away Pit and Other Multi-Use Buildings, to Concrete Platform/Possible Previous Stage Area (Located Near T3)

T5- Seaside Mahoe and Whistling Pine Forest

This area contained mounds of marl-like material, rubble, and sand, from which secondary, coastal vegetation emerged. Two abandoned, sinking buildings **Figure 5-107** as well as **Figure 5-108** are also located in this area.

Figure 5-109: ERODED SHORELINE WITH COASTAL VEGETATION

T6- Impacted mangrove forest- Salt Flat/ Salina-like Area

This area is an extremely impacted mangrove forest, which appears to be transitioning into a salt flat/salina (**Figure 5-110**). There was stagnant water present which was hypersaline (~50 ppt) and mostly dead (mangrove) trees, with some stands of living white mangroves (*Laguncularia racemosa*). The mangroves in this location will likely not survive as the area has been changed drastically since the re-alignment of Kent Avenue. Based on past aerial images and previous studies, this wetland area appears to have been sustained by freshwater (from Kent Ave.) coupled with tidal water inflow from the north. Under current conditions, water may only enter during high tide and will subsequently be trapped and subject to evaporation. This explains the hypersaline conditions observed.

FIGURE 5-110: DISTURBED SECONDARY FOREST IN T6

T7- Coastal Forest on sandy berm

This area is a sandy berm that runs parallel to the shoreline. There were no wetlands as the sand is elevated above the wetland basin. The area is dominated by the salt-tolerant creeper *Batis marina*, buttonwood trees, as well as seaside Mahoe (Figure 5-111).

T8- Coastal Forest and rubble

The vegetation in T8 was similar to that observed in T7, however the area contained a significant volume of dumped material (rubble and boulders) - most likely from the recent roadway works (**Figure 5-112**).

Figure 5-111: COASTAL FOREST ON SANDY BERM

Figure 5-112: COASTAL FOREST AND RUBBLE (T8)

Table 5-19 summarises the mangrove tree details for the plots sampled. This data shows that buttonwood or button mangrove dominated the wetland areas. White mangrove and Black mangrove (*Avicennia germinans*) species were only found in 2 transects. The solitary black mangrove tree near T4 does not represent a true "mangrove forest", and the white mangroves at T6 appear severely stressed, and are not likely to survive due to the aforementioned hydrology changes associated with the airport expansion and the subsequent Kent Avenue realignment. The paucity of mangrove seedlings throughout the "wetland area" is also a strong indication of high stress levels within the overall area. **Table 5-20** shows a list of the floral species observed on the property. Approximately 33 species were recorded from various families.

TABLE 5-19: COASTAL FOREST AND RUBBLE (T8)

Location	Salinity (ppt)	Mangrove Species	Tree density (100 m²)	Average Height (m)	Average DBH (cm)	Seedling Density (per m²)
T1	n/a	*Conocarpus erectus*	29	11.7	15.4	0
T2						
T3		*Conocarpus erectus*	38	10.375	12.6	0
T4		*Avicennia germinans*	1	11	44	0
T5						
T6	50	*Laguncularia racemosa*	1	5		0
T7		*Conocarpus erectus*	16	5.8	16.8	0
T8		*Conocarpus erectus*				0

TABLE 5-20: FLORA SPECIES FOUND ON THE PROPOSED DEVELOPMENT SITE

Family	Scientific Name	Common Name	Range**	DAFOR Ranking
Mimosaceae	*Albizia lebbeck*	Woman's Tongue	Locally common, naturalised in open secondary woodlands, mostly on gravelly soils near habitations	R
Avicenniaceae	*Avicennia germinans*	Black Mangrove	Common in all saline and brackish communities around the coast and on the cays	R
Bataceae	*Batis marina*	Batis/salt wort	Dense colonies common in salt marshes, brackish marshes, and mangrove swamps	O
Asteraceae	*Bidens pilosa*	Spanish Needle	A common weed of roadsides and waste places	O
Leguminosae	*Caesalpinia bonduc*	Seaside Nickle	Pantropical distribution, occasionally in secondary forests	R
Fabaceae	*Canavalia maritima*	Seaside Bean	Very common, on the strand and sandy wastes near the sea	O

Family	Scientific Name	Common Name	Range**	DAFOR Ranking
Moraceae	*Cecropia peltata*	Trumpet Tree	Common, especially on recently cleared forested land	R
Fabaceae	*Clitoria ternatea*	Blue Pea	Common in cultivation as an ornamental, and escaping into waste places, field margins and thickets	O
Polygalaceae	*Coccoloba uvifera*	Sea Grape	Common and locally dominant along the seacoast on strand, sand dunes and in thickets inland	D
Combretaceae	*Conocarpus erectus*	Button Mangrove	Common at the inner margins of mangrove swamps and in thickets on salinas and also on the cays	A
Poaceae	*Cynodon dactlon*	Bermuda Grass	Commonly cultivated or encouraged as lawn grass particularly in drier areas, also as a weed of roadsides, pastures and waste places	O
Cucurbitaceae	*Curcurbita sp.*	Pumpkin	Commonly cultivated or sprouts easily in areas of human use	
Caesalpiniaceae	*Delonix regia*	Ponciana	Commonly cultivated and occasionally naturalised	R
Asparagaceae	*Dracaena trifasciata*	Snake Plant	Common ornamental	R
Euphorbiaceae	*Euphorbia prostrata*	Milkweed	Locally common, a weed of sandy waste places and lawns	O
Caesalpiniaceae	*Haematoxylum campechianum*	Logwood	Common on exposed limestone hillsides in dry secondary thickets and planted in fences	R
Malvaceae	*Hibiscus tiliaceus*	Seaside Mahoe	Rather local, in brackish swamps and inner margins of mangroves	D
Convolvulaceae	*Ipomoea pes-caprae*		Common on beaches and sandy waste places near sea	F
Convolvulaceae	*Ipomoea indica*		Common in open waste places and thickets, often near the sea in sandy ground, rarer in the drier areas	A
Combretaceae	*Laguncularia racemosa*	White Mangrove	Common along the margins of lagoons and brackish creeks and also on the cays	R
Verbenaceae	*Lantana camara*	Wild Sage	Very common in rough pastures, waste places and thickets	O
Mimosaceae	*Leucaena leucocephala*	Lead Tree	Common along roadsides and in sandy waste places and thickets	D

Family	**Scientific Name**	**Common Name**	**Range****	**DAFOR Ranking**
Mimosaceae	*Mimosa pudica*	Shame Old Lady	A common weed of pastures and open stabilised waste places	A
Cucurbitaceae	*Momordica balsamina*	Cerasea	Rare in wild state	F
Rubiaceae	*Morinda citrifolia*	Noni	Locally common in open places near the sea, cultivated inland	O
Poaceae	*Panicum maximum*	Guinea Grass	Very common in rough pastures, ditches and sheltered thickets	D
Euphorbiaceae	*Ricinus communis*	Castor Oil	Common as cultivated plant and on waste ground	F
Polygalaceae	*Securidaca brownei*		Common in thickets and woodland margins on limestone	
Poaceae	*Setaria barbata*	Corn Grass	Common as weed as waste ground and thin pastures usually in rather shady places	A
Solanaceae	*Solanum torvum*	Susumber	Common in woodland clearings, thickets and waste places	R
Poaceae	*Stenotaphrum secundatum*	Crab Grass	Common in pastures on heavy poorly drained soils or on coral limestone near sea	A
Combretaceae	*Terminalia catappa*	West Indian Almond	Commonly planted and naturalised	F
Poaceae	*Zoysia tenuifolia*	Zoyza /carpet grass	Cultivated for lawns or wild in coastal areas-mild salt tolerance	O

5.2.2.3 Fauna Assessment

The faunal assessments were conducted at selected sample points placed throughout the study area, including along the trails and footpaths to and within the sample sites (**Figure 5-113**). The surveys were carried out over 5 days and 3 nights using the methods listed below. A DAFOR scale of relative abundance was used to rank the species for both the fauna and flora identified; Dominant (≥ 20), **A**bundant (15-19), **F**requent (10-14), **O**ccasional (5-9) and **R**are (<4).

5.2.2.3.1 Avifauna

The line transect method was utilised for the bird survey which was conducted along the beach, roads and trails within the adjacent wetlands. The method entailed walking slowly along selected routes for a given distance or time, noting all the birds seen or heard in the area (Wunderle 1994).

The point survey method was used for the bird survey at the pond. It entailed counting the birds at a vantage point in the area for 15 minutes. Three audio devices (AudioMoth) were deployed in the field to conduct the nocturnal bird survey.

FIGURE 5-113: THE ZONES USED FOR THE FAUNAL SURVEY OF THE PROPERTY

The devices were active from 18:00 to 06:00 over 2 nights. The audio files were processed using the Kaleidoscope Pro software from Wildlife Acoustics and the process audio file ID by experts.

Reference material used in species identification (pictures and calls) included Merlin App (Cornell University, 2021), Ebird (Fink, et al., 2018), and Birds of the West Indies (Raffaele, Garrido, Keith, & Raffaele., 1998).

Observations

Sixty-three (63) species of birds were identified during the assessment (**Table 5-21**).

TABLE 5-21: THE BIRDS OBSERVED DURING THE ASSESSMENT ON THE PROPERTY.

Common Name	Scientific name	Range	IUCN	Inland Zone	Wetland
American Kestrel	*Falco sparverius*	*Resident*	LC		R
American Redstart	*Setophaga ruticilla*	*Migrant*	LC		R
Antillean Palm-Swift	*Tachornis phoenicobia*	*Resident*	LC		R
Bananaquit	*Coereba flaveola*	*Resident*	LC	R	
Barn Owl	*Tyto alba*	*Resident*	LC	R	
Belted Kingfisher	*Megaceryle alcyon*	*Resident*	LC		R
Black-and-white Warbler	*Mniotilta varia*	*Migrant*	LC	R	
Black-crowned Night-Heron	*Nycticorax nycticorax*	*Resident*	LC		R
Black-faced Grassquit	*Melanospiza bicolor*	*Resident*	LC	R	
Black-necked Stilt	*Himantopus mexicanus*	*Resident*	LC		O
Black-throated Blue Warbler	*Setophaga caerulescens*	*Migrant*	LC	R	R
Blue-winged Teal	*Spatula discors*	*Migrant*	LC		R
Brown Pelican	*Pelecanus occidentalis*	*Resident*	LC	R	O
Cape May Warbler	*Setophaga tigrina*	*Migrant*	LC		R
Cattle Egret	*Bubulcus ibis*	*Resident*	LC		O
Chestnut Munia	*Lonchura atricapilla*	*Introduced*	LC	D	
Common Ground Dove	*Columbina passerina*	*Resident*	LC	O	
Common moorhen	*Gallinula chloropus*	*Resident*	LC		R
Common Yellowthroat	*Geothlypis trichas*	*Migrant*	LC		R
Great Blue Heron	*Ardea herodias*	*Resident*	LC		R

Common Name	**Scientific name**	**Range**	**IUCN**	**Inland Zone**	**Wetland**
Great Egret	*Ardea alba*	*Resident*	LC		O
Greater Antillean Grackle	*Quiscalus niger*	*Resident*	LC	O	F
Greater Yellowlegs	*Tringa melanoleuca*	*Migrant*	LC		R
Green Heron	*Butorides virescens*	*Resident*	LC		R
Green-rumped Parrotlet	*Forpus passerinus*	*Introduced*	LC		R
Herring Gull	*Larus argentatus*	Migrant	LC		R
Jamaican Euphonia	*Euphonia jamaica*	*Endemic*	LC	R	
Jamaican Oriole	*Icterus leucopteryx*	*Resident*	LC	R	
Jamaican Vireo	*Vireo modestus*	*Endemic*	LC	R	
Killdeer	*Charadrius vociferus*	*Resident*	LC		O
Laughing Gull	*Leucophaeus atricilla*	*Migrant*	LC		R
Least Sandpiper	*Calidris minutilla*	*Migrant*	LC		D
Lesser Yellowlegs	*Tringa flavipes*	*Migrant*	LC		R
Little Blue Heron	*Egretta caerulea*	*Resident*	LC		R
Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	LC	O	R
long-billed dowitcher	*Limnodromus scolopaceus*	*Migrant*	LC		R
Magnificent Frigatebird	*Fregata magnificens*	*Resident*	LC	O	O
Mourning Dove	*Zenaida macroura*	*Resident*	LC	R	
Northern Jacana	*Jacana spinosa*	*Resident*	LC		R
Northern Mockingbird	*Mimus polyglottos*	*Resident*	LC	O	R
Northern Parula	*Setophaga americana*	*Migrant*	LC	R	R
Northern Waterthrush	*Parkesia noveboracensis*	*Migrant*	LC	R	O
Palm Warbler	*Setophaga palmarum*	*Migrant*	LC	R	
Prairie Warbler	*Setophaga discolor*	*Migrant*	LC	R	R
Red-billed Streamertail	*Trochilus polytmus*	*Endemic*	LC	R	R
Rock Pigeon	*Columba livia*	*Resident*	LC	R	
Ruddy Turnstone	*Arenaria interpres*	*Migrant*	LC		R
Saffron Finch	*Sicalis flaveola*	*Introduced*	LC	R	
Scaly-breasted Munia	*Lonchura punctulata*	*Introduced*	LC	A	

Common Name	Scientific name	Range	IUCN	Inland Zone	Wetland
Smooth-billed Ani	*Crotophaga ani*	*Resident*	LC	F	O
Snowy Egret	*Egretta thula*	*Resident*	LC	R	F
Solitary Sandpiper	*Tringa solitaria*	*Migrant*	LC		R
Spotted Sandpiper	*Actitis macularius*	*Migrant*	LC		R
Tricoloured heron	*Egretta tricolor*	*Migrant*	LC		O
Turkey Vulture	*Cathartes aura*	*Resident*	LC	O	O
Vervain Hummingbird	*Mellisuga minima*	*Resident*	LC	R	
White-crowned Pigeon	*Patagioenas leucocephala*	*Resident*	NT	R	
White-winged Dove	*Zenaida asiatica*	*Resident*	LC	R	R
Yellow Warbler	*Setophaga petechia*	*Resident*	LC	R	R
Yellow-crowned Night-Heron	*Nyctanassa violacea*	*Resident*	LC		R
Yellow-faced Grassquit	*Tiaris olivaceus*	*Resident*	LC	O	
Yellow-throated Warbler	*Setophaga dominica*	*Migrant*	LC		O
Zenaida Dove	*Zenaida aurita*	*Resident*	LC	R	

These species included: Resident-Non endemic (n=34), Introduced (n=4), Migrant (n=21) and Resident-endemic (n=3) as shown in **Figure 5-114**.

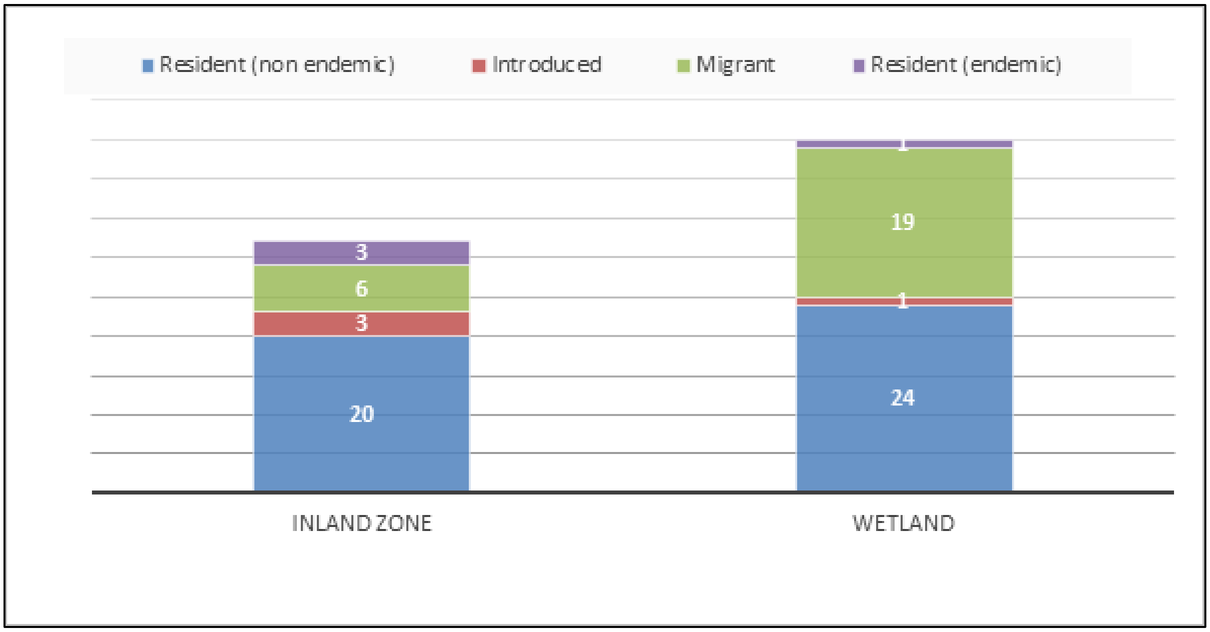

FIGURE 5-114: THE BIRD SPECIES DISTRIBUTION WITHIN THE PROJECT AREA

Only 3 of the 31 endemic birds reported in Jamaica were observed in the study. All three are not forest dependent. The low number of endemic birds could be attributed to the low number of trees on the Sandal's property. In addition, not many of the endemics are found in coastal wetlands in Jamaica. Furthermore, the area is highly disturbed.

Twenty-one winter migrants (Warblers= 9, duck=1, Water thrush= 1, gulls=2, yellowlegs=2, sandpipers=3, heron=1 and other = 2) were identified in the study (**Figure 5-115**). The majority were observed in wetlands. A low number was observed in the built-up section of the property.

FIGURE 5-115: PALM WARBLER OBSERVED DURING THE STUDY

The wetlands/ coastal birds observed in the study include egrets, Magnificent Frigatebirds, Belted Kingfisher, Long-billed dowitcher, herons, ducks, gulls, terns, Ruddy Turnstone and sandpipers. None of the coastal and wetland species were endemic. The Laughing gull was the most abundant bird on the coast. The rare bird encountered in the study, is the Herring Gull on the coast (**Figure 5-116**).

FIGURE 5-116: A FLOCK OF BIRDS OBSERVED ON THE COAST (HERRING GULL AND SEVERAL LAUGHING GULLS)

Only 1 bird species with special designated status by the IUCN (2024) was observed across the study area: White-crowned Pigeon (*Patagioenas leucocephala*), listed as near-threatened species. No wetland birds (**Figure 5-117**) were observed nesting in the mangroves.

FIGURE 5-117: BLUE WING TEALS OBSERVED FORAGING IN THE POND

5.2.2.3.2 Herpetology

The herpetology (amphibian and reptile) surveys were conducted across the different microhabitat types within the two main habitat types. The microhabitats area searched includes trees, stone piles, artificial ponds and other debris. All specimens seen were identified, and a DAFOR ranking was assigned to reflect their relative dominance; pictures were taken for further study if necessary. Herpetofauna which could not be identified in the field were collected and identified using Amphibians and Reptiles of the Caribbean Islands keys (Caribherp 2022) and Amphibians and Reptiles of the West Indies (Schwartz and Henderson 1991). The surveys were conducted in both day and night.

Only 1 amphibian, *Eleutherodactylus johnstonei,* was recorded on the property over the sample period (**Table 5-22**): No amphibians of special conservation status were identified in the study.

Table 5-22: The Herpetofauna Identified in the Study Area

Class	Family	Scientific Name	Common Name	Range	IUCN Status	Scrubland	Wet land
Amphibia	Eleutherodactylidae	*Eleutherodactylus johnstonei*	Lesser Antillean Frog	Introduced	LC	O	R
Reptilia	Dactyloidae	*Anolis lineatopus*	Jamaican Brown Anole	Endemic	LC	A	O
Reptilia	Dactyloidae	*Anolis grahami*	Jamaican Turquoise Anole	Endemic	LC	O	R
Reptilia	Gekkonidae	*Hemidactylus mabouia*	Tropical House Gecko	Introduced	LC	O	
Reptilia	Dactyloidae	*Anolis sagrei*	Brown Anole	Introduced	LC	R	R
Reptilia	Sphaerodactylidae	*Aristelliger praesignis*	Jamaican Croaking Gecko	Native	LC		R
Reptilia	Sphaerodactylidae	*Sphaerodactylus argus*	West Caribbean Ocellated Geckolet	Native	LC	R	

5.2.2.3.3 Invertebrates

The invertebrate assessment consisted of a series of walkthroughs within the project area. Various microhabitats within the project area were carefully searched or examined; these included tree trunks, leaves, dry wood, and sticks. A sweep net was also used to sample insects from the foliage, and insects in flight were recorded. The arthropods encountered in the field were identified on the spot; however, arthropods which could not be identified in the field were later identified using Insects Keys (Triplehorn, Johnson, & Borror, 2005), iNaturalist App and collections at the University of the West Indies if necessary.

Observations

The butterfly species encountered during the walkthrough of the property were noted using the appropriate butterfly keys. No specimens were collected during the assessment. However, pictures were taken of species that could not be identified in the field. Only 5 butterfly species from 3 families were identified during the study (**Table 5-23**). None of the species were endemic or of any special conservation needs.

Twenty arthropods (non-butterflies) were observed during the study (**Table 5-24**). Of the 13 species identified, there were no species of special conservation status.

TABLE 5-23: THE BUTTERFLY SPECIES OBSERVED DURING THE ASSESSMENT OF THE AREA.

Family	Scientific names	Common names	Distribution	Scrubland	Wetland
Lycaenidae	*Hemiargus ceraunus*	The Hanno Blue	Widespread and very common	O	R
Nymphalidae	*Dione vanillae*	The Tropical Silverspot	Widespread and very common	R	R
Pieridae	*Ascia monuste*	Great Southern White; Antillean Great White	Widespread, common and pest of crucifers. Southern US to Argentina	O	R
Pieridae	*Phoebis sennae*	Cloudless Sulphur	Widespread and common. Southern US to Argentina	R	R
Psychidae	*Bag worm*	Bag worm Moth		F	O
Psychidae	*Papilio demoleus*	Lime Swallowtail Butterfly	Introduced from S.E. Asia in 2006, Pest of citrus	R	

TABLE 5-24: THE ARTHROPODS (NON-BUTTERFLY) OBSERVED DURING THE ASSESSMENT.

Order	**Family**	**Scientific Names**	**Common Names**	**Status**	**Range**	**Scrubland**	**Wetland**
Araneae	Araneidae	*Argiope sp.*	Orbweavers	Resident	Native, Common	O	**R**
Araneae	Araneidae	*Trichonephila clavipes*	Banana spiders	Resident	Native, Common		**R**
Diptera	Muscidae	*Musca domestica*	housefly	Resident	Native, Common	O	R
Hemiptera	Pyrrhocoridae	*Dysdercus andreae*	Cotton Stainer Bugs	Resident	Native, Common	F	
Hymenoptera	Vespidae	*Polistes crinitus*		Resident	Native, Common	O	R
Hymenoptera	Apidae	*Apis mellifera*		Resident	Native, Common	O	R
Hymenoptera	Xylocopinae	*Xylocopa mordax*		Resident	Native, Common	R	
Hymenoptera	Formicidae	*Pheidole sp.*	Black ants	Resident	Native, Common	R	O
Isopetera	Termitidae	*Nasutitermes costalis*	Termites, Duck ants Widespread.	Resident	Native, Common		O
Odonata	Libellulidae	*Orthemis sp*	Green Dragonfly	Resident	Native, Common		R
Odonata	Libellulidae	*Orthemis macrostigma*	Red Dragonfly or Tropical King Skimmers	Resident	Native, Common		O
Odonata	Libellulidae	*Erythrodiplax umbrata*	Band-winged Dragonlet	Resident	Native, Common		R
Orthoptera	Gryllidae		Cricket	Resident	Unknown	**O**	R

5.2.2.3.4 Bats

Three AudioMoth® acoustic recorders were deployed in selected areas on the property (Open fields and Riverine Habitat) as shown in **Figure 5-118**. The AudioMoth detectors were recording duration was for 5 seconds configured to start recording from 18:30 to 06:00 for 3 nights.

FIGURE 5-118: THE LOCATION OF THE AUDIOMOTHS DEPLOYED IN THE STUDY

The sample rate was 384 kHz, and the gain was set at medium. The sleep duration was 5 seconds, and the the devices were deployed at least 2m above the ground, primarily on trees. The Kaleidoscope Pro® software was used to process and ID the bat calls from all acoustic devices. Please note that the software can only auto-ID ten of Jamaica's 21 species of bats. The other species were identified using a call library from Windsor Research Center and internet resources.

Observations

Eight bats were recorded across the study area, all native to Jamaica (**Table 5-25**). Five of the bats are insectivores, 1 piscivore (fish-eating bat), 1 nectarivore and 1 frugivore. None of the species recorded during the assessment has a special conservation status designation by the IUCN (2024); all bats observed are classified as least concerned by the IUCN (2024). It should be noted 7 of the bats were detected at the artificial pond on the property. The water within the pond at the time was fresh.

TABLE 5-25: THE BAT SPECIES DETECTED IN THE STUDY

Scientific name	Common name	IUCN	Range	Diet	Roost	Scrubland	Wetland
Artibeus jamaicensis	Jamaican Fruit Bat	LC	Native	Frugivore	Cave, man-made structure, foliage		X
Eumops glaucinus	Wagner's Bonneted Bat	LC	Native	Insectivore	Cave, man-made structures		X
Molossus molossus	Pallas' Mastiff Bat	LC	Native	Insectivore	Cave, man-made structures		X
Monophyllus redmani	Leach's Single Leaf Bat	LC	Native	Nectarivore	Obligate cave	x	X
Noctilio leporinus	Fishing Bat	LC	Native	Piscivore	Cave, crevice, Tree hollow		X
Pteronotus macleayii	MacLeay's Mustached Bat	LC	Native	Insectivore	Obligate cave	x	X
Pteronotus parnellii	Parnell's Mustached Bat	LC	Native	Insectivore	Obligate cave	x	X
Pteronotus quadridens	Sooty Mustached Bat	LC	Native	Insectivore	Obligate cave	x	X
Tadarida brasiliensis	Free-tailed Bat	LC	Native	Insectivore	Cave, man-made structures	x	X

5.3 Natural Hazards

Storm Surge - Several hurricane storm surge hazard assessments have been undertaken by the Organization of American States (OAS) for the Montego Bay area using historical hurricane information from the National Hurricane Center (NHC) in the USA. The storm surge heights were also mapped for various return intervals regardless of the magnitude of the hurricane that caused the surge. All the storms in the NHC database up to 1997 (approximately 960 storms) were evaluated by the OAS model based on wave, wind and atmospheric pressure effects and tidal variances. The analysis shows that storm surge along the Montego Bay shoreline was computed to vary from 1.8m to 2.4m and up to 3.1m at the Montego Bay Freeport. The 25-yr storm surge map is presented in **Figure 5-119** below. A quick analysis of this OAS model (1999) shows that the airport, resorts, commercial, offices and light industrial areas are most likely to be impacted by the 25yr storm surge.

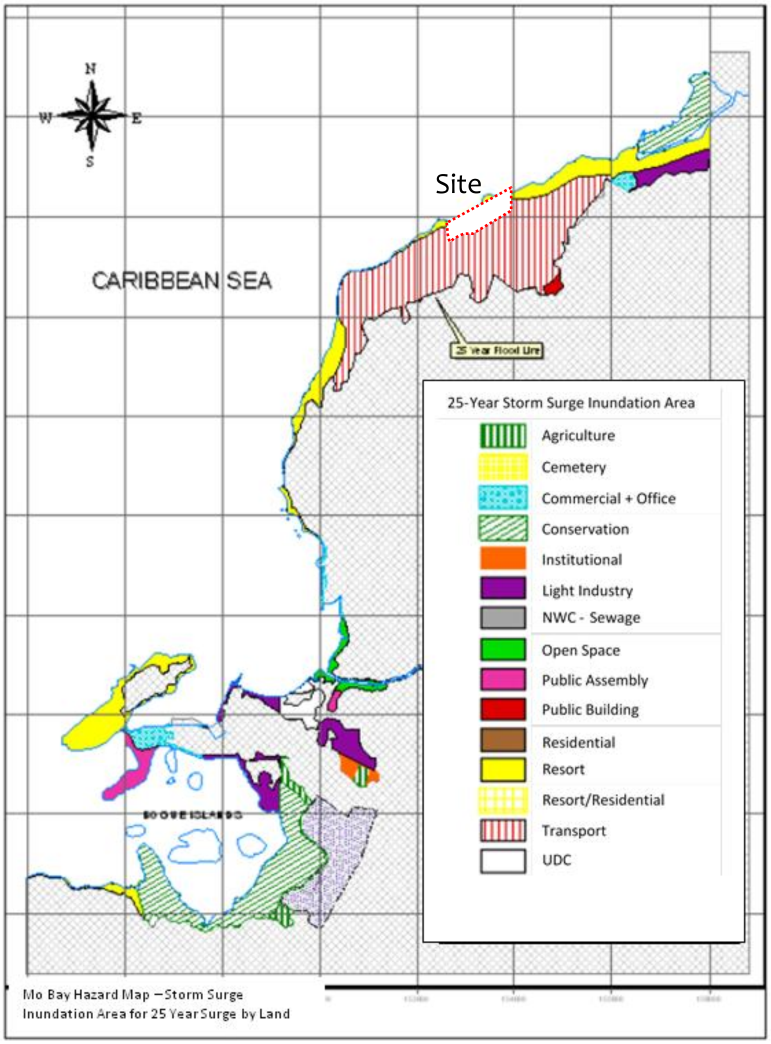

FIGURE 5-119: INUNDATION STORM AREAS FOR THE 1 IN 25 YR HURRICANE SURGE FOR THE MONTEGO BAY AREA (OAS, 1999)

Storm surge damage along the coast, approximately 2km west of the site, was recorded during Hurricane Allen in the 1980 and shown in **Figure 5-120**. The limited impact shows that hurricane Allen was much less than a 50yr return storm surge event.

The storm surge impact due to hurricanes can and does occur along the coastline of Jamaica resulting from low pressure over the sea due to hurricanes and the waves generated by the wind associated with hurricanes and can affect exposed structures, such as overwater rooms.

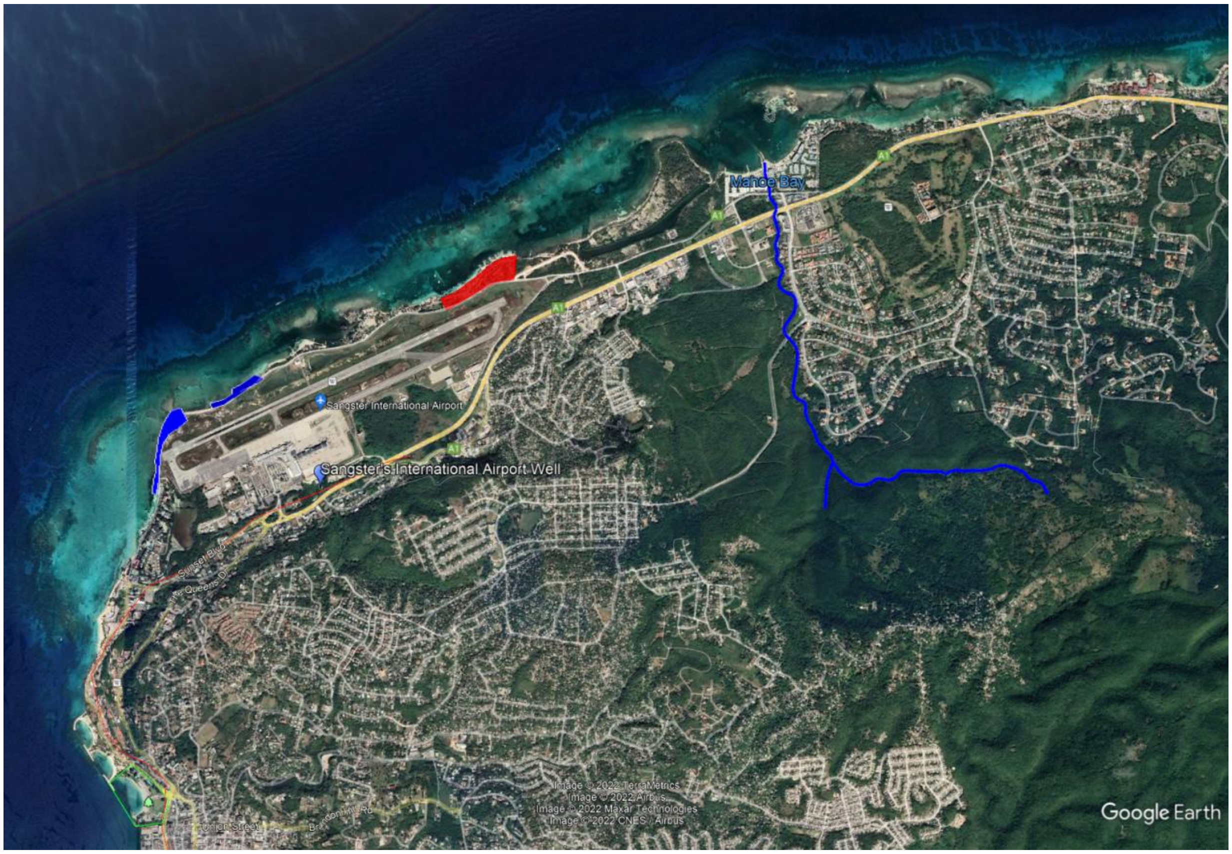

FIGURE 5-120: HURRICANE ALLEN (1980) RECORDED STORM SURGE (BLUE POLYGONS) IMPACTS AS NOTED BY THE ODPEM. SALT SPRING GUT SHOWN AS BLUE POLYLINE.

Earthquake - Jamaica is prone to a number of natural hazards. Earthquakes are one such frequent hazard. In the distant past, it is recorded that a small shock was felt in Montego Bay that agitated vessels in October 1787. Offshore earthquake epicenters are well recorded around Montego Bay.

In Jamaica the Plantain-Garden Fault in eastern Jamaica is the most likely source of intense earthquakes above 6.0 magnitude. However, Montego Bay has recorded structural damage from an earthquake in March 1957.

Figure 5-121 below presents the relative contribution in terms of exceedance rates for each of the anticipated earthquake sources and for the city of Kingston. Based on the graph for a return period of 500 years, probable maximum ground acceleration on bedrock (like limestone) would be of the order of 19% of gravity (190 gals) according to a report done in 2009[10].

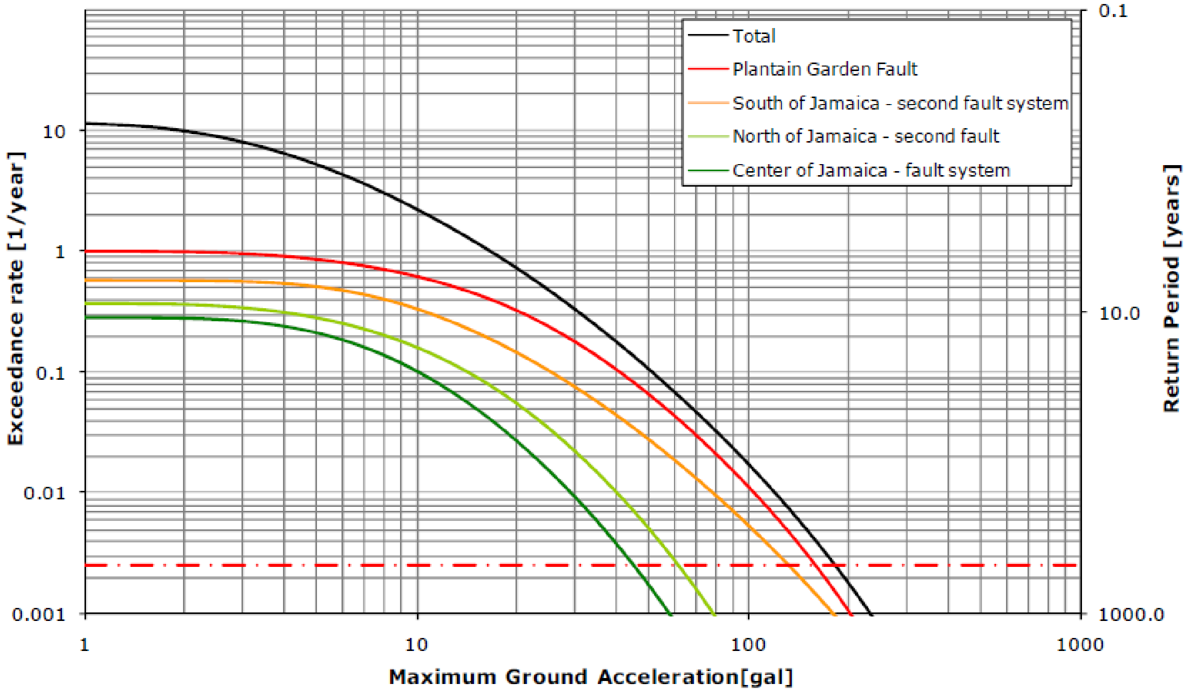

FIGURE 5-121: EXCEEDANCE RATES OF MAXIMUM ACCELERATION FOR KINGSTON

The IDB country profile report further showed that based on all the four fault systems the total hazard by each system can be shown that the Plantain Garden Fault and the South Coast Fault systems together account for about 99% of Jamaica's seismic hazard potential (**Figure 5-122**).

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[10] Country-Specific Risk Evaluation for Boliva, Guatemala, Jamaica and Peru done for the IDB in April 2009

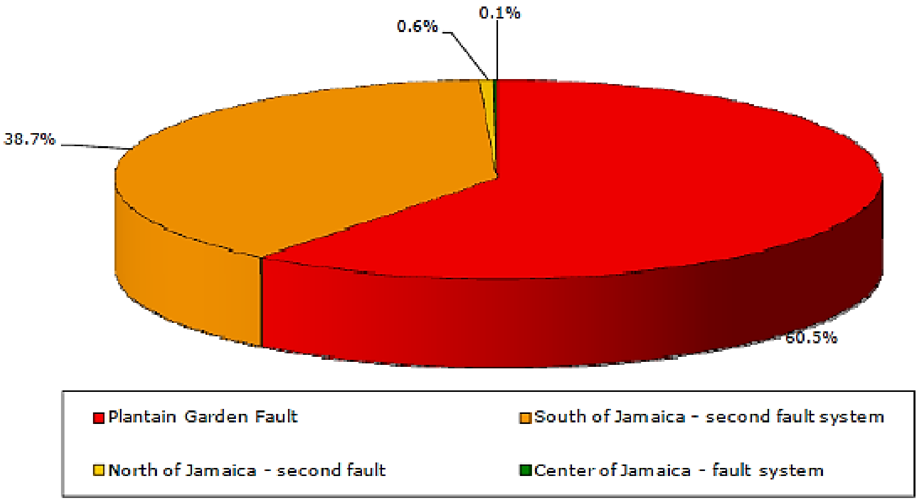

FIGURE 5-122: PERCENTAGE OF OCCURRENCE OF EVENTS ON THE FOUR FAULT SYSTEMS IN KINGSTON BASED ON A 500 YR RETURN PERIOD

Scientific research since 2010 has indicated that the lack of surface ruptures of the Enriquillo-Plantain Garden Fault in Haiti (which is linked to Jamaica) along with other geological and seismologic evidence confirms to geoscientists that the Enriquillo-Plantain Garden fault remains a significant seismic hazard.

Recent spectral seismic hazard maps were created by the UWI and based on specifications incorporated in the International Building Code (IBC). The maps created (**Figure 5-123)** show ground motion as a function of earthquake magnitude, distance from epicenter, path effects due to geology and frequency. Any construction within the site would need to comply with International Building Code (IBC) and all local building codes due to the potential earthquake risk.

Figure 5-124 shows the historical records of all earthquake activity up to 2007.Noteworthy of mention are epicenters close to Montego Bay as well as offshore and to the east. Three historical earthquakes are noted in western Jamaica, one in 1839 of magnitude VII, one in 1943 of magnitude VII and the most recent in 1957 of magnitude VII.

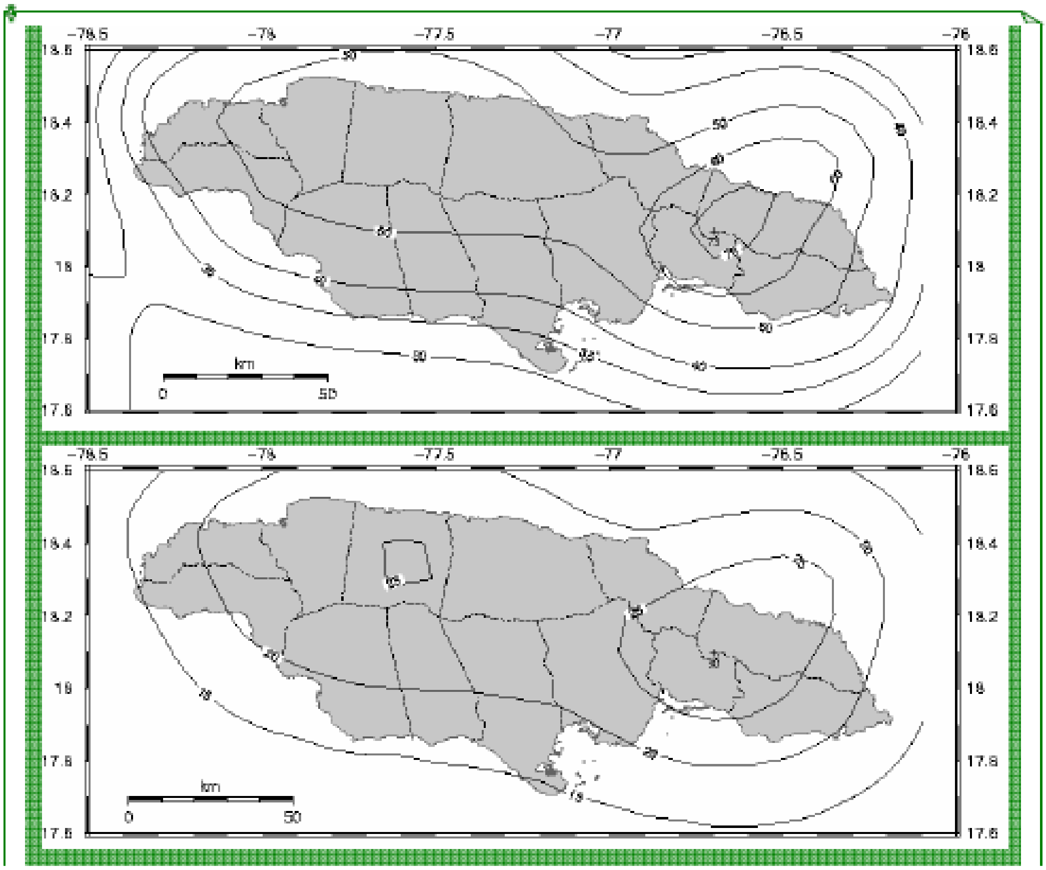

FIGURE 5-123: IBC BASED HAZARD MAPS FOR JAMAICA, WITH A 2,745 YR RETURN PERIOD FOR SPECTRAL RESPONSE ACCELERATION OF 0.2 SECONDS (TOP MAP) AND 1.0 SECONDS (BOTTOM MAP) EXPRESSED AS A PERCENTAGE OF GRAVITY (UWI EARTHQUAKE UNIT, JULY 2006)

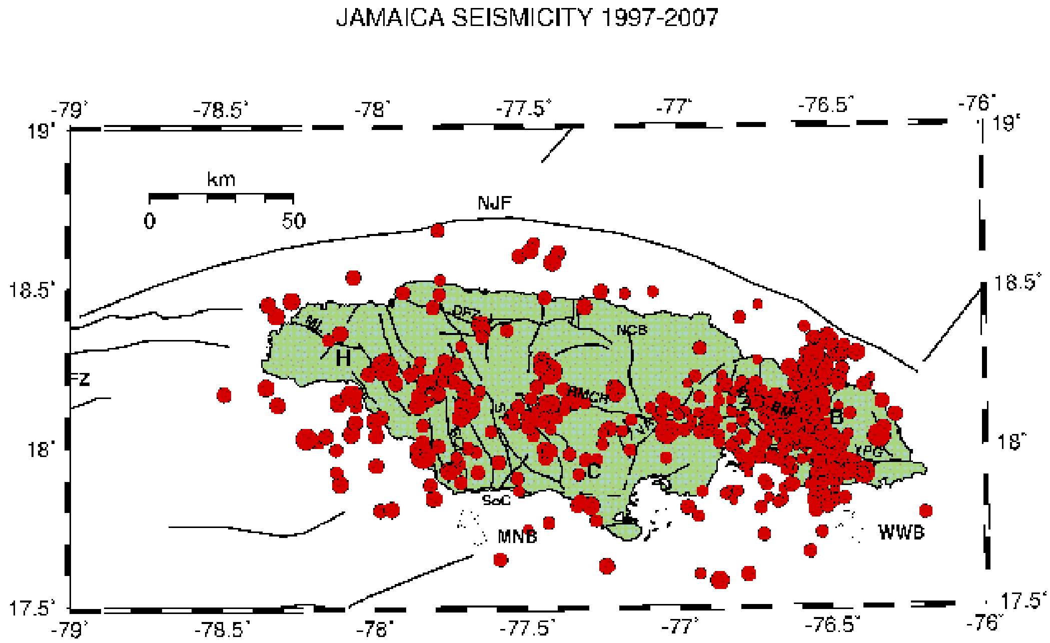

FIGURE 5-124: MAP OF THE SEISMIC EVENTS ACROSS JAMAICA BETWEEN 1997 AND 2007. NOTE MOST ACTIVITY LOCATED TO THE EAST AND CENTRAL JAMAICA

The average return frequency of earthquakes, based on magnitude, is presented in **Table 5-26**.

TABLE 5-26: AVERAGE FREQUENCY OF EARTHQUAKES IN JAMAICA (WIGGINS-GRANDISON 2005)

MAGNITUDE	RETURN PERIOD (Yrs.)
4.0	1.1
5.0	8.7
5.4	20
6.0	70
7.0	611

Tsunami - Tsunami hazards are inextricably linked to earthquakes, particularly offshore earthquakes, and submarine landslides triggered by earthquakes. In Jamaica, the tsunamis that have affected the coastline have been recorded since 1688. Jamaica's geological setting makes the coastline particularly susceptible to tsunamis as well as storm surges. Both are similar; however, tsunamis are quite different from storm surges. Tsunamis are caused by earthquakes; though all earthquakes do not seem to cause tsunamis; while storm surges are related solely to hurricanes. A 2002 assessment by global insurers Munich Re shows Jamaica's entire coastline being exposed to tsunami risk.

The recorded tsunamis in Jamaica are presented in

Table 5-27. Based on the evidence there is an earthquake hazard that is likely to occur in Jamaica in the future. The tsunami risk associated with any large magnitude earthquake, which may be of the type seen in the Pacific, recently, is considered to be low when compared to the Pacific. In the records, there are no reports of anyone being killed by a tsunami in Jamaica.

TABLE 5-27: RECORDED TSUNAMIS IN JAMAICA

RECORDED TSUNAMIS along the coastline in JAMAICA BETWEEN 1688 AND 1907		
1688	March 01	Earthquakes felt. No report of the tsunami reaching shore. A ship at sea was destroyed by waves.
1692	June 07	Earthquake with estimated magnitude of 7.5 caused portions of Port Royal to sink killing 2000 souls. Reported that the sea withdrew 274m and a 1.8m wave came to shore. Sea withdrawal at Yallahs was also noted.
1812	November 11	Earthquake agitated the sea in Annotto Bay causing a ship to lose its anchor. No report of wave reaching the shore.
1781	October 2	In Savanna-La-Mar a tsunami was recorded when an earthquake and hurricane occurred simultaneously.
1852	July 17	No earthquake reported, however, a ship 113km from Jamaica was affected by turbulent sea and simultaneous agitation in the harbour at Santiago de Cuba. There was no report of tsunami reaching shore
1907	January 14	Earthquake with estimated magnitude of 6.5 affect Kingston with 1000 souls lost. Seiches (oscillating waves in water) of 2.5m reported in Kingston Harbour. Waves up to 2.5m affected the north coast from Buff Bay to St Ann's Bay. Sea receded 93m at Annotto Bay and 69m at Ocho Rios.

Hurricanes and associated hazards - Despite the frequency of hurricanes being perceived as very high, the frequency of occurrence in Jamaica is low, particularly catastrophic hurricanes. However, the impacts from hurricanes and storms are more frequent as they impact the island annually. It is expected that this will be further exacerbated in light of climate change and variability. The historic hurricane trajectories for Jamaica are presented in **Figure 5-125**.

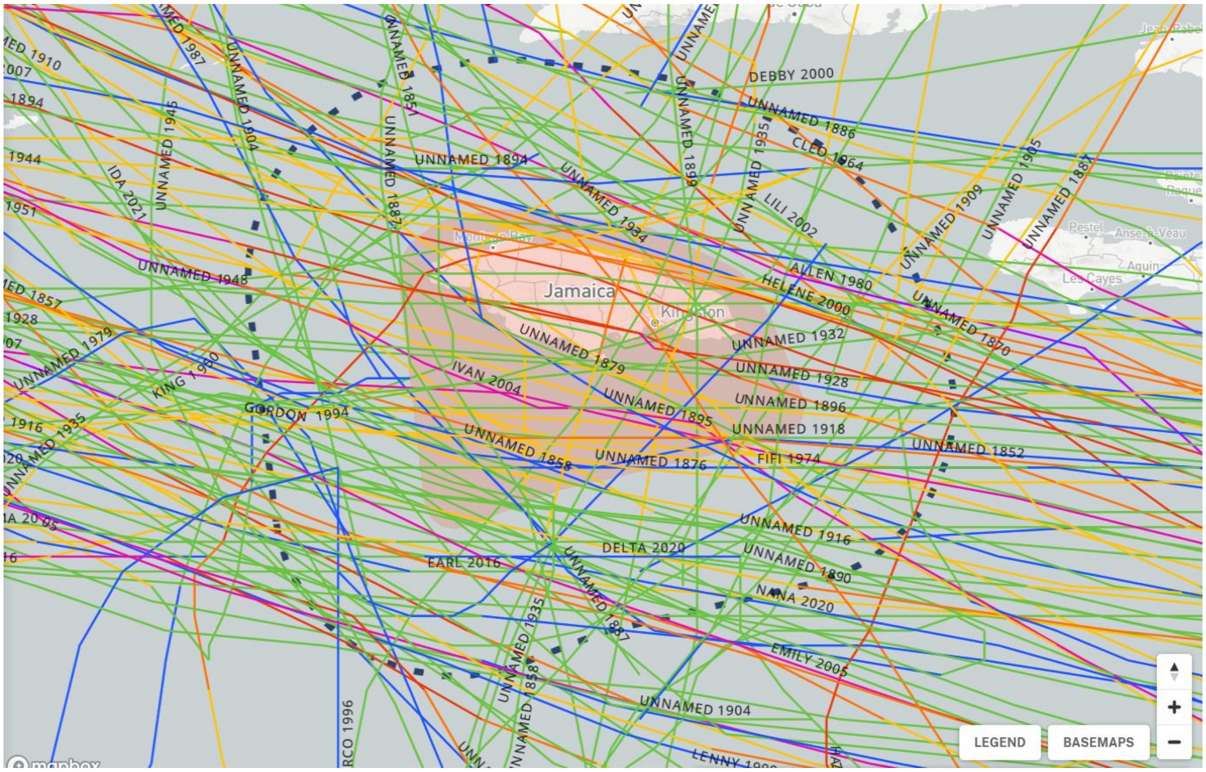

FIGURE 5-125: HURRICANE TRAJECTORIES ACROSS JAMAICA FROM 1854 TO PRESENT. OVER 50 STORMS ARE MAPPED COURTESY OF THE NOAA ARCHIVES.

Based on the annual frequency of hurricanes several multinational agencies have sponsored studies on the impacts of such storms/Hurricanes on Jamaica. The assessment evaluated storm surges, winds and waves effects of storms along the coast. The 1 in 50 yr. return maps for surges, wind and waves are presented in **Figure 5-126, Figure 5-127** and **Figure 5-128**. The surges do not include wave run-up and consequently should not be compared to the storm surge maps presented earlier in this report.

These maps indicate that there are several impacts that can be expected on any coastal structure due to hurricanes. The proposed structures should be designed to withstand such hurricane associated impacts which will most likely occur more frequently and possibly on an annual basis.

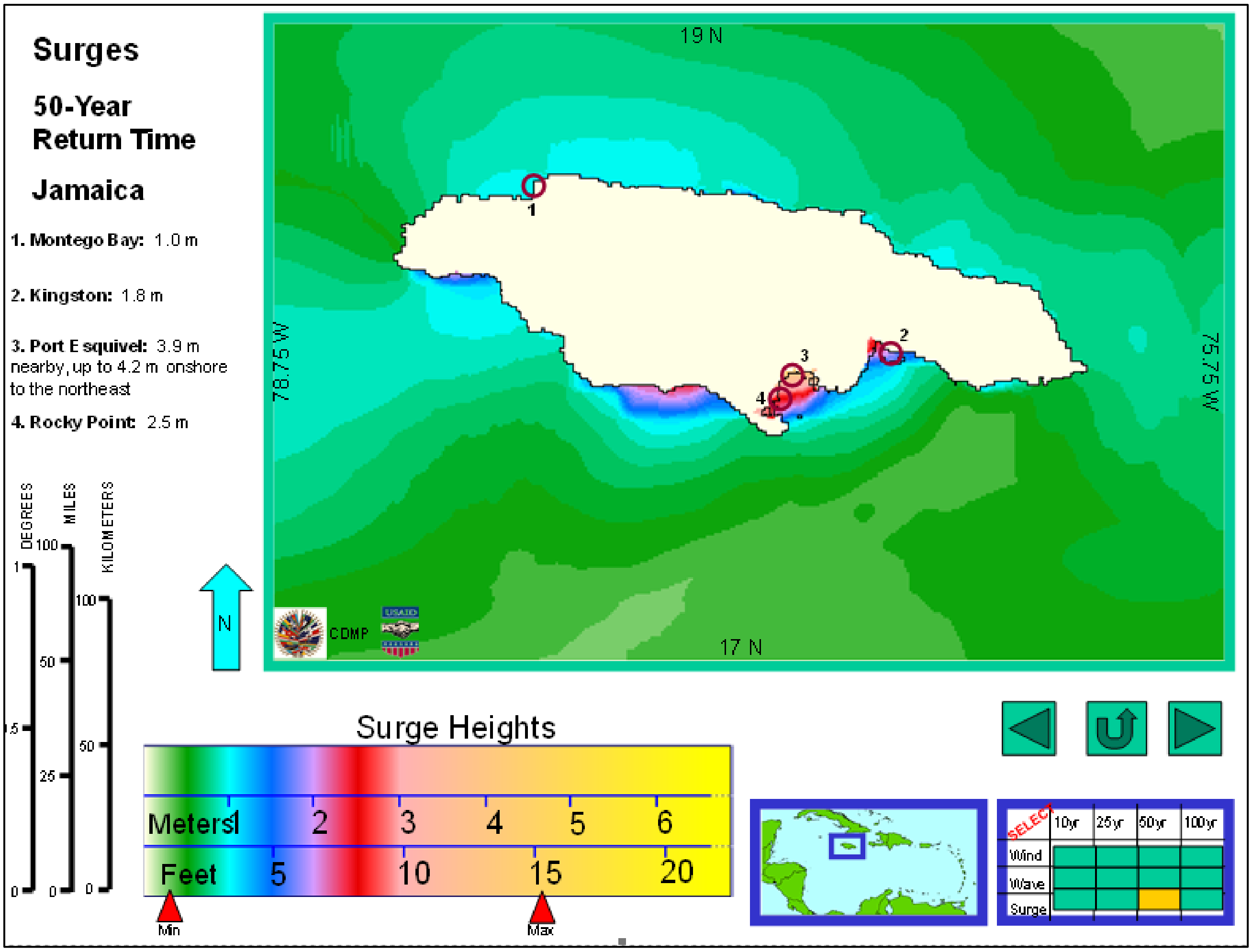

FIGURE 5-126: SURGE MAP FOR JAMAICA WITH 50 YR RETURN PERIOD. MAXIMUM SURGE HEIGHTS 1.0M AT MONTEGO BAY

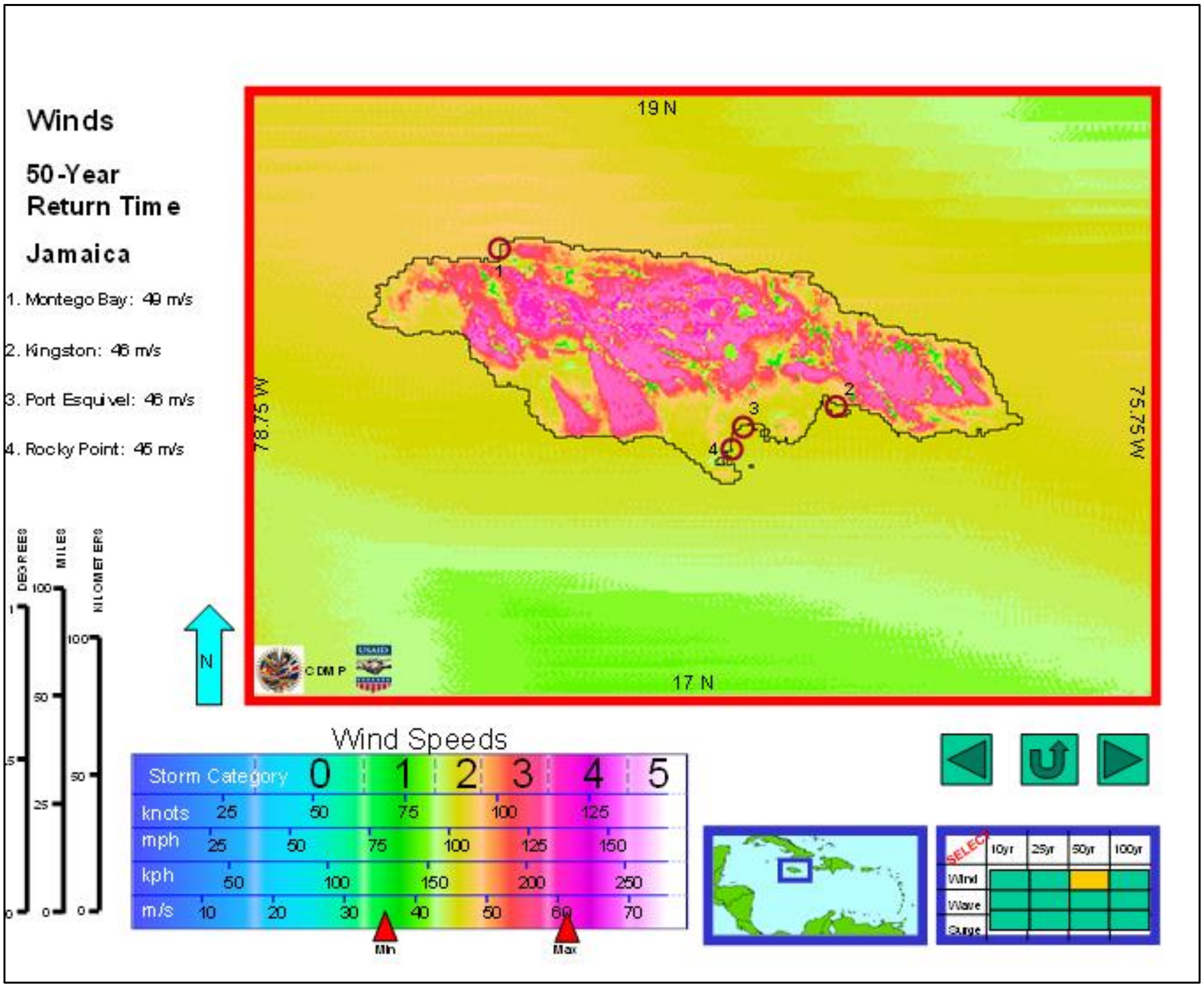

FIGURE 5-127: WIND MAP FOR JAMAICA WITH 50 YR RETURN PERIOD. MAXIMUM SUSTAINED WINDS 49 M/S

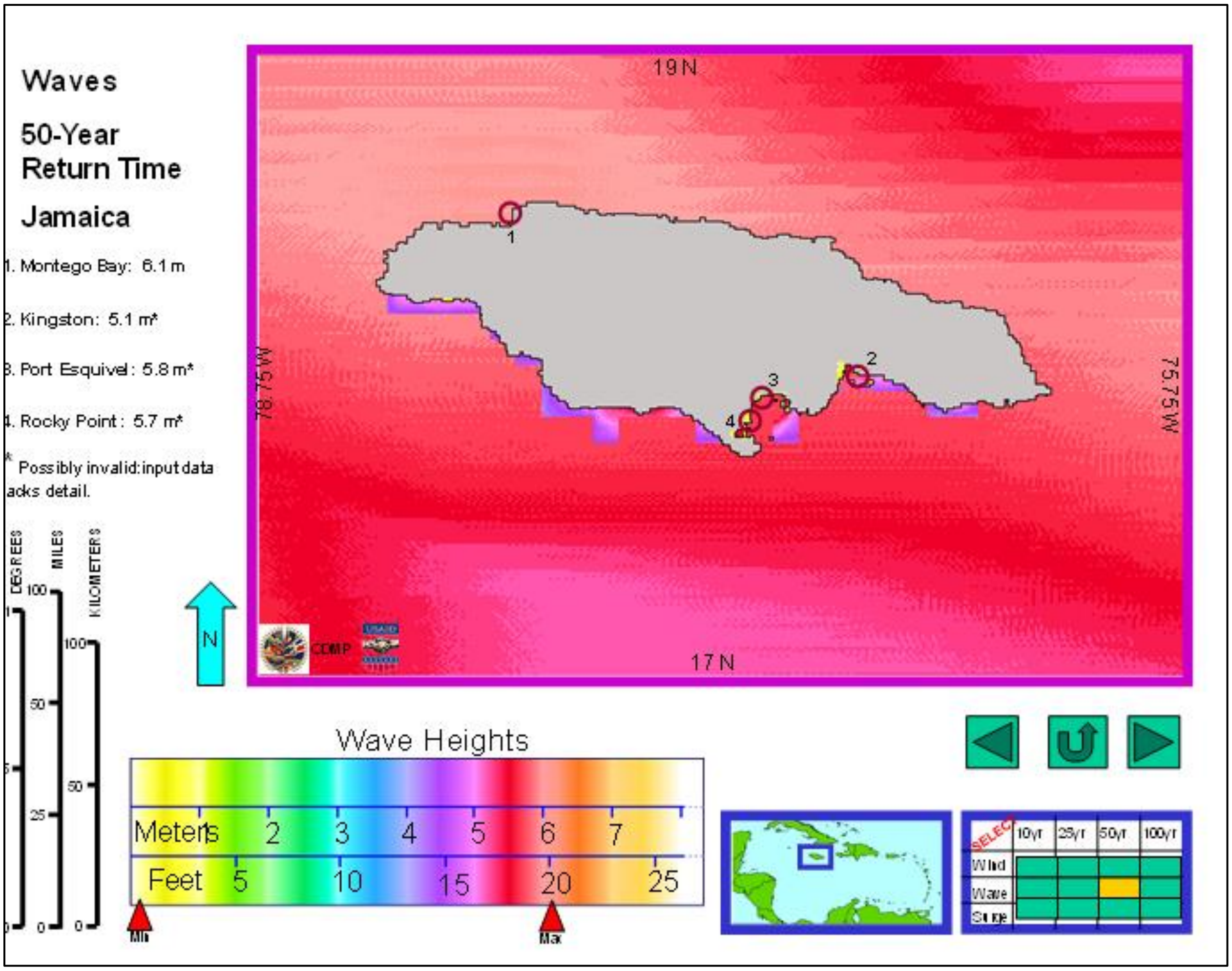

FIGURE 5-128: WAVES 50 YEAR RETURN TIME

6 Socio-economic Environment and Public Participation

6.1 Socio-economic Environment

This section provides a detailed description of the existing socio-economic conditions of the study area. The demographic, housing, and economic characteristics of the study area (zone of influence/ impact zone) surrounding the Sandals Montego Bay project site, and the parish of St. James, are presented.

6.1.1 Demography and Housing

Population – Population data from the Statistical Institute of Jamaica (STATIN), and the Planning Institute of Jamaica (PIOJ) indicate that at the end of 2022, the parish of St. James had an estimated 192,300 persons (**Table 6-1**). The current figure represents a 4.2% growth over the 2011 census population figure of 183,719 persons. The parish presently accounts for 7.0% of Jamaica's total population (STATIN, 2019; PIOJ, 2022).

TABLE 6-1: POST 2011 CENSUS POPULATION - NATIONAL AND PARISH 2015-2022

Parish	2015	2016	2017	2018	2019	2022P	% of country population (2022)
Jamaica	2,719,471	2,721,665	2,725,883	2,730,983	2,734,093	2,738,100	100.0
St James	188,237	189,041	189,885	190,915	191,737	192,300	7.0
Revised 2015-2019; preliminary 2022 projected by PIOJ							

St. James is home to Jamaica's second largest city Montego Bay, where 60.0% of the parish's population are found. Montego Bay is the capital of St. James and the parish's only urban center. The city had a population of 110,115 persons in 2011, a 14.1% growth from the 96,477 persons residing in the city in 2001 (Statin, 2012). Assuming the proportion of population in urban centers in the parish of St.

James remains at 60%, the population of Montego Bay is estimated to be 115,187 persons based on the PIOJ's 2022 preliminary end of year population (**Table 6-2**).

The project site is located within the city of Montego Bay. According to the 2011 census data, the population within a 5km radius of the project site is 86,588 (STATIN, 2012). Approximately 6,889 of those persons can be found within a one-mile radius of the project site. Estimates for 2022 (assuming proportions remain constant) show approximately 88,587 persons with the 5-mile radius and 7,206 persons within a one-mile radius of the site.

Sex – Disaggregation of the population by sex shows the parish has 96.9 males for every 100 females (**Table 6-2**). This parish sex ratio is lower than the national sex ratio but higher than that for the city of Montego Bay, which has 93.4 males per 100 females. Females account for an estimated 51.5% of the total population residing in the impact zone. The data shows that there are approximately 94.1 males for every 100 females in the impact zone.

TABLE 6-2: POPULATION SEX DISTRIBUTION, 2011

Parish/ Community	Total	Male	Female	Sex Ratio (males per female 100)
Jamaica	**2,697,983**	**1,334,533**	**1,363,450**	**97.9**
St. James	183,811	90,450	93,361	96.9
Montego Bay	110,207	53,212	56,995	93.4
Designated Impact Zone of the Sandals Montego Bay Site (1 km)				
Total Zone of Influence	6,889	3,339	3,550	94.1

Age Distribution – Based on the age distribution data from the 2011 census, 27.0% of the total population of the parish of St. James is under the age of 15; 65.8% is between the age of 15 and 64; and 8.1% are 65 and over (**Table 6-3**). The pattern for the city of Montego Bay is similar to the islandwide mean with 26.1% under the age of 15 years; 66.0% in the active economic years of 15 and 64; while 7% is over 64 years.

TABLE 6-3: POPULATION DISTRIBUTION BY AGE AND SEX, 2011

	Age Group					
	Under 15 Years	**15-29**	**30-44**	**45-64**	**65+**	**Total**
Jamaica						
Male	357,083	374,844	259,921	241,187	100,709	1,333,744
Female	345,750	376,537	283,040	240,474	117,513	1,363,314
Total by Age	702,833	751,381	542,961	481,661	218,222	2,697,058
Percent by Age	26.1%	27.9%	20.1%	17.9%	8.1%	100.0%
St. James						
Male	25,357	25,972	17,795	15,255	5,989	90,368
Female	24,234	27,218	20,168	14,804	6,928	93,352
Total by Age	49,591	53,190	37,963	30,059	12,917	183,720
Percent by Age	27.0%	29.0%	20.7%	16.4%	7.0%	100.0%
Montego Bay						
Male	14,708	15,454	10,726	8,938	3,302	53,128
Female	14,034	16,795	12,747	9,277	4,134	56,987
Total by Age	28,742	32,249	23,473	18,215	7,436	110,115
Percent by Age	26.1%	29.3%	21.3%	16.5%	6.8%	100.0%
Zone of Influence						
Male	999	1,028	630	513	169	3,339
Female	983	1,042	739	550	236	3,550
Total by Age	1,982	2,070	1,369	1,063	405	6,889
Percent by Age	28.8%	30.0%	19.9%	15.4%	5.9%	100.0%

*- The difference in the population totals provided in Table 3.5 is as a result of the method used by STATIN to calculate its data. Data entered with a decimal place higher than 0.5 is generally rounded up to 1 to calculate total. The updating of census data between published reports also adds to the difference.

The age group distribution pattern in the impact zone varies from the patterns observed for the parish and the city of Montego Bay. The zone of influence has a younger population with 28.8% of the total population under the age of 15; approximately 65.4% are between the age of 15 and 64, while 5.9% is 65 and over (**Table 6-3**).

In 2011, the parish of St. James had a total dependency ratio of 55.6, similar to the national ratio of 51.9. The city of Montego Bay had a lower age dependency ratio of 48.9; however, the age dependency ratio for the impact zone is higher at 53.0. This figure is approximately 12% lower than the parish figure and close to 6% lower than the national figure (STATIN, 2013).

The PIOJ (2023) computed the current national dependency ratio based on the 2022 population estimates at 44.1. This indicates that for every 100 working age individuals, there are 44.1 dependents (children <15, and elderly >65) per 100 persons, suggesting ratio of 43.8 for the parish of St. James and 45.3 for the Impact zone.

Housing and Tenure – St. James according to the 2011 census, has 58,690 dwelling units, which accounts for 6.9% of the total number of dwelling units in Jamaica (**Table 6-4**). More than half (54.6%) of the parish's dwelling units is in Montego Bay. Similar to the number of dwellings, 54.6% of the parish's 60,332 households are in Montego Bay. The average household size in the parish is 3.0, lower than both the national. Household size in Montego Bay and the impact zone is higher at 3.3 and 3.6, respectively (**Table 6-4**).

TABLE 6-4: HOUSING DATA, 2011

Parish	Number of Dwelling Units	Number of Households	Household Size
	2011	2011	2011
Jamaica	853,668	881,089	3.1
St. James	58,690	60,332	3.0
Montego Bay	32,046	32,953	3.3
Impact Zone	-	1,896	3.6

Census data shows that home ownership is the most popular tenure type at the national, parish and local level. An estimated 60.6% of Jamaican households owned the dwelling they occupied in 2011

(**Table 6-5**). At the parish level, ownership is higher with 65.9% of all households in St. James owning the units they occupied. In Montego Bay, 61.8% of households reportedly owned their units in 2011. Rented was the second most common tenure type in the city accounting for 28.8% of households. Some 7.7% reported living rent free.

TABLE 6-5: HOUSING TENURE, 2011

Tenure of Dwelling	Owned	Leased	Rented	Rent Free	Squatted	Other	Not Stated	Total
Jamaica	534,334	15,074	176,867	136,835	8,834	1,163	7,930	881,037
St. James	39,735	558	12,479	6,865	174	48	472	60,330
Montego Bay	19,750	203	9,206	2,462	71	27	234	31,953

6.1.2 Utilities and Services

Water - The National Water Commission (NWC) is the major supplier of water across Jamaica, producing more than 90% of Jamaica's potable water. More than 70% of water is supplied via house connections and the remaining is supplied using standpipes, water trucks, wayside tanks etc. Small providers, including the Four Rivers Development Company (FRDC) produce and supply less than one percent (1%) of the nation's water. The 2021 ESSJ (PIOJ, 2017) estimates that 62.6% of Jamaica's households have access to piped water.

The National Water Commission (NWC) supplies water to approximately 74% of St. James population. According to the draft St. James Water Sector Plan (2011), surface water sources supply 68% of total production for the parish. The main surface sources are Great River, Niagra River, Sevens River, Tangle River, and 8 springs. Ground water provides 32% of the parish's water, with the major ground water sources being the Caanan, Catherine Mount, Irwindale, Porto Bello, Fairfield, and Pitfour Wells. Approximately 13.71 million gallons per day (mgd) is supplied via these sources.

Montego Bay is within the Great River Demand Zone, which obtains its water from the Great River, and the Catherine Mount#2 Demand Zone which obtains its water from the Catherine Mount Well.

Water for domestic use is acquired from public and private sources. In St. James, 60.9% of households had water piped into their dwelling from a public source, while 5.0% had water piped into their dwelling from a private source (Statin, 2011).

Electricity - According to the 2011 Census, an estimated 94.0% of households had access to electricity in the parish of St. James. This figure is approximately one percentage point below national level figures (**Table 6-6**). Electricity coverage data, showed that within Montego Bay and the impact zone, coverage as 96.4% - 98.1% of households.

TABLE 6-6: ACCESS TO ELECTRICITY

Parish/Community	Number of Households	Electricity	Electricity (%)
Jamaica	881,089	809,746	91.9
St. James	60,330	56,678	93.9
Montego Bay	32,953	31,769	96.4
Impact Zone (1 km)	1,889	1,854	98.1

Source: Statin, 2013

Sewage - The NWC operates nearly 100 sewage treatment plants island wide, collecting wastewater from approximately 25% of the Jamaican population. The NWC currently operates one treatment plant with a capacity of 1.5 mgd, in Montego Bay, which serves the city. The Rose Hall Sewage Treatment Plant also serves the Montego Bay area, particularly hotels, resorts, and commercial establishments located at Rose Hall and environs.

Solid Waste Services - WPM Waste Management Limited (WPM) is responsible for the collection and disposal of solid waste from the communities within the impact zone. The WPM serves the parishes of St. James, Hanover, Westmoreland and Trelawny.

Jamaican households generate on average 2.7 million kilograms (kg) of solid waste on a daily basis.[11] The parish of St. James generates approximately 183,719 kg of solid waste daily. St. James accounts

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[11] Domestic garbage generation is calculated at the average waste generation rate of 1kg/person/day identified in the 2013 waste composition study by the National Solid Waste Management Authority.

for six percent (6.8%) of all solid waste generated daily in Jamaica. In the impact zone, approximately 6,889 kg of solid waste is generated daily based on average waste generation rates for Jamaica.

Health Services – The parish of St James is served by one public hospital and 24 health centres. The Cornwall Regional Hospital is a Type A facility with a 400-bed capacity, which provides primary and secondary health care services, including most of the specialist services. Montego Bay communities are served by the

- Cornwall Regional Hospital
- Montego Bay Comprehensive Referral Center
- Hospiten Montego Bay (a private hospital network with a 27-bed capacity)

Educational Institutions – According to the Ministry of Education School Statistics 2018-2019 (MOE, 2019) the parish of St. James has 59 public education institutions and 90 independent educational institutions, beginning at the early childhood/infant level through to the tertiary level. The city of Montego Bay is served by 138 public educational institutions. There are 18 public schools listed in Montego Bay in the MOE's database.

Emergency Protection Services – The parish of St. James is served by 12 police stations and 2 fire stations. The Summit, Coral Gardens and Montego Hills Police Stations, and the Ironshore and Montego Bay Fire Stations are the primary providers of policing and emergency services respectively to the communities located closest to the site and the impact zone.

Community Organisations – The impact area is served by several community citizen associations, youth groups, non-profit organisations and charities, including the Sandals Foundation.

Communication Technology – Flow and Digicel are the major providers of telecommunication services across Jamaica. Both telecommunication companies provide cellular and fixed line services to the communities within the social impact zone. Internet service is also provided via these two major communication companies.

6.1.3 Economic Baseline

6.1.3.1 Macro Economy (National and Parish)

The Jamaican economy achieved a 5.2% increase in Real Value Added, at a recorded value of $774,342.4 million JMD for 2022, relative to 2021 (PIOJ, 2023). The PIOJ stated that this "growth was a continuation of the economic recovery following the negative effects of COVID-19 in 2020. Growth was driven by real increases in the Services Industry (6.1%), and the Goods Producing Industry (2.1%).", which resulted in an increase in demand and supply of goods and services." All industries increased except for Mining and Quarrying which was impacted by the closure of an alumina plant and slowdown in civil engineering activity. Producers of Government Services reportedly remained flat.

The Goods producing sectors account for 26.0% of total GDP in 2022 (**Table 6-7**). The Manufacturing Industry is the highest earner for the goods producing sector, averaging total GDP contribution of 8.8% annually over the last 5 years. In 2022, goods production sectors earned an estimated $645 billion, a 12.6% increase relative to 2021 earnings (PIOJ, 2023). Agriculture, Forestry & Fishing as well as the Construction sector were the second highest contributors accounting for 7.7% and 7.6%, respectively, over the last 5 years.

The Service Industry accounted for 78.7% of total GDP in 2022. The sub group titled Wholesale & Retail Trade, Repair and Installation of Machinery was the highest earner for the goods producing sector, averaging total GDP contribution of 17.6% annually over the last 5 years. In 2022, services sector earned an estimated $1,619 billion, a 19.0% increase relative to 2021 earnings.

The Hotels and Restaurants sector account for 5.9% of total GDP in 2022, an increase from 4.2% in 2021. According to the PIOJ (2023), the improvement resulted from increased visitors to hotels and other accommodations in the Hotels sub-industry. The sector averaged total GDP contribution of 5.1% annually over the last 5 years.

TABLE 6-7: GROSS DOMESTIC PRODUCT CONTRIBUTION BY INDUSTRY

	Unit	2018	2019	2020	2021	2022
Goods Producing Industry	%	**25.7**	**25.3**	**26.8**	**26.8**	**26.0**
- Agriculture, Forestry & Fishing	%	7.1	7.1	7.8	8.0	8.3
- Mining & Quarrying	%	2.7	2.4	2.1	1.5	1.0
- Manufacturing	%	8.6	8.6	9.1	8.9	9.0
o Food, Beverage & Tobacco	%	5.0	5.0	5.3	5.2	5.4
o Other Manufacturing	%	3.6	3.6	3.8	3.7	3.7
- Construction	%	7.3	7.2	7.9	8.2	7.6
Services Industry	%	**78.4**	**78.9**	**78.0**	**78.0**	**78.7**
Electricity & Water	%	3.1	3.1	3.3	3.2	3.1
Transport, Storage & Communication	%	11.0	10.9	10.7	10.8	10.9
Wholesale & Retail Trade, Repair, and Installation of Machinery	%	17.2	17.2	17.5	17.9	18.0
Finance & Insurance Services	%	11.1	11.4	12.2	11.9	11.4
Real Estate, Renting & Business Activities	%	10.6	10.5	11.4	11.1	10.7
Producers of Government Services	%	12.4	1.4	13.8	13.2	12.5

Source: PIOJ, various years

Labour Market – The labour force consists of persons 14 years and over. In 2023, Jamaica's labour force had an estimated 1,377,600 persons, an increase of 1.5% relative to 2022 figures (**Table 6-8**). In 2023, the labour force participation rate stood at 65.5%, up 0.8 per cent over 2022 levels. Males accounted for 53.6% of the total labour force in 2023 and had a participation rate of 69.5%. The number of females joining the labour force increased by 1.1% over 2022 levels, while there were 1.8% more males entering the labour force in 2023, compared to 2022.

TABLE 6-8: JAMAICA LABOUR FORCE 2019-2023

	2019	2020	2021	2022	2023
Labour Force	**1,349,000**	**1,297,700**	**1,328,700**	**1,357,700**	**1,377,600**
Male	727,600	704,600	714,800	726,000	738,900
Female	621,400	593,100	613,900	631,700	638,700

Participation rate	**64.6**	**62**	**63.4**	**64.7**	**65.5**
Male	71.0	68.6	69.5	70.5	69.5
Female	58.5	55.6	57.5	54.3	56.4
Total Employment	**1,244,900**	**1,158,200**	**1,234,800**	**1,268,000**	**1,320,400**
Male	685,300	643,300	675,900	688,500	715,900
Female	559,700	514,900	558,900	579,500	604,500
Total Unemployment rate (%)	**7.7**	**10.7**	**7.1**	**6.6**	**4.2**
Male (%)	5.8	8.7	5.4	5.2	3.1
Female (%)	9.9	13.2	9.0	8.2	5.4

Source: PIOJ, Statin, various years

In terms of actual employment, 54.2% of the labour force currently employed consists of males. However, the number of females gaining employment increased at a faster rate when compared to males. Female employment increased by approximately 4.3%, while males increased by 4.0% in 2023. Overall employment grew locally by 4.1% in 2023 compared to 2022. In 2022, 95.8% of the total labour force was employed, resulting in a 2.4 percentage point decline in the unemployment rate between 2022 and 2023.

At the end of 2023, the unemployment rate stood at 4.2%. The unemployment rate for males was 3.1% at the end of 2023, compared to 5.2% in 2022; a 2.1 percentage point decline over the one-year period. The female unemployment rate saw a slightly higher decline when compared to their male counterparts over the same period, recording a 2.8 percentage point decline. At the end of 2023 the female unemployment rate was 5.4%, compared to 8.2% in 2022.

Poverty – According to STATIN, approximately 16.7% of Jamaicans lived in poverty[12] in 2021 (PIOJ, 2023). The figure represented a 51.8% increase over 2019 figures (**Table 6-9**). The Greater Kingston

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[12] Poverty in Jamaica is defined using a consumption based methodology. The poverty line is calculated on the value of the basic food basket which includes food and non-food items e.g. education, transportation etc. The value of the food basket changes each year. In 2012 the food basket had an adult equivalent per year value of $143,686.90. The approach is different from that of the World Bank which uses an income based approach and defines poverty line as the number of persons earning less than US$2.50 per day.

Metropolitan Area (GKMA) and Other Urban Centers (OUC) had poverty rates, 60.6% and 7.7% lower than the national rate. Rural Areas however had poverty rates 24.4% higher than the national rate in 2021.

TABLE 6-9: INCIDENCE OF POVERTY BY REGION

Region	2017^r	2018	2019	2021
Kingston Metropolitan Area	17.1	9.2	4.7	10.4
Other Urban Centers	19.8	12.0	13.4	15.5
Rural Areas	20.2	15.0	14.2	22.1
Jamaica	19.3	12.6	11.0	16.7
^{r} - revised				

Source: PIOJ, 2022

At the parish level, 2012 data shows that the parish of St. Thomas had the highest poverty rate at 32.5%, while St. Mary had the lowest at 9.4% (**Table 6-10**). The parish of St. James has one of the lowest poverty rates in Jamaica. The parish's poverty rate is 11.2%. The parish witnessed a 31.8% increase in its poverty rate in the 4-year period between 2008 and 2012.

TABLE 6-10: POVERTY RATE BY PARISH IN JAMAICA, 2008 AND 2012

Parish	**2008**	**2012**
Hanover	**15.5**	**10.8**
Westmoreland	**10.7**	**18.9**
St. James	**8.5**	**11.2**
St. Elizabeth	**30.6**	**23.8**
Trelawny	**19**	**13.2**
Manchester	**15.3**	**22.5**
Clarendon	15	19.3
St. Ann	12.5	18.4
St. Mary	**21.3**	**9.4**
St. Catherine	7.5	24
St. Andrew	**8.7**	**17.7**
Portland	**17.3**	**21.5**

Kingston	**14.5**	**28.6**
St. Thomas	**14.4**	**32.5**

Source: PIOJ, 2015

Agriculture, Forestry and Fishing – The Agriculture, Forestry & Fishing industry accounted for 8.3% of Total Gross Domestic Product (GDP) in 2022, an increase of 0.3 percentage points compared to 2021. Earnings from Agriculture Exports were valued at US$81.2 million in 2022, compared with US$80.4 million in 2021 (PIOJ, 2023). According to the PIOJ, the increase was attributed to gains in several sub-industries, mainly coffee, other fruit and beverage crops, and other agriculture exports.

The Agriculture, Forestry and Fishing sector had a decline in the number of persons employed in 2022. An average of 183,400 persons was employed in the Agriculture, Forestry & Fishing industry in 2022, a decrease from the 191,600 employed in 2021. The industry employs 14.5% of the total employed labour force; 80.3% males and 19.7% females.

Fishing production was estimated to have increased by 6.2% despite adverse conditions such as weather conditions, influx of Sargassum seaweed, fish-kills due to pollution or climate impacts, as well as destruction of fishing grounds due to anchorage by ships, among other factors. In 2022, there were 34,605 registered fisherfolk operating 9,780 registered vessels from the 187 fishing beaches and two cays. This was an increase from the 28,334 registered fisherfolk and 8,508 registered vessels operating on 2021 from the same locations. Fish and Fish Product exports totaled US$708,000 in 2022; a 40.4% decrease from US$1,324,000 in 2021.

Data from the Rural Agricultural Development Authority's (RADA) Agricultural Business Information System (ABIS) indicated that there are currently a total of 254,486 registered farmers in Jamaica (

Table 6-11). The parish of St. James accounts for 5.2% with 11,616 registered farmers. Registered fisherfolk account for and 4.6% or 1083 in 2015.

TABLE 6-11: POVERTY RATE BY PARISH IN JAMAICA, 2008 AND 2012

PARISH	# REGISTERED FARMERS (2021)	% SHARE	# REGISTERED FISHERMEN (2015)	% SHARE
CLARENDON	32,335	14.6	2,226	9.5
HANOVER	7,221	3.3	707	3.0
KINGSTON & ST. ANDREW	11,153	5.0	4,317	18.4
MANCHESTER	33,983	15.3	521	2.2
PORTLAND	12,235	5.5	1,577	6.7
ST. ANN	26,157	11.8	1,223	5.2
ST. CATHERINE	24,258	10.9	2,651	11.3
ST. ELIZABETH	38,212	17.2	1,301	5.5
ST. JAMES	11,616	5.2	1,083	4.6
ST. MARY	13,366	6.0	1,078	4.6
ST. THOMAS	17,507	7.9	1,461	6.2
TRELAWNY	11,810	5.3	601	2.6
WESTMORELAND	14,633	6.6	2,687	11.4
UNKNOWN	-	-	1,109	4.7
OFFSHORE BANK	-	-	981	4.2
TOTAL	222,151	100.0	23,523	100.0

Source: RADA, MOAF, various years

Tourism – In 2022, the Hotel and Restaurant Industry accounted for 5.9% of Jamaica's Gross Domestic Product (PIOJ, 2023). The sector earned in excess of US$3,621 million, an increase of US$1,523.3 million relative to 2022 and employed an estimated 109,700 persons; 8.0% of Jamaica's total labour force (**Table 6-12**). The sector continues to recover from the effects of COVID-19 that resulted in a 65.5% decrease in earnings in 2020 compared with 2019. Since 2020, annual earnings increased by 66.8% and 72.8% in 2022 and 2023, respectively. The number of persons employed in the sector also increased by 15% in 2022 compared to 2021.

TABLE 6-12: TOURISM FOREIGN EXCHANGE EARNINGS

Year	Direct GDP (%)	Earnings (US$M)	Employment	% of total Labour Force
2018	6.0	$3,305.5	100,500	7.5
2019	6.2	$3,643.9	108,000	8.0
2020	3.2	$1,256.0	90,800	7.0
2021	4.2	$2.095.1	95,300	7.2
2022	5.9	$3621.4	109,700	8.0

Source: Jamaica Tourist Board and PIOJ, various years

Jamaica had an approximate room capacity (accommodation) of 28,400 rooms in 2015/2016 and an average hotel room occupancy rate of 69 per cent. The resort town of Montego Bay accounts for 25% of total room capacity in Jamaica, with approximately 7,304 rooms.

Tourist Arrivals – In 2022, approximately 2.5 million tourists visited Jamaica. Stopover visitors accounted for the majority (74.4%) of total visitors to the island (

Table 6-13).

Examination of tourist arrival data covering the period 2016-2018, showed that the total number of tourists arriving in Jamaica increased by an average 5.4% annually. There was a 2% decrease in total visitors, due to a decline in cruise arrivals followed by a 68.6% decrease in 2020 due to public Physical Health and Social Measures (PHSM) in response to COVID-19. Recovery is evident in the subsequent increases in total tourist arrivals in 2021 (15.5%) and 2022 (117.0%).

TABLE 6-13: JAMAICA TOURIST ARRIVAL, 2016-2022

Year	Cruise Passenger	Cruise % change	Stopover	Stopover % change	Total	% change
2016	1,656,151	**5.5**	2,181,684	**2.8**	**3,837,835**	**3.9**
2017	1,923,274	**16.1**	2,352,915	**7.8**	**4,276,189**	**11.4**
2018	1,845,873	**-4.0**	2,472,727	**5.1**	**4,318,600**	**1.0**
2019	1,552,346	**-15.9**	2,680,920	**8.4**	**4,233,266**	**-2.0**
2020	449,271	**-71.1**	880,404	**-67.2**	**1,329,675**	**-68.6**
2021	70,766	**-84.2**	1,464,399	**66.3**	**1,535,165**	**15.5**
2022	852,294	**1104.4**	2,478,386	**69.2**	**3,330,680**	**117.0**

Source: Jamaica Tourist Board, PIOJ, various years

Stopover visitors have consistently accounted for the larger proportion of tourist arrivals in Jamaica over the years. The group accounted, on average, for over 65.0% of total tourist visitors annually to the island from 2016-2022. The number of visitors in this group has increased annually, with average per annum growth recorded at 6.0% between 2016 and 2019. There was a drastic decrease in 2020 (67.2%) followed by increases of over 66.0% annually in 2021 and 2022 **(**

Table 6-13).

In 2022, an estimated 0.852 million cruise passengers visited the island. The figure represented a 1,104% increase over 2021 levels. This drastic increase follows four consecutive years of declines in cruise passenger arrivals, the largest decline being 84.2% in 2021 when only 70,766 cruise passengers arrived compared to 449,271 in 2020 and 1.55 million in 2019.

Tourist Expenditure –

In 2022, visitors spent an estimated US$3.6 billion; a 72.9% increase over 2021 spending of US$2.1 billion. The 2022 expenditure represents a return to pre-COVID spend levels which averaged US $3.13 billion for the period 2016-2019 **(Table 6-14)**

With an average length of stay for Foreign Nationals at 8.1 days and 17.3 for Non-Resident Jamaicans, stopover tourists accounted for approximately 97.5% of gross visitor spending in 2022. Since 2016, stopover visitors spending has been on a general increasing trend except for the decrease observed during COVID-19 when spending declined by 65.5% in 2020, compared with 2019. There was, however, an immediate recovery in 2021 with a 66.8% increase in spend of US$2.095 billion (**Table 6-14**)

TABLE 6-14: JAMAICA TOURIST EXPENDITURE 2016-2022

	Tourist Expenditure (US$)				
	All tourist	**Stopover**	**Cruise Passengers**	**Stopover (avg. per person)***	**Cruise passenger (avg. per person)***
2016	$2.609bn	$2.372bn	$0.150bn	$134	$90
2017	$3.010bn	$2.828bn	$0.017bn	$149	$93
2018	$3.305bn	$3.121bn	$0.184bn	$162	$100
2019	$3.639bn	$3.483bn	$0.107bn	$169	$102
2020	$1.256bn	$1.210bn	$0.455bn	$140	$101
2021	$2.095bn	$2.087bn	$0.007bn	$147	$101
2022(prelim. est.)	$3.62bn	$3.53bn	$0.092bn	$133	$108
*average per person per night			bn-billion		

Source: Jamaica Tourist Board and PIOJ, various years

While cruise passengers do not account for a significant portion of gross visitor expenditure, the group has drastically increased their average per annum spending from USD7.1 million in 2021 to US$92.1 million in 2022 (**Table 6-14**). Despite the declining trends in gross cruise visitor expenditure over a 4-year period 2018 -2021, the average daily spending per person by cruise passengers has remained relatively consistent at US$100-$102 per person per day. The average daily-spend however increased by 7.0% to US$108 in 2022. The average daily spending by stopover tourists decreased by 10.0% to US$133 in 2022 from $147 in 2021.

6.1.3.2 Micro Economy (Montego Bay/ Local)

Local Tourism – The parish of St. James is home to Jamaica's second largest city, Montego Bay. Tourism is the main foreign exchange earner for the parish, and over 80% of the entire parish of St. James is dependent on the tourism industry, according to the Ministry of Local Government and Community Development's (MLGCD) website. Montego Bay is also described as the tourism capital of Jamaica and a cosmopolitan holiday center, boasting the most hotel accommodation, transport facilities, and offering a wide choice of amenities.

Jamaica had an approximate room capacity (accommodation) of 21,086 rooms in 2021 and an average hotel room occupancy rate of 44.4 per cent. The resort town of Montego Bay accounts for 40.2% of total room capacity in Jamaica, with 8,468 rooms in 2021 (**Table 6-15**). This room capacity represents a 46.5% increase from the 5,782 capacity in 2020, but an 11.6% decrease from 9,578 in 2019 (pre COVID-19 PHSM). Montego Bay's occupancy rate was 48.3% in 2021, which was 9.6 percentage points lower than the 2020 rate (38.7%), and 20.6 percentage points lower than pre COVID-19 PHSM, averaging 68.9% for the period 2018-2019.

TABLE 6-15: TOURISM STATISTICS – MONTEGO BAY

Montego Bay	**2018**	**% share**	**2019**	**% share**	**2020**	**% Share**	**2021**	**% Share**
Employment (accommodation)	22,081	43.8%	22,367	43.7%	10,796	35.2%	14,539	32.2%
Room capacity	9,277	39.3%	9,578	40.6%	5,782	36.8%	8,468	40.2%
Occupancy rate	68.7	-	69.1	-	38.7	-	48.3	-
Stopover Tourist	2,012,381	81.4%	2,137,245	79.7%	696,754	79.1%	1,209,341	82.6%
Us stopover visitors	608,667	37.4%	712,330	38.7%	235,428	36.9%	511,398	40.0%

Montego Bay	2018	% share	2019	% share	2020	% Share	2021	% Share
Canadian stopover visitors	139,972	35.0%	134,494	34.0%	43,168	20.0%	18,736	27.9%
Cruise arrivals	512,563	27.8%	390,665	36.4%	100,248	22.3%	4,846	6.8%

Source: Jamaica Tourist Board and PIOJ, various years

In terms of visitor numbers, Montego Bay, for the period 2018-2021, accommodated on average 80.7% of total stopover visitors and 38.3% of US stopover visitors- the largest visitor market for Jamaica (**Table 6-15**). In terms of cruise passengers, Montego Bay received only 6.8% of cruise arrivals in 2021, a 15.5 percentage points decrease relative to 2020 arrivals.

Approximately 32.2% of the total number of persons employed in Jamaica's accommodation/hotel sector work in Montego Bay. In 2021, there were 14,539 persons directly employed in the accommodation sector (**Table 6-15**). While the number of persons employed in the accommodation sector in the city showed signs of recovery in 2021 increasing by 34.7% over 2020 numbers. The 14,539 persons employed however, continued to be well below (34.6%) numbers for 2018-2019.

6.1.3.3 Project Economy

Sandals Montego Bay is the first ever Sandals all-inclusive resort. The resort reportedly sits along the shoreline of the largest, exclusive white-sand beach in Jamaica and offers an array of accommodation types, amenities, entertainment and activities. The room capacity of the resort is 272. Sandals Resorts International (SRI) intends to expand and enhance this resort with:

- construction of eighteen (18) single-storey overwater bungalows;
- construction of ten (10) single storey villa-style units;
- beach improvements that will feature the construction of a sea wall, rock groynes, a rock revetment; and
- construction of boardwalks/linkways, a swimming pool, and a bar

The project will increase the room capacity of the resort to 290, representing 11% of Montego Bay's capacity. At a construction budget of US$9,000,000, this project will add 50 new permanent jobs to the industry after construction. Jobs created will include butlers, housekeepers, cooks, chef, landscaper, waiters, concierge representative and lifeguards.

6.1.4 Land Use & Zoning

Land use data was ascertained for land parcels within a 1km radius of the Sandals Montego Bay Resort. Same was done for land parcels outside of the said radius, including 2 km of the resort. Secondary sources were also used to inform land uses within the wider area.

Zoning – The project site and neighboring properties to the east and west (including the currently operating Sandals Montego Bay Resort) are zoned 'Resort' according to the St. James Parish Development Order (2018). The properties to the south across the Kent Avenue are zoned 'Airport & Airport Related'. The 2018 St. James Provisional Development Order notes that the tourism product is concentrated in Montego Bay, which apart from its white sandy beaches has a variety of hotel accommodations and entertainment opportunities; however, the Provisional Development Order acknowledges the fact that the rest of the parish of St, James offers other activities which appeal to tourists. On this note, the objectives (proposals) of the Order that relates to the proposed development are:

- To develop sustainable tourism initiatives through the improvement of tourist facilities, amenities and support services, thus diversifying the tourism infrastructure.
- Facilitate the development of a sustainable tourism industry while protecting the environment and factoring climate change considerations, thereby fostering a desirable ecological balance.
- To make provisions for the incorporation of small dexter and large-scale support services through development of non-traditional tourism products, thereby creating a broader economic base.
- To make provisions for the development of a full range of tourist attractions that complements the landscape and enhance cultural heritage.

As it relates to the urban economy, the 2018 Provisional Development Order seeks to maintain and enhance the competitiveness of business including encouraging tourism in Local Planning Areas such as the Greater Montego Bay Planning Area.

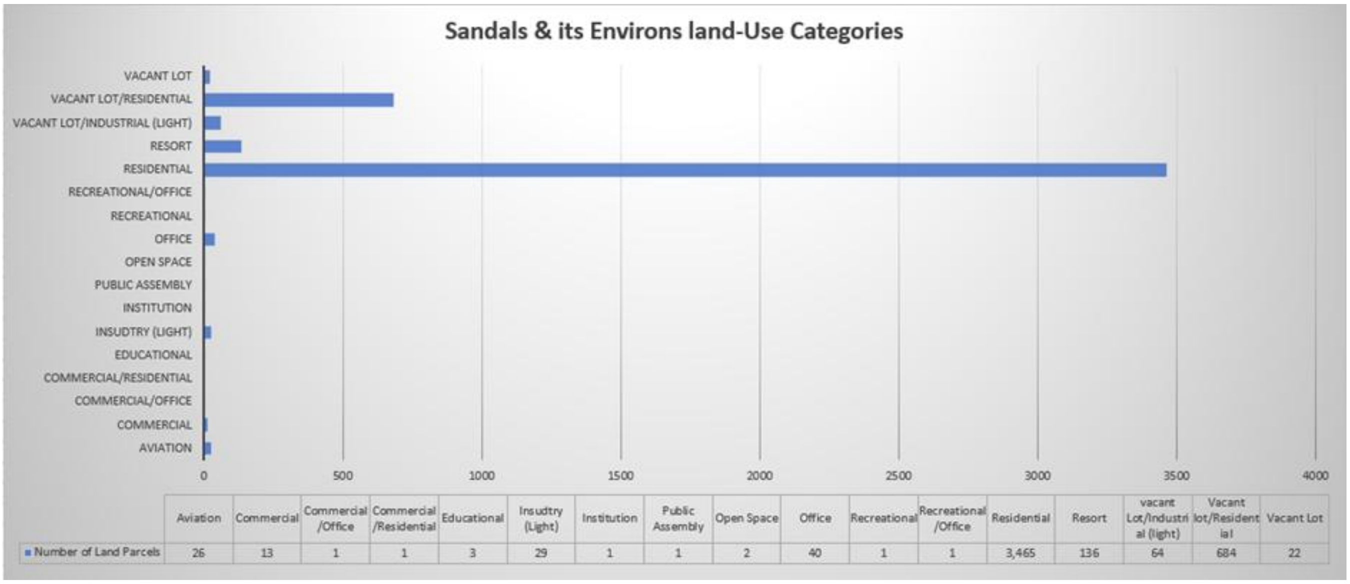
Land Use Findings – Onsite – The land use of the proposed site for the villa-style bungalows consists of a 2-ha vacant parcel of land that is covered in secondary coastal forest with two wetland areas and a concrete pool, while the site of the overwater bungalows is the Caribbean Sea (Figure 6-1). Access to the overwater bungalows extends from the eastern boundary of the existing Sandals Montego Bay Resort (resort land use category). The site is bordered to the west by a drainage gully beyond which is vacant land. To the north of the site is the Caribbean Sea, while the roadway – Kent Avenue borders the site to the south. Beyond Kent Avenue is the western end of the runway of Sangster International Airport.

FIGURE 6-1: PROPOSED PROJECT SITE - OCEAN AND VACANT LOT

Land use of wider project area - The land use categories identified within 1km, 2km and the wider environs of Sandals Montego Resort were residential, resort, civil aviation, commercial, industrial, institutional, office, 'inter alia'. The majority of land parcels within the select areas, 1 and 2 km from the subject site, were residential **(Figure 6-2)**.

Figure 6-2 represents the total number of land parcels visible on the land use map (1km, 2km and the wider area). According to the data presented, the residential land use category accounted for 77% of the total land parcels; this represented Three Thousand Four Hundred & Sixty-five (3,465) land parcels.

The vacant 'lot/residential' land use type was the second largest category, which commanded 15% of the total land parcels. This land use category accounted for Six Hundred and Eighty-four (684) parcels, which typically represents lands that were undeveloped but zoned for residential use.



	Aviation	Commercial	Commercial /Office	Commercial /Residential	Educational	Insudtry (Light)	Institution	Public Assembly	Open Space	Office	Recreational	Recreational /Office	Residential	Resort	vacant Lot/Industrial (light)	Vacant lot/Residential	Vacant Lot
■ Number of Land Parcels	26	13	1	1	3	29	1	1	2	40	1	1	3,465	136	64	684	22

Figure 6-2: land use categories within the wider environs of Sandals Montego Bay resort

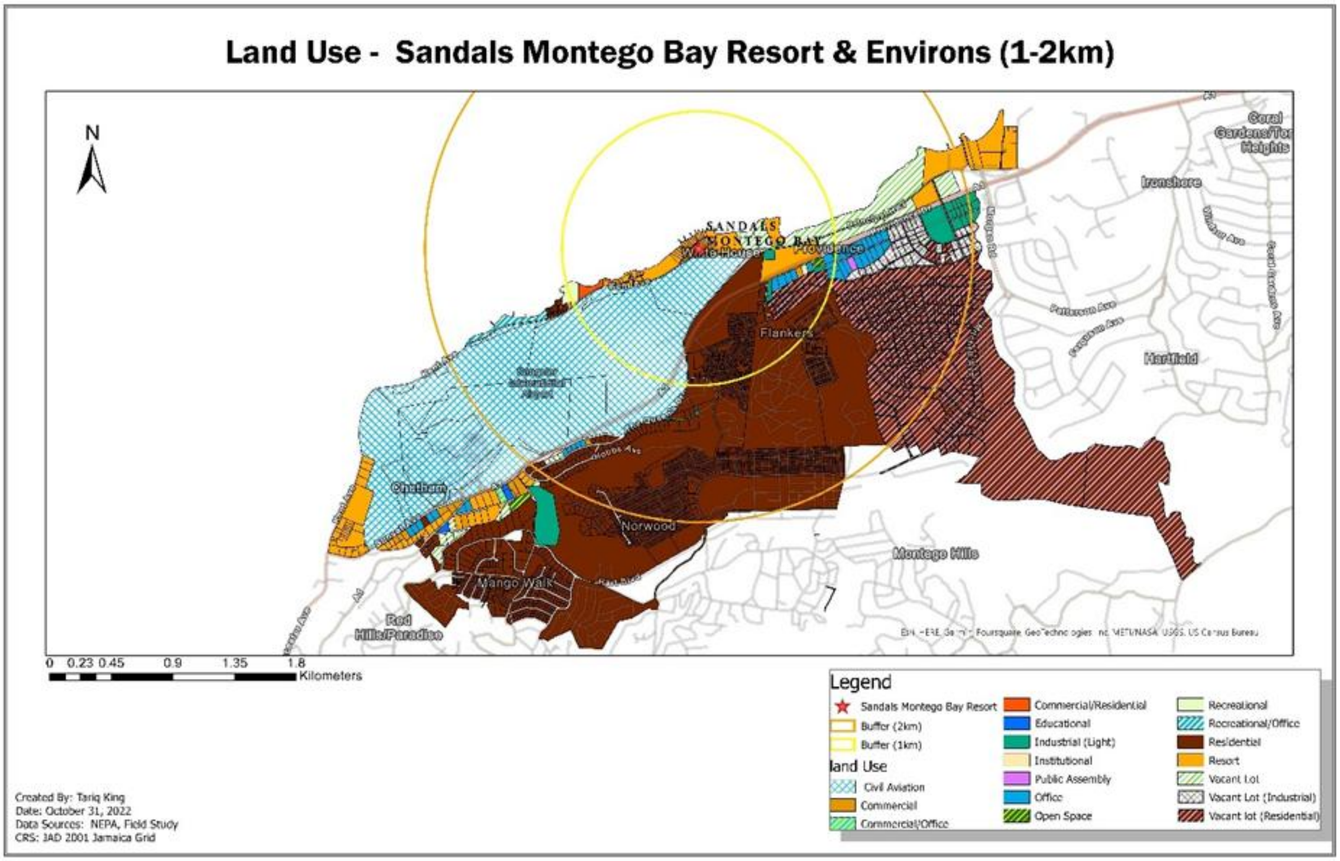
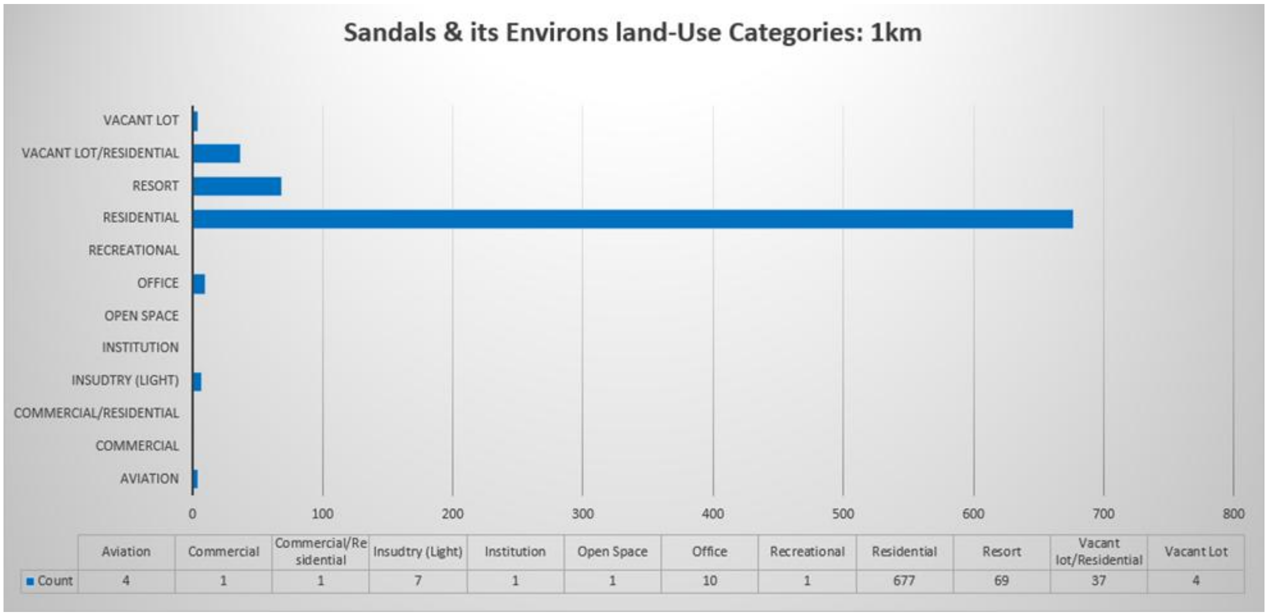


FIGURE 6-3: LAND USES WITHIN 1KM, 2KM AND THE WIDER AREA OF SANDALS MONTEGO RESORT

Land uses within 1km – The residential land use category was the predominant land use within 1km of the project location (**Figure 6-3**). This was by a considerable margin, commanding Six Hundred & Seventy-seven (677) land parcels, representing 83% of the subject land parcels. With Sixty-nine (69) parcels, the 'resort' land use group accounted for the second highest land use category. These properties were being used within the tourism industry. The third largest land use group was 'vacant lot/residential', which accounted for Thirty-seven (37) land parcels, 5% of the subject parcels (**Figure 6-4**).



	Aviation	Commercial	Commercial/Residential	Insudtry (Light)	Institution	Open Space	Office	Recreational	Residential	Resort	Vacant lot/Residential	Vacant Lot
■ Count	4	1	1	7	1	1	10	1	677	69	37	4

FIGURE 6-4: LAND USE CATEGORIES WITHIN 1KM OF THE SANDALS MONTEGO RESORT

6.1.5 Heritage & Cultural Resources

Introduction

The city of Montego Bay has a rich cultural heritage that dates back to the 18th Century when it was a small town. The town grew in size, population and importance as a center for commerce and trade along the coast after addition of lands from a new subdivision in the 18th Century that created Charles Square, now known as Sam Sharpe Square (St. James Municipal Council, 2016). Montego Bay is now the Jamaica's second city and the largest center for tourism on the island.

The cultural heritage and archaeological asset baseline assessment included a review of available literature on designated cultural and heritage sites that could be affected by project activities. The level of significance of any identified site was determined by its proximity to the Sandals Montego Bay property and project activities before, during and after construction. Data sources included the Jamaica National Heritage Trust Directory of Cultural Heritage Sites and the Mona Geoinformatics list of historical and important sites in the Parish of St. James. The list of sites from both sources were combined and a map generated to show selected sites with 5km and 10km buffers around the study site (**Figure 6-5**).

The Jamaica National Heritage Trust identified 23 designated National Heritage Sites within the Parish of St. James. Ten of these sites are located within a 5km radius of the Sandals Montego Bay property and project activities. Mona Geoinformatics identified an additional 34 sites categorised as "Historical Site and Important Location" within the city of Montego Bay.

Jamaica National Heritage Sites within 5km of the site

Fort Montego reportedly housed four 12 pounder guns and five smaller guns but was considered an "inefficient" fort as its location was deemed to be not strategic.

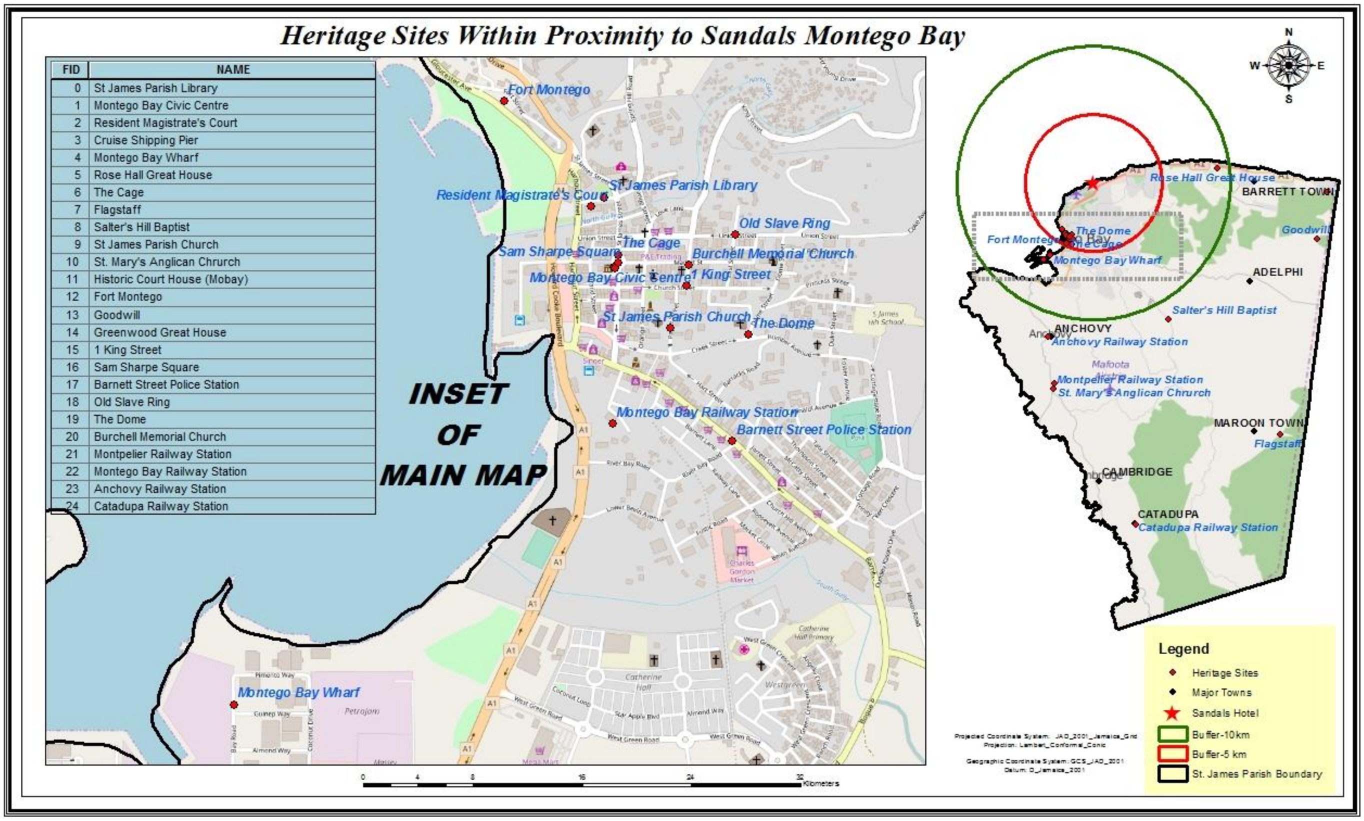
St. James Parish Church, built between 1775 and 1782 of white limestone. The church was severely damaged in the 1951 earthquake and was subsequently repaired with slight changes from the original Greek cross plan.

Sam Sharpe Square was a part of the 18th Century subdivision of Captain Barnett that created Charles Town and Charles Square. Charles Square was renamed in honour of national hero Sam Sharpe who was from Montego Bay in 1976 (JHNT, 2011). The square includes several heritage structures:

- ***the Sam Sharpe Monument*** consisting of five bronze statues depicting "Sam Sharpe holding a bible and speaking to the people unveiled in 1983" (JIS, 2018).
- ***the Cage*** described as "a gaol for enslaved Africans, disorderly seamen and vagrants" originally built in 1806 of wood and rebuilt with brick stone in 1822.
- the ***Historic Court House*** built in 1803 is noted as the court where many slaves including Sam Sharpe were sentenced to be hanged for participation in the 1831 Slave Rebellion (Emancipation Rebellion). The Court House was destroyed in 1968 but was restored in 2001

and now houses the ***Montego Bay Civic Center*** with a museum, art gallery, as well as performing arts and conferencing facilities.

- the ***Freedom Monument*** was reportedly "erected in 2007 to memorialise the enslaved persons who participated in the 1831-32 Emancipation War" (JNHT, 2011)
- ***Old Slave Ring*** is located at the corner of Union and East Streets in Montego Bay. The site is described as "a semi-circular arena-like structure with brick walls and was the site prospective buyers viewed slaves as they were paraded and auctioned" (JNHT, 2011).



FID	NAME
0	St James Parish Library
1	Montego Bay Civic Centre
2	Resident Magistrate's Court
3	Cruise Shipping Pier
4	Montego Bay Wharf
5	Rose Hall Great House
6	The Cage
7	Flagstaff
8	Salter's Hill Baptist
9	St James Parish Church
10	St. Mary's Anglican Chrurch
11	Historic Court House (Mobay)
12	Fort Montego
13	Goodwill
14	Greenwood Great House
15	1 King Street
16	Sam Sharpe Square
17	Barnett Street Police Station
18	Old Slave Ring
19	The Dome
20	Burchell Memorial Church
21	Montpelier Railway Station
22	Montego Bay Railway Station
23	Anchovy Railway Station
24	Catadupa Railway Station

FIGURE 6-5: SELECTED SITES WITH 5KM AND 10KM BUFFERS

The property at ***1 King Street*** was formerly the Manse of the Burchell Baptist Church. The Manse is of Georgian Architecture and was the resident of renowned Baptist Missionary and pioneer Thomas Burchell. The ***Burchell Memorial Church*** was established in 1824 and was the base for missionaries such as Reverend Thomas Burchell, James Phillipo and William Knibb, George Liele and Moses Baker. The Baptists were popular due to their stand against slavery. The church was also known as the choice for large numbers of converts from the enslaved and free black population including Samuel Sharpe who was a Deacon at the church. The Church was destroyed during the 1831-1832 Emancipation War, also known as the Baptist War and the Christmas Rebellion. The church was rebuilt and the cornerstones laid in 1835 and completed and dedicated in 1937.

The Dome was erected over the source of a creek in Montego Bay and was an important water supply for the city prior to the installation of water pipes in 1893. While water pipes reduced usage of the water supply protected by the Dome, it continued to prove "a great alternative in times of drought."

Town House built in 1776 and predates the parish which was established in 1786.

JNHT Heritage Sites between 5km and 10km from the study site

The ***Barnett Street Police Station*** is an architectural significant site construed of cut stone in Georgian style architecture. The Police station was the station from which policemen marched in ranks with fixed bayonets in Jamaica. This was during the Montego Bay Riots of 1902.

Montego Bay Railway Station built in 1894 and was operational until 1992, when all railway passenger services in Jamaica ceased

Rose Hall Great House is located on the grounds of the former Rose Hall Sugar Estate. The Great House was built in the mid-19th Century of Georgian architecture with cut stone and stucco. The house was built for John Palmer and is famous for stories about John's wife Annie Palmer and the "cruelty she meted out to her slaves."

JNHT Heritage Sites in St. James and over 10km from the study site

- ***Grove Hill House*** built in the early 18th century. The house is a two storey Georgian structure
- ***Flagstaff***, the site of a small Maroon community and features notably in the Maroons Wars which begun in 1795
- ***Salter's Hill Baptist***, which was reportedly voluntarily constructed by enslaved Africans in 1825
- ***St. Mary's Anglican*** on the Montpelier Estate, which dates back to the days of slavery.
- ***Greenwood Great House,*** built in 1790 by The Barretts of Wimpole Street
- ***Anchovy Railway Station*** - erected around 1894, a two storey Jamaica/Georgian timber structure

- ***Cambridge Railway Station*** - built around 1894, a two-storey timber building
- ***Catadupa Railway Station*** - constructed in 1895, a two-storey Jamaica/Georgian timber structure
- ***Montpelier Railway Station*** - a uniquely designed building which demonstrates Jamaica/Georgian architecture with Victorian elements.

Other sites of importance within close proximity to the study site include numerous attractions such as beaches, craft markets, sports facilities and other landmarks (**Table 6-16**).

TABLE 6-16: HISTORICAL SITES & IMPORTANT LOCATIONS IN ST. JAMES WITH SITES IN MONTEGO BAY IN GREEN (MONA GEOINFORMATIX)

NAME	ADDRESS	PARISH	TELEPHONE
Montego Bay Sports Complex	Catherine Hall	St. James	
Refuge of Hope Boys Home	Albion Rd, Albion	St. James	
Dovecot Cemetery of St James	Sign	St. James	
Pye River Cemetery	Bogue	St. James	
Montego Bay Cemetery	Montego Bay	St. James	
Blue Hole Nature Park	Roehampton	St. James	
Nature Village Farm	Anchovy	St. James	
Palms Entertainment Park	Bogue Village	St. James	
St James Parish Library	Merge Bay Rd, Montego Bay	St. James	(876) 952-4185-6
Rocklands Bird Sanctuary	Mount Parnassus	St. James	(876) 952-2009
Sangster International Airport	Montego Bay	St. James	(876) 952-3124
Montego Bay Civic Center	St James St, Sam Sharpe Square, Montego Bay	St. James	(876) 952-5500
Jamaica 4 H Club Western Regional Training Facility	Cottage Rd, Mount Salem	St. James	
Jamaica Red Cross	Union St, Brandon Hill	St. James	(876) 952-4751
Cornwall Court Community Center	Cornwall Court	St. James	
Teamwork Christian Center	Ironshore	St. James	(876) 953-3123
Y.E.S. (Youth Enhancement Service)	3-5 Fort St, Montego Bay	St. James	(876) 971-2001
Y.M.C.A. Western Regional Training Facility (Young Men's Christian Association)	Cottage Rd, Mount Salem	St. James	
Hanna's Better-Buy	St James St, Montego Bay	St. James	
Kingdom Hall Of Jehovah's Witnesses - Anchovy	Anchovy	St. James	
Montego Bay Resident Magistrate's Court	Merge Bay Rd, Montego Bay	St. James	
Montego Bay Cricket Club	Cottage Rd, Barnett	St. James	

NAME	ADDRESS	PARISH	TELEPHONE
Farm Heights / Rose Heights Basketball Court (Digicel Foundation)	Catherine Mount	St. James	
Jarrett Park	Cottage Rd, Montego Bay	St. James	
Kiddies Fun Park	Cornwall Court	St. James	
I.A.M. Jet Center	The Queen's Dr., Montego Bay	St. James	(876) 979-3855
The Montego Bay Cruise Ship Terminal	Montego Bay	St. James	
Montego Freeport Shipping Center (1)	Montego Bay	St. James	
Montego Freeport Shipping Center (2)	Mantica Wy, Freeport	St. James	
Montego Bay Cruise Shipping Pier	Southern Cross Blvd, Freeport	St. James	
Montego Bay Wharf	Bay Rd, Freeport	St. James	
Johns Hall Adventure Tours	Montego Bay	St. James	(876) 952-0873
River Raft Ltd	Claude Clarke Ave, Montego Bay	St. James	(876) 940-6398
Montego Bay Craft Market	Harbour St, Montego Bay	St. James	
Evening on the Great River	Unity Hall	St. James	
Mountain Valley Rafting	Anchovy	St. James	(876) 956-4920
Aquasol Theme Park	Gloucester Ave, Montego Bay	St. James	(876) 979-9447
Doctor's Cave Beach	Gloucester Ave, Montego Bay	St. James	(876) 952-4355
Cornwall Beach	Kent Ave, Montego Bay	St. James	
Rose Hall Beach Club	Ironshore	St. James	
Dumped Up Beach	Gloucester Ave, Montego Bay	St. James	
Rose Hall Great House	Rose Hall, Montego Bay	St. James	(1-888) 767-3425
Blue Hole Plantation	Ironshore	St. James	
Croydon Plantation	Catadupa	St. James	(876) 979-8267
Old Fort Craft & Heritage Park	Fort St, Montego Bay	St. James	
Morant Point Lighthouse	Dalvey	St. James	
Catherine Hall Entertainment Center	Howard Cooke Blvd, Catherine Hall	St. James	
Montego Bay Convention Center	Half Moon P.O. 4058, Rose Hall, Montego Bay	St. James	(876) 622-9330
Montego Bay Marine Park Fish Sanctuary	Kent Ave, Montego Bay	St. James	(876) 952-5619
Tropical Beach	Kent Ave, Montego Bay	St. James	
The Cage	Sam Sharpe Sq, Montego Bay	St. James	
Western Regional Gun Court	Merge Bay Rd, Montego Bay	St. James	
Dance Spirit Performing Arts Studio	Nnatts Complex, Montego Bay	St. James	
Gallery of West Indian Art	West Green Ave, West Green	St. James	(876) 952-4547

NAME	ADDRESS	PARISH	TELEPHONE
Wings Performing Arts Center	Howard Cooke Blvd, Montego Bay	St. James	
Old Hospital Park	Gloucester Ave, Montego Bay	St. James	
U.D.C. Football Field	Howard Cooke Blvd, Montego Bay	St. James	
Barnett Oval	Jarrett Terr, Montego Bay	St. James	
Reggae Sumfest Venue	Howard Cooke Blvd, Catherine Hall	St. James	
Computer Depot	Fairview Shopping Center, Montego Bay	St. James	
Croydon In The Mountains	Catadupa	St. James	(876) 979-8267
Chukka Caribbean Adventures - Montpelier	Montpelier	St. James	(876) 402-0354
Flankers Peace and Justice Center	Morning View Dr, Flankers	St. James	
Deep Sea Sport Fishing Montego Bay	Sandals Montego Bay, 100 Kent Ave, Montego Bay	St. James	(1-800) 744-1150
Island Routes Reggae Family Catamaran Cruise Montego Bay	Sandals Montego Bay, 100 Kent Ave, Montego Bay	St. James	(1-800) 744-1150
Cinnamon Hill Golf Experience	Rose Hall Estate, Montego Bay, St. James	St. James	(1-800) 744-1150
Rose Hall Great House Day Tour	Rosehall, Montego Bay	St. James	(1-800) 744-1150
A Round of Golf at the White Witch Golf Course	Rose Hall, Montego Bay	St. James	(1-800) 744-1150
Jungle River Tubing	Montpelier, St. James	St. James	(1-800) 744-1150
Zipline & River Tubing	Montpelier, St. James	St. James	(1-800) 744-1150
Zipline Canopy	Montpelier, St. James	St. James	(1-800) 744-1150
Sandals Cay	Off Coast, Ironshore	St. James	(876) 953-2232
Wespow Park Football Field	Tucker, Montego Bay	St. James	
Mobay Kart World	Tucker, Montego Bay	St. James	(876) 441-3310
Unity Hall Open Bible Church	Unity Hall, Reading P.O.	St. James	
Belmont Baptist Church	Moy Hall	St. James	
Anchovy Seventh Day Adventist Church	Anchovy	St. James	(876) 383-7973
Mount Carey Seventh Day Adventist Church	Mount Carey	St. James	
Triumphant Deliverance Center	Triumphant Carey, Montpelier P.O.	St. James	
Flagstaff	Flagstaff Community	St. James	
Maroon Town	Maroon Town	St. James	
Salter's Hill Baptist	John's Hall	St. James	
St James Parish Church	Payne St, Montego Bay	St. James	

NAME	ADDRESS	PARISH	TELEPHONE
St. Mary's Anglican Church	Montpelier	St. James	
Historic Court House (Montego Bay)	Sam Sharpe Square, Montego Bay	St. James	
Fort Montego	Fort St, Montego Bay	St. James	
Goodwill	Goodwill Community	St. James	
Greenwood Great House	Greenwood, Barrett Hall	St. James	
1 King Street	King Street, Montego Bay	St. James	
Sam Sharpe Square	St James St, Montego Bay	St. James	
Barnett Street Police Station	Barrett St, Montego Bay	St. James	
Old Slave Ring	Union St, Montego Bay	St. James	
The Dome	Dome St, Montego Bay	St. James	
Burchell Memorial Church	King St, Montego Bay	St. James	

6.2 Public Participation

6.2.1 Approach

In October 2022, perception surveys were first conducted with stakeholder groups to assess the levels of awareness and identify potential concerns and impacts associated with the proposed construction of eighteen (18) over-water bungalows at the Sandals Montego Bay Resort located at Kent Avenue, Montego Bay, St. James. These perception surveys were used as one medium to collect data integral to the preparation of a technical report which will guide Sandals Resort International (SRI) in its beach license application process.

Following this initial survey exercise SRI expanded the project scope. The expanded project as proposed will entail:

- construction of eighteen (18) over-water bungalows (as initially proposed)
- construction of ten (10) single-storey villa-style units
- coastal modification for beach improvements featuring the construction of a seawall, rock groynes and a rock revetment on the eastern side of the property. The beach area will also be extended with sand fill. The removal of mangroves will also be necessary to facilitate the construction of the villa-style units.

Based on this expanded project scope, stakeholder engagement and public participation was expanded to cover a wider study area and solicit feedback on the new project scope.

Survey Instruments were emailed to the Montego Bay Marine Park and Trust and MBJ Airports Limited. In addition to circulating survey instruments electronically, surveys were administered via in-person interviews conducted within a two-kilometer radius of the project site in March 2024.

Surveys were administered to community residents and business entities within this one-kilometer study area. Fisherfolk of the Whitehouse Fishing Beach were also surveyed as a unique stakeholder group. It should be noted that Whitehouse fishing Beach is a recognised and regulated fishing beach under the National Fisheries Authority.

A total of one hundred and twenty-four (124) survey instruments were completed. The breakdown is as follows:

- Local Stakeholders
    - The Montego Bay Marine Park and Trust
    - The MBJ Airports Limited
- Community Residents within the study area – 81
- Business establishments within the study area - 32
- Fisherfolk of the Whitehouse Fishing Beach – 9

Given the average household size of 3.1 persons per household for the parish and the city of Montego Bay, it is estimated that the number of surveys completed represents 5.2% of the total population within a one-mile radius of the project site.

6.2.1.1 Limitations

Some challenges were experienced that affected data gathering.

- Safety and Security risks for the survey team to enter communities. At the time of conducting the survey exercise in March 2024, the community of Flankers remained tense following the shooting of a community member on February 26, 2024. In addition, the communities within the study area (Flankers, Norwood, Providence Heights) are known to be volatile communities that experience sporadic outbreaks of violence, especially shootings. Therefore, survey team members remained in open public spaces along the periphery of these communities, and interviewed residents as they were entering or leaving the communities.

- Scepticism and unwillingness to participate in the survey exercise by potential interviewees. In the case of the Whitehouse community, respondents were unwilling to participate in the repeat survey exercise as it was perceived that SRI was being dishonest in their dealings. For the remaining communities, the general day-to-day volatility caused some persons to automatically decline to participate on the grounds of personal safety.

- Overall disinterest in the project. Some persons, who initially agreed to participate, declined after the project details were shared. Some potential interviewees held a negative view of SRI and declined to be a part of the exercise, while others considered themselves as being "too far away" from the project area and as such were not interested as they perceived no impact.

- As it pertained to the questionnaire instrument. The length of the instrument proved to be a "turn-off" to some respondents, as some persons who initially agreed to participate discontinued the interview stating that it was taking more time than they anticipated.

Despite the challenges faced, individuals who participated in the survey exercise were in general willing and honest in their responses.

Respondents were from four main communities and resided, or worked in the Whitehouse, Flankers, Norwood and Providence Heights Communities.

6.2.2 Community Perception Survey Results

Percentages presented are for the total number of responses received; in instances where no answer was offered to a question, it was not considered part of the analysis.

6.2.3 Community Cohort Description

Eighty-one (81) Community Survey Instruments were administered. Twenty-seven percent (27.0%) of respondents resided in Whitehouse, six percent (6.0%) resided in Providence Heights, while thirty-one percent (31.0%) resided in Flankers and the remaining thirty-six percent (36.0%) resided in the Norwood Community (**Figure 6-6**).

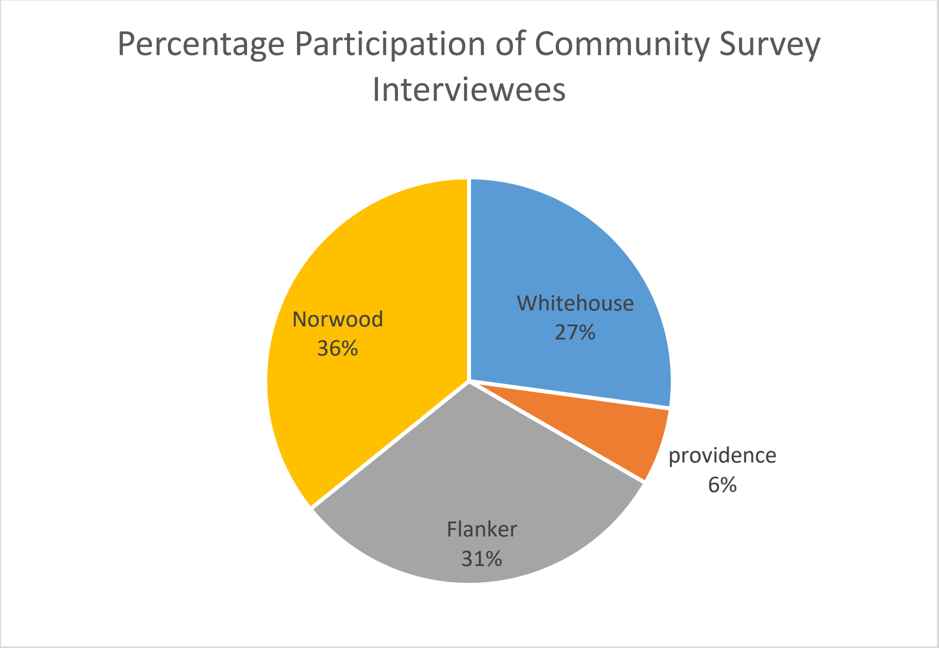


Figure 6-6: Distribution of Community Participants

Most participants were lifelong residents of their communities. Seventy-three percent (73.0%) of participants indicated that they lived in their community all their life. Seven percent (7.0%) indicated that they lived in the community for more than twenty years, while five percent (5.0%) stated that they lived in their community for between 16 - 20 years. Four percent (4.0%) of respondents resided in their community for between 11 - 15 years, six percent (6.0%) for between 6 - 10 years and five percent (5.0%) for less than two years.

6.2.3.1 Community - Age and Sex

Seventy-four percent (74.0%) of survey participants were male while twenty-six percent (26.0%) were female. Regarding the age cohort distribution of participants, eleven percent (11.0%) of those interviewed were between the age of eighteen and twenty-five years of age. Twenty-six percent (26.0%) of respondents were between 26-33 years of age, nineteen percent (19.0%) were between ages 34 and 41. Twenty percent (20.0%) were between 42 and 50 years of age, seventeen percent (17.0%) were within the 51-60 age group, while seven percent (7.0%) of survey participants were over sixty (60) years of age (**Figure 6-7**).

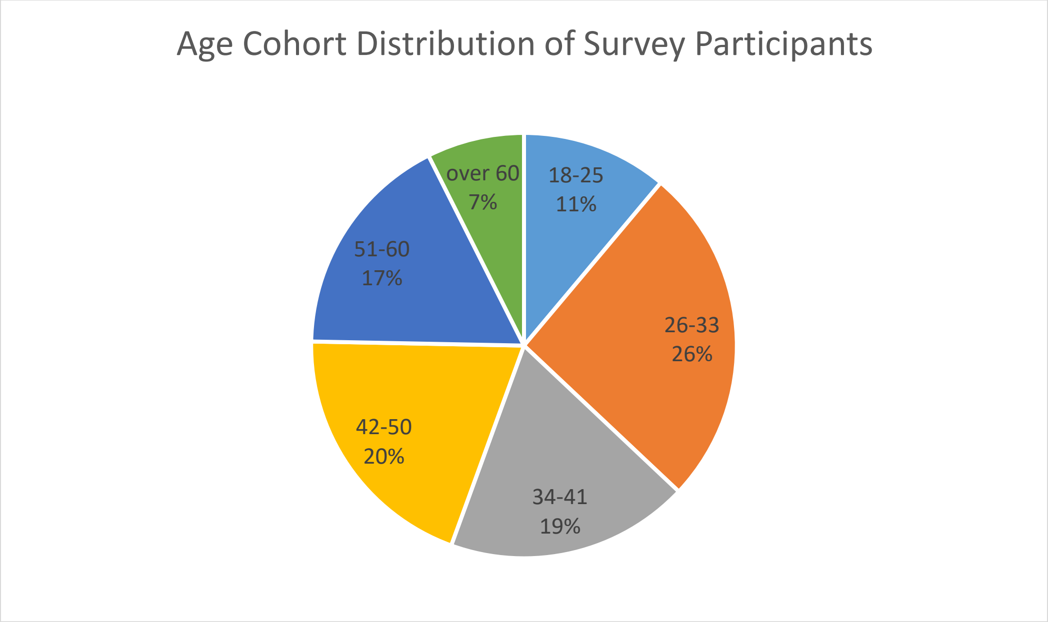


FIGURE 6-7: AGE COHORT DISTRIBUTION OF SURVEY PARTICIPANTS

6.2.3.2 Community - Household Characteristics

Of those persons interviewed, sixty-five percent (65.0%) stated that they were the head of the household while thirty-five percent (35.0%) stated that another family member was the household head. Eleven percent (11.0%) of interviewees stated that they were the sole household occupant; twenty-two percent (22.0%) indicated that two persons lived in their household, while twenty-one percent (21.0%) stated that their household comprised three members. Twenty-two percent (22.0%) of households comprised four members; fourteen percent (14.0%) of households had five members while ten percent (10.0%) of households had more than five persons. Based on household size of participants, community surveys represent four percent (4.0%) of the total population within the designated 1-mile impact zone.

Forty-seven percent (47.0%) of survey participants confirmed that someone in the household was attending school, while fifty-three percent (53.0%) had no household member currently attending school. Of the forty-seven percent (47.0%) of households indicating that someone was attending school, twenty-nine percent (29.0%) stated infant/basic school, fifty-three percent (53.0%) stated primary/all age, thirty-nine percent (39.0%) stated high school while five percent (5.0%) stated college.

Three percent (3.0%) of survey participants indicated University and a similar three percent (3.0%) stated HEART/Vocational Training as the learning institution being attended.

Forty-four percent (44.0%) of participants indicated high school as the highest level of education completed. Ten percent (10.0%) indicated that they started but did not complete high school, while twelve percent (12.0%) indicated primary/all age school as the highest level of education completed. Approximately fourteen percent (14.0%) stated college, one percent (1.0%) stated university, and nineteen percent (19.0%) stated HEART/vocational institution as the highest level of attained education completed.

6.2.3.3 Community - Employment and Income

Eighty-six percent (86%) of interviewees indicated that they were employed, forty-two percent (42.0%) were self-employed, while forty-four percent (44.0%) stated that they had an employer. Nine percent (9.0%) of survey participants stated that they were unemployed, while five percent (5.0%) were retired.

Respondents in general expressed reluctance to disclose information pertaining to weekly income earned. When asked, seventy-four percent (74.0%) of persons interviewed declined to offer any information on weekly income. Six percent (6.0%) of respondents indicated that they did not have a weekly income. Six percent (6.0%) also stated that their weekly income was below the national minimum wage of $13,000.00, while two percent (2.0%) stated that the weekly income was at the minimum wage of $13,000.00 per week. Four percent (4.0%) of respondents stated that their weekly income ranged between $16,001.00 and $20,000.00. Seven percent (7.0%) of survey participants stated that weekly income was in excess of $20,000.00.

6.2.3.4 Community Amenity and Health

On the issue of recreational spaces, sixty-three percent (63.0%) of interviewees indicated that a recreational space was present in the community, while thirty-seven percent (37.0%) stated that the community did not have a recreational space.

Of the sixty-three percent (63.0%) of interviewees confirming that a recreational space was present in their community, the following places were named:

- The Flankers Community Center
- The Providence Heights Community Center

- The Norwood Playing Field
- The Whitehouse Playing Field

As it pertained to whether respondents suffered from common health conditions such as asthma, sinusitis, coughing, congestion/bronchial problems, chest pains or bouts of diarrhea, eighty-six percent (86.0%) of interviewees stated that they did not suffer from any of these named ailments. Six percent (6.0%) stated asthma as a medical condition and nine percent (9.0%) stated sinusitis. No one interviewed (0.0%) named coughing, congestion/bronchial problems, chest pains or bouts of diarrhea as a medical condition affecting them.

6.2.3.5 Community - Project Awareness

The majority of community participants (98.0%) were aware of the Sandals Resorts International Company, while two percent (2.0%) stated that they did not know of a company by that name. As it pertained to whether respondents were aware of the proposal to construct the eighteen (18) single-storey overwater bungalows, eighty percent (80.0%) of survey participants stated that they were not aware of the proposal, while 20.0% stated that they knew of the proposal[13] (**Figure 6-8**).

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[13] It should be noted that of the twenty percent (20.0%) of interviewees confirming awareness of the proposal to construct the overwater bungalows most respondents seventy-three percent (73.0%) were from the community of Whitehouse which was previously surveyed in 2022.

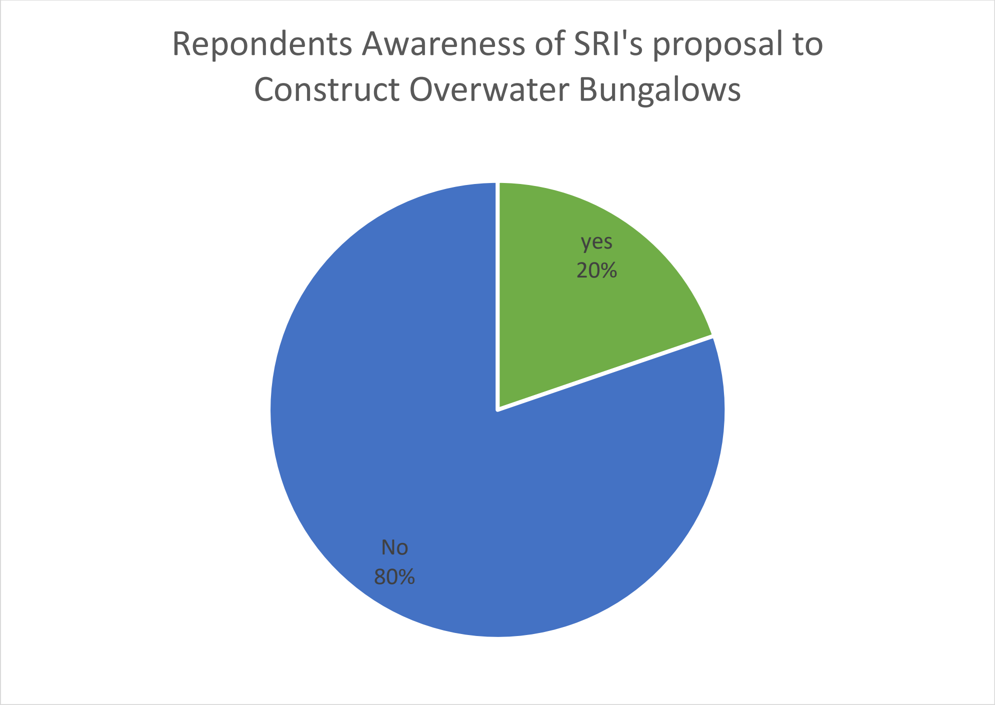

FIGURE 6-8: RESPONDENTS AWARENESS OF SRI'S PROPOSAL TO CONSTRUCT OVERWATER BUNGALOWS

The 20.0% of persons confirming awareness of the project were further asked about being aware of a swimming pool, bar area, boardwalks/linkways and the installation of piles being part of the overall overwater bungalows construction. Of these respondents forty-four (44.0%) stated that they were aware of these subcomponents, while 56.0% stated that they had no knowledge[14].

Among those aware of the proposed project, seventy-five percent (75.0%) stated that they were made aware of the project by "word of mouth" while twenty-five percent (25.0%) stated "other" and referenced the survey exercise done in 2022 as the medium through which they were made aware of the project.

As it regarded awareness of SRI's proposal to construct eighteen (18) single-storey overwater bungalow-style units, 96.0% of survey participants indicated that they were not aware of this proposal, while 4.0% of interview participants stated that they were aware of this aspect of the proposed project (**Figure 6-9**). Of the four percent (4.0%) of persons confirming awareness of the proposal to construct

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[14] It should be noted that of 44.0% of interviewees confirming awareness of the sub-components forming part of the overwater bungalows construction most respondents (71.0%) were from the Whitehouse community that was previously surveyed in 2022.

the bungalow-style units, all respondents (100.0%) indicated that they knew the project would include modifying a section of the existing wetland and coastal modification work. These respondents further stated "word of mouth" as the medium through which they were made aware of this aspect of the project.

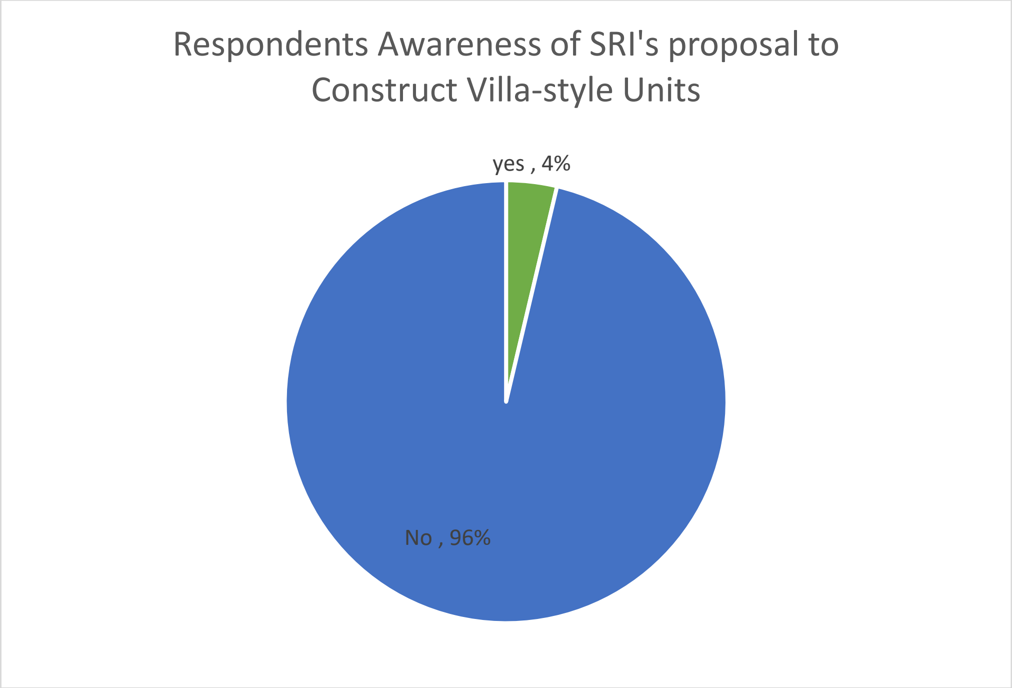


FIGURE 6-9: RESPONDENTS AWARENESS OF SRI'S PROPOSAL TO CONSTRUCT BUNGALOW-STYLE UNITS

6.2.3.6 Community - Issues/Problems/Concerns at the Proposed Site

On the issue of whether there have been issues/problems at the proposed project site 93.0% of respondents indicated that there were no issues at the proposed project site while 5.0% of interviewees stated that they were unaware of any issues/problems. Two percent (2.0%) of respondents stated that there have been past issues/problems at the proposed project site including effluent discharge into the marine environment, flooding caused by tidal surge.

Twenty-five percent (25.0%) of respondents confirmed that they had general concerns with the project as proposed while 73.0% stated that they did not have any general concern. Two percent (2.0%) of respondents expressed uncertainty (**Figure 6-10**).

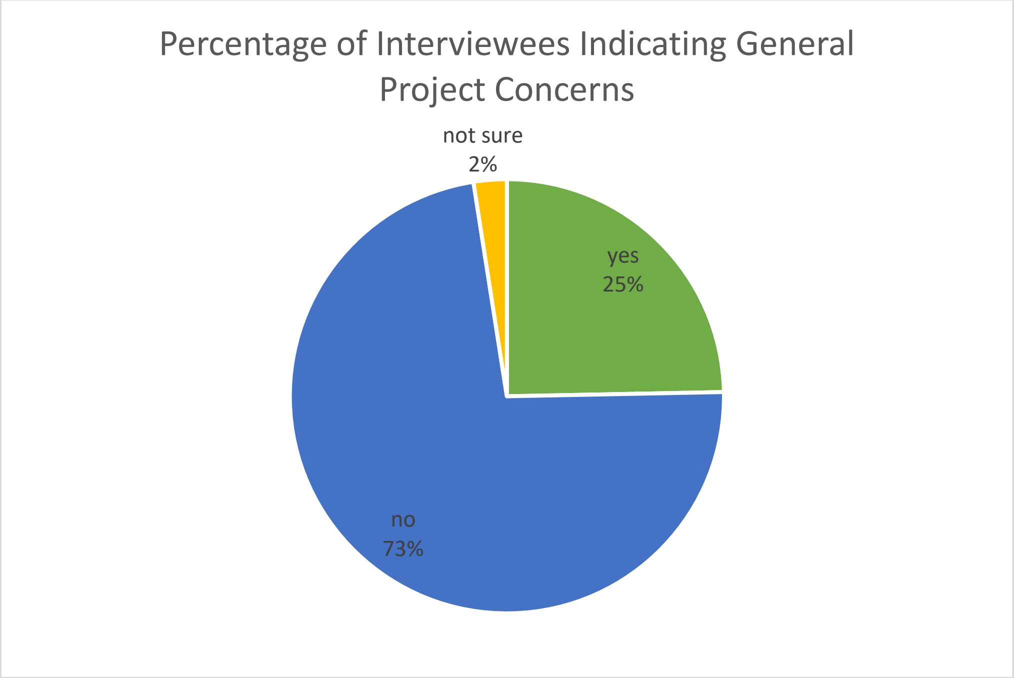


FIGURE 6-10: PERCENTAGE OF INTERVIEWEES INDICATING GENERAL PROJECT CONCERNS

Of the 25.0% of survey participants who indicated that they had concerns about the project, the following concerns were expressed:

- Loss of fishing area and livelihood of fisherfolk - 25.0%
- Increased water pollution/pollution of the marine environment – 15.0%
- Loss of the beach to include areas used for recreation – 15.0%
- Mangrove areas will be destroyed – 10.0%
- Lack of work opportunities (for locals/community residents) – 10.0%
- Increased risk of tidal surge – 10.0%
- Would local/community residents derive positive benefits from the project – 5.0%
- Loss of the fish population and associated habitat – 5.0%
- (Continued) pollution of the environment that may result in health issues – 5.0%
- No structures should be erected in the areas being proposed – 5.0%
- The project’s potential impacts on neighbouring communities – 5.0%

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

In response to respondents having concerns specific to the bungalows being built overwater, 86.0% of interviewees stated that they had no concern while 4.0% expressed uncertainty. Ten percent (10.0%) of respondents indicated that they had concerns specifically relating to the bungalows being built overwater. Concerns expressed were:

- Further destruction/degradation of marine life – (26.0%)
- Destruction of the fish habitat – (26.0%)
- Migration of fish species – (12.0%)
- Destruction of the coral reef – (12.0%)
- Whether the bungalows would be built at a "safe" height – (12.0%)
- No overwater bungalows should be erected in the area being proposed – 12.0%.

With regards to respondents having specific concerns relating to the installation of piles to facilitate construction, 77.0% of survey participants indicated that they did not have any concern while 2.0% expressed uncertainty. Twenty-one percent (21.0%) of survey participants indicated that they had specific concerns relating to the installation of piles. Concerns expressed were:

- Coral reef destruction (18.0%)
- Damage to the sea floor (23.0%)
- Migration of fish species – (18.0%)
- Activities will result in fish kills – (23.0%)
- Displacement of water-sports recreational activities – (6.0%)
- Structural damage to homes caused by excessive/prolonged vibrations – (6.0%)
- Loss of the fish habitat – (18.0%)
- Fishing boat access will be blocked/impeded – (6.0%)
- Increased intrusion of pollutants – (6.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked, 90.0% of respondents indicated that they did not have any concern relating to the construction of bungalow-style units being a part of the proposed project while 3.0% expressed uncertainty. Seven percent (7.0%) of participants indicated that they had concerns specifically relating to bungalow-style units being a part of the project. Specific concerns highlighted were:

- Fisherfolk will be displaced – (33.0%)

- There will be damage to the marine ecosystem- (33.0%)
- There will be a loss of fish habitat – (17.0%)
- Traffic congestion will be increased in the area – (17.0%)
- No bungalow-style units should be erected in the area being proposed – (17.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

With regards to respondents having specific concerns relating to wetland and coastal modification being a part of the proposed project, 65.0% of survey participants indicated that they did not have any concerns, while 4.0% of participants expressed uncertainty. Thirty-one percent (31.0%) of interviewees indicated that they had concerns about wetland and coastal modification being a part of the project. Concerns expressed were as follows:

- There will be a loss/destruction of fish habitat – (52.0%)
- Modification will result in flooding – (20.0%)
- Modifications will negatively impact water quality– (10.0%)
- Beach erosion will occur – (12.0%)
- Loss of fishing area – (12.0%)
- Loss of Mangroves – (8.0%)
- Harmful effluent discharge in the marine environment – (4.0%)
- Loss of /damage to coral reefs – (4.0%)
- Loss of recreational beach – (4.0%)
- The extent of the proposed modification – (5.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

On the issue of the project's proximity to the runway of the airport, 91.0% of respondents indicated that they did not have any concerns regarding the proximity of the proposed project to the airport runway, while 4.0% expressed uncertainty. Five percent (5.0%) of survey participants stated that were concerned about the proximity of the project to the airport runway. Concerns expressed related to:

- The height of the structure creating an obstruction – (50.0%)
- Structures may be in the aircraft flight path – (25.0%)
- No response offered – (25.0%)

To address the highlighted concerns, respondents suggested the following: Do not modify the coastline/mangroves/beach.

- Do not build/implement the project.
- SRI should engage the community.
- Measures should be implemented to protect marine wildlife (specifically coral reefs).
- A fish breeding ground should be established in a suitable area.
- A proper sewage treatment facility should be built.
- Bungalows should be built in the water at a distance from shore so that it would not cause negative impacts to water-sports activities.
- An alternate option to driving piles should be implemented to prevent environmental damage.
- Mangroves should be replanted in a suitable area.
- Ensure building height will not obstruct the flight path.

Percentages have not been presented for the suggestions presented above. Suggestions presented are for respondents who expressed concern in one or multiple areas and therefore repeat in some instances.

6.2.3.7 Community - Dependence on Proposed Project Location

When asked about dependence on the location proposed for the overwater bungalows and villa-style units, 19.0% of interviewees stated that they depended on the proposed location, while 81.0% stated that they did not depend on any of the areas. Of the 19.0% of respondents confirming dependence on the area, respondents stated they depended on the area for:

- Fishing – (47.0%)
- Accessing the beach for recreation – (53.0%)

As it pertained to respondents knowing of any other person who depended on the location of the overwater bungalows and villa-style units for any type of activity, 44.0% of interviewees indicated that they knew other persons who depended on the area. Fifty-six percent (56.0%) of respondents stated that they did not know of anyone who depended on the area. Of the 44.0% of survey participants indicating that they knew of other persons who depended on the area, respondents stated they depended on the area for:

- Fishing – (81.0%)

- Accessing the beach for recreation – (19.0%)

6.2.3.8 Community - Impacts on Lives/Livelihoods

As it pertained to how respondents thought the project may impact their lives or livelihood, 51.0% indicated that the proposed project would not impact their lives in any way, 21.0% stated that they were unsure how the project may impact their lives. Fourteen percent (14.0%) of respondents anticipated a positive impact while a similar 14.0% anticipated that their lives would be negatively impacted from the project (**Figure 6-11**).

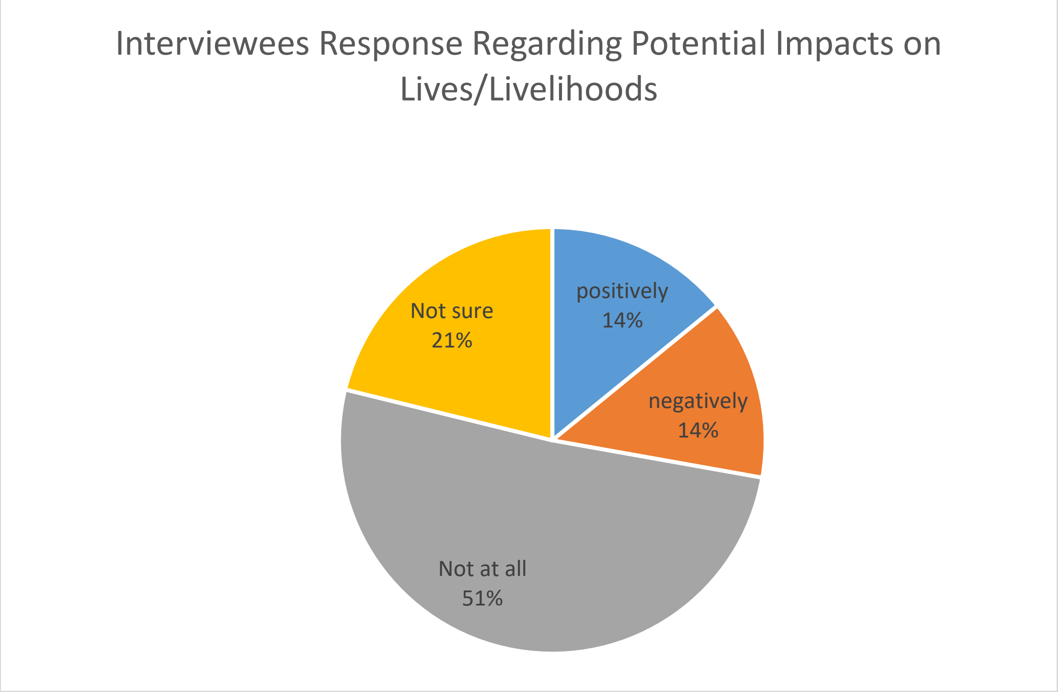


FIGURE 6-11: INTERVIEWEES RESPONSE REGARDING POTENTIAL IMPACTS ON LIVES/LIVELIHOODS

Of the 14.0% of respondents indicating a positive impact on their lives from the project, the following positive project benefit were identified:

- Employment opportunities – (55.0%)
- Community development – (27.0%)
- Increased business opportunity – (18.0%)

For the 14.0% of interviewees who expected a negative impact on their lives from the project, the following negative impacts are anticipated:

- Loss of fishing livelihood – (73.0%)
- Loss of income – (9.0%)
- Loss of recreational space – (9.0%)
- Increase in the unit cost of fish (if fisherfolk will have to relocate) – (9.0%)

Possible solutions to address the highlighted concerns recommended by participants were:

- Allow fishers to access the area – (9.0%)
- No further suggestions – (91.0%)

6.2.3.9 Community - *Impacts on Removal of Mangroves*

When asked about the type of impact that would be caused by removing mangroves, 26.0% of respondents stated that the removal of mangroves would not cause an impact in any way, while 28.0% of participants stated that they were uncertain. Two percent (2.0%) of respondents anticipated a positive impact associated with mangrove removal while 44.0% percent stated that there would be a negative impact (**Figure 6-12**).

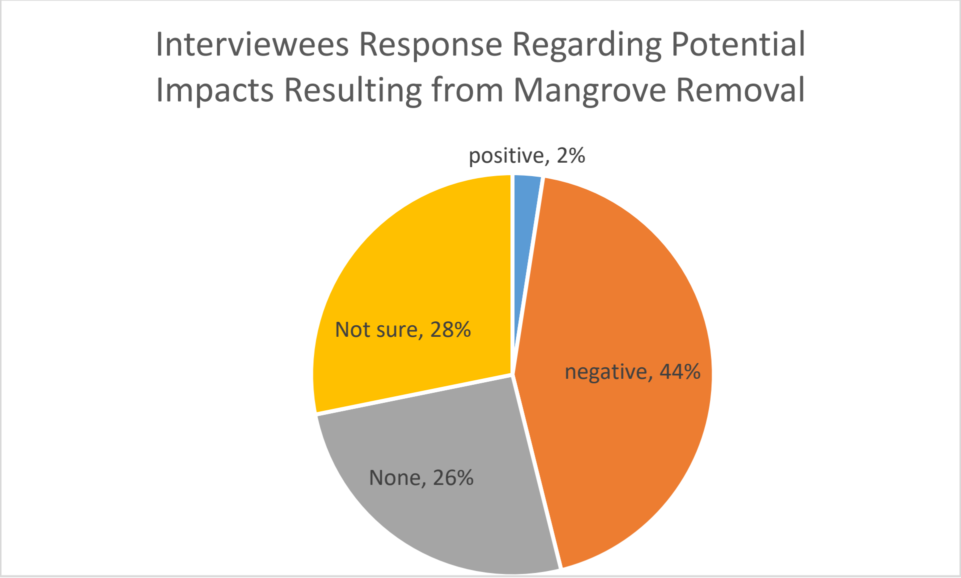


FIGURE 6-12: INTERVIEWEES RESPONSE REGARDING POTENTIAL IMPACTS RESULTING FROM MANGROVE REMOVAL

Only one positive impact was identified - less water (marine) pollution – (50.0%). However, among the 44% of respondents anticipating a negative impact caused by mangrove removal (44.0%), the following negative impacts were stated:

- Destruction of fish habitat and nursery area – (71.0%)
- Increased risk of flooding – (11.0%)
- Beach erosion – (9.0%)
- Migration of fish species – (6.0%)
- Loss of coral reef - (3.0%)

In response to these concerns the following suggestions were offered to avoid these negative impacts:

- Do not remove mangroves – (17.0%)
- Implement measures to preserve the coral reef (3.0%)
- Leave a section of the mangrove undisturbed – (3.0%)
- Establish an alternative breeding area for fish species – (3.0%)
- No further suggestion – (74.0%)

6.2.3.10 Community - Impacts during Construction

Community participants were asked about the extent to which the project would impact the selected variables during project construction and after construction.

Table 6-17 presents the summary of perceived impacts during construction and **Table 6-18** presents the summary of perceived impacts after construction.

Survey data revealed that in general respondents were mostly unsure of the project's impacts during construction when asked about specific variables. On average 47.3% of community interviewees expressed uncertainty about the project's impact during construction while 26.2% believed there would be no impacts, while 13.5% believed impacts would be negative. Only 13.0% of interviewees believed the project would have positive impacts during the construction phase.

TABLE 6-17: COMMUNITY RESPONDENTS PERCEIVED IMPACTS – DURING CONSTRUCTION

Perceived Impacts After Construction (During Operations)					
	Positively	**Negatively**	**No Impact**	**Not Sure**	**Total**
Marine Water quality	1.0	28.0	19.0	52.0	100.0
Marine Wildlife/Fish Population	4.0	36.0	15.0	45.0	100.0
Air Quality	1.0	8.0	38.0	53.0	100.0
Noise Levels	0.0	2.0	51.0	47.0	100.0
Fisherfolk	4.0	44.0	11.0	41.0	100.0
Flooding	1.0	11.0	34.0	54.0	100.0
Businesses & Services Nearby the Project Area	25.0	0.0	28.0	47.0	100.0
Residential Communities Nearby the Project Area	17.0	0.0	29.0	54.0	100.0
Employment Opportunities	56.0	6.0	10.0	28.0	100.0
The Tourism Product	21.0	0.0	27.0	52.0	100.0
Average	**13.0**	**13.5**	**26.2**	**47.3**	

It should be noted that respondents anticipated greatest positive impact during construction on the following variables:

- Businesses and Services nearby the project area - (25.0%)
- Residential Communities nearby the project area – (17.0%)
- Employment Opportunities – (56.0%)
- The Tourism Product – (21.0%)

It was perceived by community respondents that the specific aspects to realise the greatest negative impact during construction were:

- Marine Water Quality – (28.0%)
- Marine Wildlife/Fish Population – (36.0%)
- Fisherfolk – (44.0%)

6.2.3.11 Community - Impacts after Construction

Similar to the project's construction phase, when asked about specific variables, respondents were unsure of the project's impacts after construction. On average 48.7% of community interviewees expressed uncertainty. This was followed by 21.8% of respondents who anticipated a negative impact post construction. Approximately nineteen percent (18.7%) of community survey participants indicated that after construction there would not be any impact while 10.8% (on average) anticipated a positive impact.

TABLE 6-18: COMMUNITY RESPONDENTS PERCEIVED IMPACTS – AFTER CONSTRUCTION

Perceived Impacts During Construction					
	Positively	**Negatively**	**No Impact**	**Not Sure**	**Total**
Marine Water quality	0.0	40.0	12.0	48.0	100.0
Marine Wildlife/Fish Population	0.0	53.0	9.0	38.0	100.0
Air Quality	0.0	21.0	27.0	52.0	100.0
Noise Levels	0.0	19.0	32.0	49.0	100.0
Fisherfolk	1.0	56.0	1.0	42.0	100.0
Flooding	0.0	12.0	26.0	62.0	100.0
Businesses & Services Nearby the Project Area	20.0	2.0	25.0	53.0	100.0
Residential Communities Nearby the Project Area	10.0	4.0	27.0	59.0	100.0
Employment Opportunities	54.0	10.0	7.0	29.0	100.0
The Tourism Product	23.0	1.0	21.0	55.0	100.0
Average	**10.8**	**21.8**	**18.7**	**48.7**	

Respondents anticipated some positive impact post-construction on the following variables:

- Businesses and Services nearby the project area - (20.0%)
- Residential Communities nearby the project area – (10.0%)
- Employment Opportunities – (54.0%)
- The Tourism Product – (23.0%)

Environmental and related variables are perceived to have negative impact by the largest proportion of respondents. These included:

- Marine Water Quality – (40.0%)
- Marine Wildlife/Fish Population – (53.0%)
- Fisherfolk – (56.0%)

It should be noted that negative impacts were anticipated by community interviewees for all variables post construction.

6.2.3.12 Community - Impacts on Beach Erosion, Beach Alteration, Mangrove Relocation/Replanting

In an effort to gauge how respondents perceived the project's potential impact on beach erosion, beach alteration and the potential impact on seagrass beds, as well as the potential acceptance of mangrove removal with associated restoration/replanting, respondents were asked to indicate the extent to which they agreed or disagreed with the following statements:

- The project as proposed will increase the chance of beach erosion.
- I would be more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting.
- Any alteration of the beach will negatively affect seagrass beds and the environmental purpose they serve.

As shown in **Table 6-19**, a large proportion of participants agreed with these three statements. Fifty-eight percent (58.0%) of respondents agreed **that the project as proposed would increase the chance of beach erosion** (23.0% - strongly agreed and 35.0% - agreed). Nine percent (9.0%) expressed disagreement (0.0% - strongly disagreed and 9.0% - disagreed), while 10.0% neither agreed nor disagreed and 23.0% expressed uncertainty as it regarded whether the project would increase the potential for beach erosion to occur.

TABLE 6-19: COMMUNITY PERCEPTION OF BEACH EROSION, BEACH ALTERATION ON SEAGRASS BEDS, AND MANGROVE RELOCATION/REPLANTING

	Strongly Agree	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**	**Not Sure**	**Total**
The project as proposed will increase the chance of beach erosion	23.0	35.0	10.0	9.0	0.0	23.0	100.0
I would be more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting	19.0	33.0	21.0	7.0	4.0	16.0	100.0
Any alternation of the beach will negatively affect seagrass beds and the environmental purpose they serve	22.0	46.0	10.0	5.0	1.0	16.0	100.0

On the issue of respondents being more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting, fifty-two percent (52.0%) of respondents indicated that they would be more accepting if mangrove restoration/ replanting was a component of the project (19.0% - strongly agreed and 33.0% - agreed). Eleven percent (11.0%) expressed disagreement (4.0% - strongly disagreed and 7.0% - disagreed), while 21.0% neither agreed nor disagreed and 16.0% expressed uncertainty.

Pertaining to whether any alteration of the beach would negatively affect seagrass beds and the environmental purpose they serve, sixty-eight percent (68.0%) of respondents agreed that altering the beach would cause a negative impact on seagrass beds and their purpose (22.0% - strongly agreed and 46.0% - agreed). Six percent (6.0%) expressed disagreement (1.0% - strongly disagreed and 5.0% - disagreed), while 10.0% neither agreed nor disagreed and 16.0% expressed uncertainty regarding whether beach alteration would result in negative impact to seagrass beds and their purpose.

6.2.4 Business Perception Survey Results

Percentages presented are for the total number of responses received; in instances where no answer was offered to a question, it was not considered part of the analysis. Thirty-Two (32) Business Survey Instruments were administered to persons who owned/operated or worked in business establishments within the study area.

6.2.5 Business Cohort Description

Eighty-One percent (81.0%) of persons interviewed were the owners of the business establishments while 19.0% were not business owners. Forty-seven percent (47.0%) of businesses were within the wholesale and retail sector, 28.0% were within transportation, 19.0% were within accommodation and food service, and 6.0% the social and personal services sector. Businesses were located in the Whitehouse, Norwood and Flankers communities and also along Hobbs Avenue, Claude Clarke Avenue, Kent Avenue and Sunset Boulevard (**Figure 6-13**).

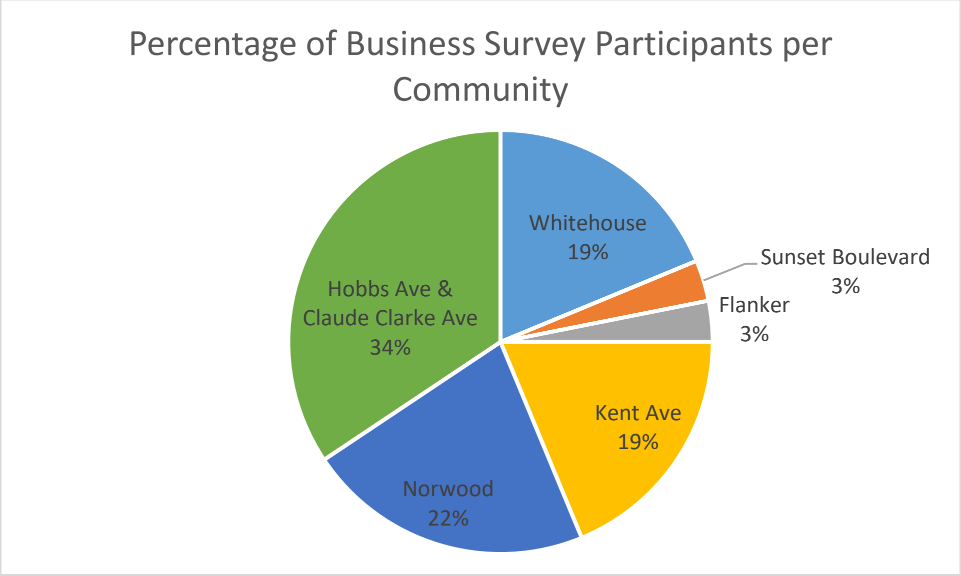


FIGURE 6-13: PERCENTAGE OF BUSINESS SURVEY PARTICIPANTS PER COMMUNITY

Most participating businesses have been in operation for at least eleven years. Forty-one percent (41.0%) of interviewees stated that the business was in operation for more than 15 years, while 19.0% stated an operational period of between 11-15 years. Twenty-eight percent (28.0%) stated that businesses were in operation for between 6-10 years while 9.0% indicated 2-5 years, and 3.0% stated that the business was in operation for less than two years.

Ninety-one percent (91.0%) of businesses surveyed indicated that they were open for business more than five days per week, 6.0% were open for five days, while 3.0% were open for business four days each week.

6.2.5.1 Business - Project Awareness

All business participants were familiar with the company Sandals Resorts International. However, awareness of the company's proposal to construct the eighteen (18) single-storey overwater bungalows was low. Eighty-four percent (84.0%) of business interviewees stated that they were not aware of the proposal, while 16.0% were aware (**Figure 6-14**).

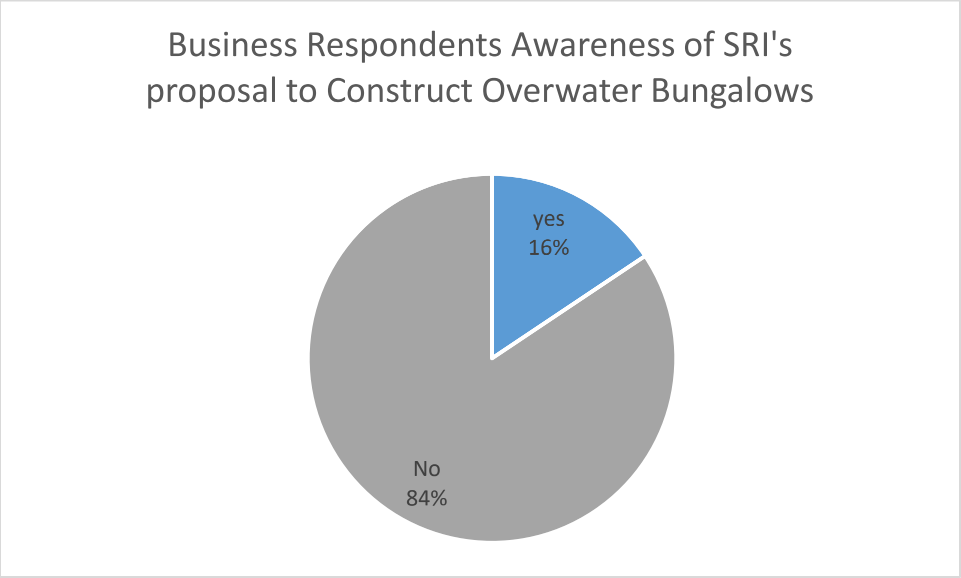


FIGURE 6-14: BUSINESS RESPONDENTS AWARENESS OF SRI'S PROPOSAL TO CONSTRUCT OVERWATER BUNGALOWS

The sixteen percent (16.0%) of business participants confirming awareness of the project were further asked about being aware of a swimming pool, bar area, boardwalks/linkways and the installation of piles being part of the overall overwater bungalows construction. All (100.0%) of these respondents stated that they were aware of these subcomponents.

Word of mouth (60%) was the main media through which business participants were made aware of the proposed project. Other media identified were the survey exercise done in 2022 (20.0%), and a business meeting (20.0%).

As it regarded awareness of SRI's proposal to construct ten (10) single-storey villa-style units, 94.0% of business survey participants indicated that they were not aware of this proposal, while 6.0% of interview participants stated that they were aware of this aspect of the proposed project (**Figure 6-15**).

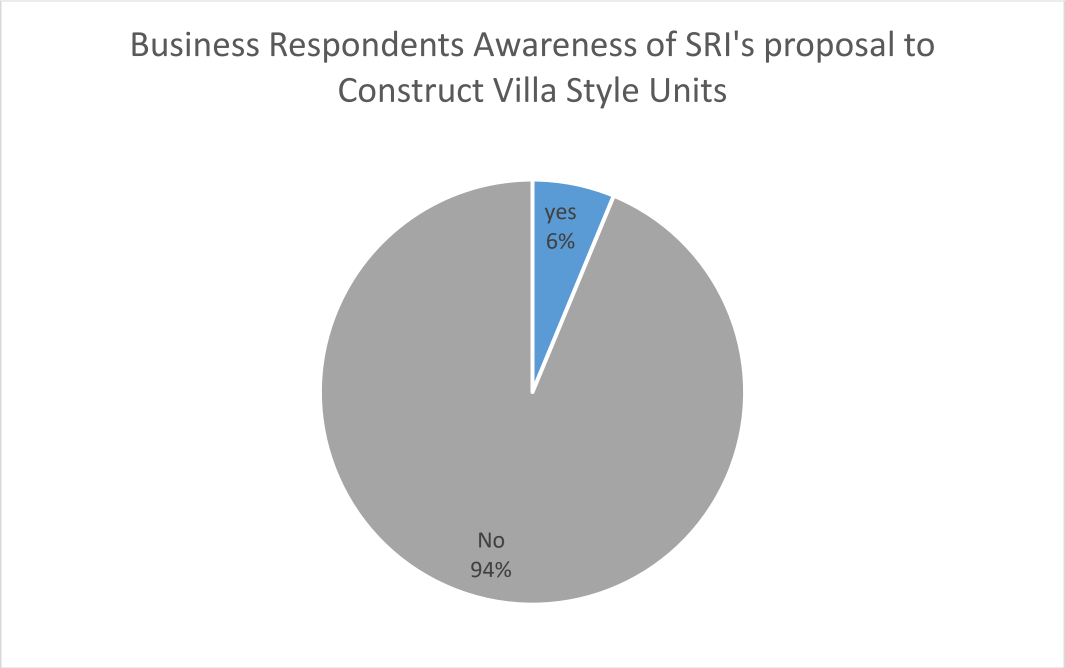


FIGURE 6-15: BUSINESS RESPONDENTS AWARENESS OF SRI'S PROPOSAL TO CONSTRUCT BUNGALOW -STYLE UNITS

Of the six percent (6.0%) of persons confirming awareness of the proposal to construct the bungalow-style units, all respondents (100.0%) indicated that they knew the project would include modifying a section of the existing wetland and coastal modification work.

Fifty percent (50.0%) stated that they were made aware of this aspect of the project by "word of mouth" while 50.0% stated "other" and referenced a business meeting as the medium through which they were made aware of the project.

6.2.5.2 Business - Issues/ Problems/ Concerns at the Proposed Site

On the issue of whether there have been issues/problems at the proposed project site ninety-four percent (94.0%) of business respondents indicated that there were no issues at the proposed project site while 6.0% of interviewees stated that they were unaware of any issues/problems.

Six percent (6.0%) of business respondents confirmed that they had general concerns with the project as proposed while 81.0% stated that they did not have any general concern. Thirteen percent (13.0%) of respondents expressed uncertainty. Of the 6.0% of business participants who indicated that they had concerns about the project, the following concerns were expressed:

- Loss of fishing area and livelihood of fisherfolk - 50.0%
- Loss of the fish population and associated habitat – 50.0%
- Loss of Mangroves – 50.0%

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

In response to having concerns specific to the bungalows being built overwater, 84.0% of interviewees stated that they had no concern while 10.0% expressed uncertainty. Six percent (6.0%) of respondents indicated that they had concerns specifically relating to the bungalows being built overwater. Concerns expressed were:

- Destruction of the fish habitat – (50.0%)
- No overwater bungalows should be erected in the area being proposed – 50.0%

Eighty-eight percent (88.0%) of business participants indicated that they did not have any concern relating to the installation of piles to facilitate construction of the overwater bungalows, while 6.0% expressed uncertainty. Six percent (6.0%) of survey participants indicated that they had specific concerns relating to the installation of piles. Concerns expressed were:

- Fishing boat access will be blocked/impeded – (50.0%)
- No response offered – (50.0%)

When asked, 91.0% of business survey respondents indicated that they did not have any concern relating to the construction of bungalow-style units being a part of the proposed project while 3.0% expressed uncertainty. Six percent (6.0%) of participants indicated that they had concerns specifically relating to bungalow-style units being a part of the project. Specific concerns highlighted were:

- Water sports recreational activities will be displaced (Loss of Access) – (50.0%)
- No response offered – (50.0%)

Regarding respondents having specific concerns relating to wetland and coastal modification being a part of the proposed project, 74.0% of survey participants indicated that they did not have any concerns, while 13.0% of participants expressed uncertainty. Thirteen percent (13.0%) of interviewees indicated that they had concerns about wetland and coastal modification being a part of the project. Concerns expressed were as follows:

- There will be a loss of fish habitat – (50.0%)
- Beach erosion will occur – (50.0%)
- Water sports recreational activities will be displaced (Loss of Access) – (25.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

On the issue of the project's proximity to the runway of the airport, 75.0% of business respondents indicated that they did not have any concerns regarding the proximity of the proposed project to the airport runway, while 3.0% expressed uncertainty. Twenty-two percent (22.0%) of survey participants stated that were concerned about the proximity of the project to the airport runway. Concerns expressed related to:

- The height of the structure creating an obstruction – (44.0%)
- Increased noise impact caused by aircraft – (14.0%)
- Potential risk to (hotel) guests in the event of an airport runway incident – (14.0%)
- Potential risk to aircraft and passengers in emergency situations – (14.0%)
- No response offered – (14.0%)

To address the highlighted concerns, it was suggested by respondents expressing general and/or specific concerns that:

- The airport runway should be realigned.
- Measures should be implemented to protect marine wildlife.
- Bungalows should be built in the water at a distance from shore that would not cause negative impacts to water-sports activities.
- Consideration should be given to ensuring that the livelihood of fisherfolk is not negatively affected.
- Consult with the Airports Authority of Jamaica in the planning and design of buildings.

Percentages have not been presented for the suggestions presented above. Suggestions presented are for respondents who expressed concern in one or multiple areas and are therefore repeated in some instances.

6.2.5.3 Business – Dependence on Proposed Project Location

When asked about dependence on the location proposed for the overwater bungalows and bungalow-style units, six percent (6.0%) of business interviewees stated that they depended on the proposed location, while 94.0% stated that they did not depend on any of the areas.

Of the 6.0% of business respondents confirming dependence on the area, respondents stated they depended on the area for:

- Jet skiing business – (50.0%)
- Accessing the beach for recreation – (50.0%)

As it pertained to business respondents knowing of any other person who depended on the location of the overwater bungalows and bungalow-style units for any type of activity, thirty-four percent (34.0%) of interviewees indicated that they knew other persons who depended on the area. Sixty-six percent (66.0%) of respondents stated that they did not know of anyone who depended on the areas.

Of the 34.0% of survey participants indicating that they knew of other persons who depended on the area, respondents stated they depended on the area for:

- Fishing – (73.0%)
- Accessing the beach for recreation – (27.0%)

6.2.5.4 Business - Impact on Business

As it pertained to how respondents thought the project may impact their business, 46.0% indicated that the proposed project would not impact their business in any way, 16.0% stated that they were unsure how the project may impact their business. Nineteen percent (19.0%) of respondents anticipated a positive impact while a similar 19.0% anticipated that their business would be negatively impacted from the project (**Figure 6-16**).

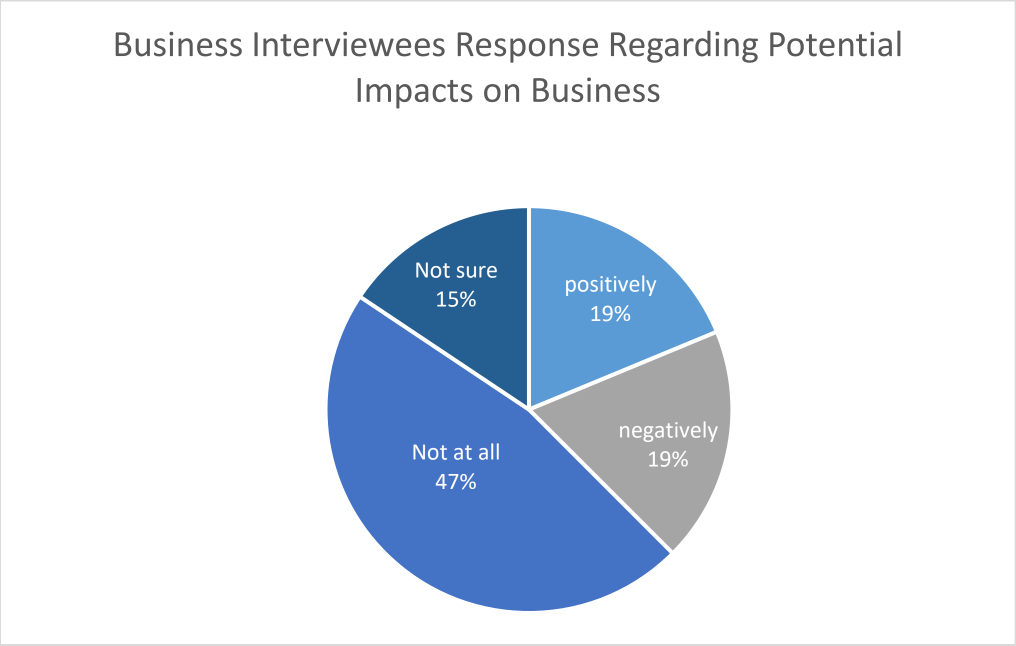


FIGURE 6-16: BUSINESS INTERVIEWEES RESPONSE REGARDING POTENTIAL IMPACTS ON BUSINESS

Of the 19.0% of respondents indicating a positive impact on their business from the project, impacts anticipated included:

- Employment opportunities – (33.0%)
- Increased business opportunity – (67.0%)

For the 19.0% of interviewees who expected a negative impact on their business from the project, the following negative impacts were stated:

- Loss of income – (67.0%)
- Loss of fishing livelihood – (17.0%)
- Loss of recreational space – (17.0%)
- Unavailability of fish for purchase – 17.0%)

Percentages exceeded 100.0% as multiple negative impacts were stated by some business participants.

As it pertained to possible solutions to address the highlighted concerns, the following suggestions were supported:

- Do not build in the area – (17.0%)
- Replant mangroves – (17.0%)
- Establish a new area for a (public use) recreational beach – (17.0%)
- Sandals should engage external tour operators – (17.0%)
- No further suggestions – (32.0%)

6.2.5.5 Business - Impact of Mangrove Removal

When asked about the type of impact that would be caused by removing mangroves, 19.0% of business respondents stated that the removal of mangroves would not cause an impact in any way, while 28.0% of participants stated that they were uncertain. Fifty-three (53.0%) percent of business interviewees stated that there would be a negative impact (**Figure 6-17**).

For those anticipating a negative impact caused by mangrove removal (53.0%), the following negative impacts were stated:

- Destruction of fish habitat and nursery area – (71.0%)
- Migration of fish species – (24.0%)
- Increased risk of flooding – (6.0%)
- Damage to the ecosystem - (6.0%)

Percentages exceeded 100.0% as some business participants stated multiple negative impacts.

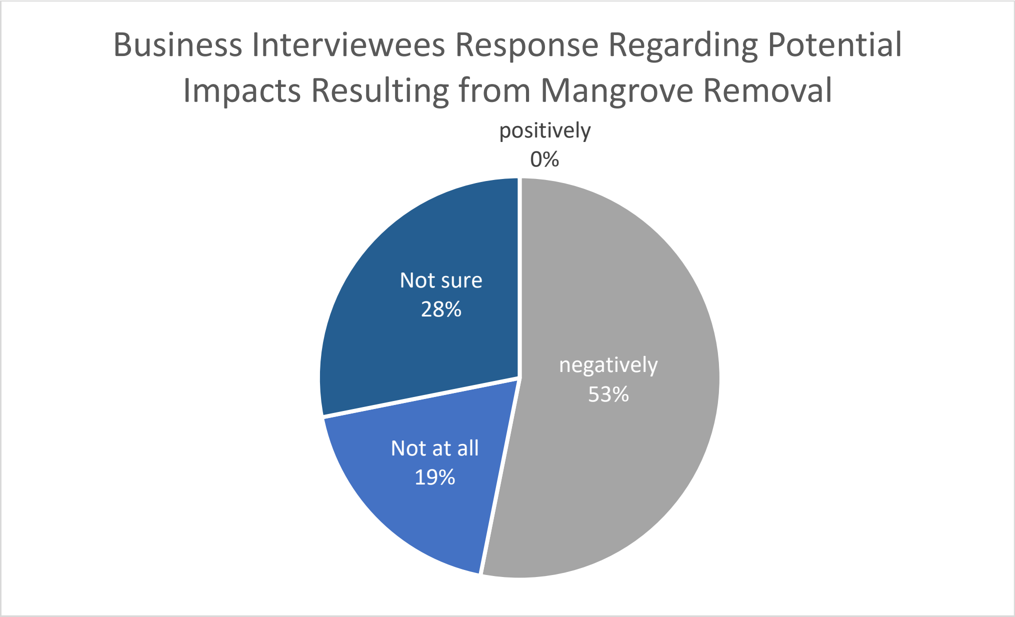


FIGURE 6-17: BUSINESS INTERVIEWEES RESPONSE REGARDING POTENTIAL IMPACTS RESULTING FROM MANGROVE REMOVAL

In response to these concerns the following was recommended:

- Do not remove mangroves – (12.0%)
- No further suggestion – (88.0%)

6.2.5.6 Business - Impact during Construction

Business participants were asked about the extent to which the project would impact the following variables during the construction phase and after construction / operations phase of the project:

- Marine Water Quality
- Marine Wildlife/Fish Population
- Air Quality
- Noise Levels
- Fisherfolk
- Flooding
- Businesses and Services nearby the project area

- Residential Communities nearby the project area
- Employment Opportunities
- The Tourism Product

Irrespective of whether it was during or post construction, business survey participants did not anticipate a positive impact on:

- Marine Water Quality
- Marine Wildlife/Fish Population
- Air Quality
- Noise Levels
- Fisherfolk
- Flooding

Table 6-20 presents the summary of perceived impacts during construction and **Table 6-21** presents the summary of perceived impacts after construction.

TABLE 6-20: BUSINESS RESPONDENTS PERCEIVED IMPACTS – DURING CONSTRUCTION

Perceived Impacts During Construction					
	Positively	**Negatively**	**No Impact**	**Not Sure**	**Total**
Marine Water quality	0.0	47.0	13.0	40.0	100.0
Marine Wildlife/Fish Population	0.0	53.0	6.0	41.0	100.0
Air Quality	0.0	28.0	38.0	34.0	100.0
Noise Levels	0.0	9.0	50.0	41.0	100.0
Fisherfolk	0.0	63.0	3.0	34.0	100.0
Flooding	0.0	16.0	34.0	50.0	100.0
Businesses & Services Nearby the Project Area	19.0	9.0	31.0	41.0	100.0
Residential Communities Nearby the Project Area	6.0	6.0	41.0	47.0	100.0
Employment Opportunities	47.0	9.0	16.0	28.0	100.0
The Tourism Product	25.0	0.0	22.0	53.0	100.0
Average	**9.7**	**24.0**	**25.4**	**40.9**	

Survey data revealed that in general respondents were unsure of the project’s impacts during construction when asked about specific variables (**Table 6-20**). On average, 40.9% of business interviewees expressed uncertainty. This was followed by 25.4% of interviewees who perceived that there would be no impact on the specific variables during the construction phase of the project. Twenty-four percent (24.0%) of business respondents anticipated a negative impact during the project’s construction phase while 9.7% (on average) anticipated a positive impact.

It should be noted that respondents anticipated some positive impact during construction on the following variables:

- Businesses and Services nearby the project area - (19.0%)
- Residential Communities nearby the project area – (6.0%)
- Employment Opportunities – (47.0%)
- The Tourism Product – (25.0%)

It was perceived by business respondents that the areas to experience the greatest negative impact were:

- Marine Water Quality – (47.0%)
- Marine Wildlife/Fish Population – (53.0%)
- Fisherfolk – (63.0%)

6.2.5.7 Business – Impact after Construction

Similar to the project’s construction phase, when asked about specific variables, survey data revealed that on average, the greater percentage of business respondents were unsure of the project’s impacts after construction (**Table 6-21**). On average 38.9% of business interviewees expressed uncertainty. This was followed by 31.5% of interviewees who perceived that there would be no impact on the specific variables after construction. Approximately eighteen percent (17.7%) of business respondents anticipated a negative impact post construction while 11.9% (on average) anticipated a positive impact.

It should be noted that respondents anticipated some positive impact post construction on the following variables:

- Businesses and Services nearby the project area - (19.0%)
- Residential Communities nearby the project area – (6.0%)

- Employment Opportunities – (56.0%)
- The Tourism Product – (35.0%)

It was perceived by business respondents that the areas to realise the greatest negative impact were:

- Marine Water Quality – (47.0%)
- Marine Wildlife/Fish Population – (44.0%)
- Fisherfolk – (56.0%)

TABLE 6-21: BUSINESS RESPONDENTS PERCEIVED IMPACTS – AFTER CONSTRUCTION

Perceived Impacts After Construction (During Operations)					
	Positively	**Negatively**	**No Impact**	**Not Sure**	**Total**
Marine Water quality	0.0	47.0	13.0	40.0	100.0
Marine Wildlife/Fish Population	0.0	44.0	16.0	40.0	100.0
Air Quality	0.0	3.0	56.0	41.0	100.0
Noise Levels	0.0	0.0	66.0	34.0	100.0
Fisherfolk	0.0	56.0	9.0	35.0	100.0
Flooding	0.0	6.0	35.0	59.0	100.0
Businesses & Services Nearby the Project Area	19.0	9.0	41.0	31.0	100.0
Residential Communities Nearby the Project Area	6.0	3.0	44.0	47.0	100.0
Employment Opportunities	56.0	6.0	19.0	19.0	100.0
The Tourism Product	38.0	3.0	16.0	43.0	100.0
Average	**11.9**	**17.7**	**31.5**	**38.9**	

6.2.5.8 Business - Perception – Beach Erosion, Beach Alteration, Mangrove Relocation/Replanting

In an effort to gauge how business respondents perceived the project's potential impact on beach erosion, beach alteration and the potential impact on seagrass beds, as well as the potential acceptance of mangrove removal with associated restoration/replanting, respondents were asked to indicate the extent to which they agreed or disagreed with the following statements:

- The project as proposed will increase the chance of beach erosion.
- I would be more accepting of mangrove removal or modification if the project incorporated mangrove restoration/ replanting.

- Any alteration of the beach will negatively affect seagrass beds and the environmental purpose they serve.

Sixty-five percent (65.0%) of respondents agreed that the project as proposed would increase the chance of beach erosion - 31.0% - strongly agreed, and 34.0% - agreed (**Table 6-22**). Six percent (6.0%) expressed disagreement (0.0% - strongly disagreed and 6.0% - disagreed), while 9.0% neither agreed nor disagreed and 20.0% expressed uncertainty as it regarded whether the project would increase the potential for beach erosion to occur.

TABLE 6-22: BUSINESS PERCEPTION OF BEACH EROSION, BEACH ALTERATION ON SEAGRASS BEDS, AND MANGROVE RELOCATION/REPLANTING

	Strongly Agree	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**	**Not Sure**	**Total**
The project as proposed will increase the chance of beach erosion	31.0	34.0	9.0	0.0	6.0	20.0	100.0
I would be more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting	28.0	16.0	21.0	3.0	13.0	19.0	100.0
Any alternation of the beach will negatively affect seagrass beds and the environmental purpose they serve	34.0	31.0	9.0	0.0	6.0	20.0	100.0

On the issue of respondents being more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting, forty-four percent (44.0%) of respondents indicated that they would be more accepting if mangrove restoration/ replanting was a component of the project (28.0% - strongly agreed and 16.0% - agreed). Sixteen percent (16.0%) expressed disagreement (3.0% - strongly disagreed and 13.0% - disagreed), while 21.0% neither agreed nor disagreed and 19.0% expressed uncertainty.

Pertaining to whether any alteration of the beach would negatively affect seagrass beds and the environmental purpose they serve, sixty-five percent (65.0%) of respondents agreed that altering the beach would cause a negative impact on seagrass beds and their purpose (34.0% - strongly agreed and 31.0% - agreed). Six percent (6.0%) expressed disagreement (0.0% - strongly disagreed and 6.0% -

disagreed), while 9.0% neither agreed nor disagreed and 20.0% expressed uncertainty regarding whether beach alteration would result in negative impact to seagrass beds and their purpose.

6.2.6 Fisherfolk Perception Survey Results

6.2.6.1 Fisherfolk – Cohort Description

All fisherfolk interviewed (100.0%) were from the Whitehouse Fishing Beach. The Whitehouse Fishing Beach is their primary location for launching and docking boats, constructing fish pots, selling catch, and conducting general activities associated with the fishing profession.

The Whitehouse Fishing Beach is a recognised fishing beach and falls under the oversight of the National Fisheries Authority. All (100.0%) fishers interviewed stated that they were registered with the National Fisheries Authority. Some fishers who use the Whitehouse Fishing Beach are affiliated with the "Whitehouse Fisherfolk Cooperative". Information received suggests that there are approximately seventy-five registered fishers who are affiliated with the Fishing Beach.

Age and Sex

During the 2024 field survey exercise, eleven (11) fishers were interviewed, and all (100.0%) were male. Of this number 73.0% were residents of the Whitehouse community, while 27.0% lived outside the community. For those living outside the Whitehouse community, 34.0% were from the nearby community of Flankers(s), 33.0% were from John's Hall and 33.0% were from Norwood. During the 2022 survey exercise fishers who lived in Bogue Village and Kingston were encountered. Regarding the age cohort distribution of participants, no one interviewed was under twenty-five years of age. Nine percent (9.0%) of respondents were between 26-33 years of age, a similar nine percent (9.0%) were between ages 34 and 41. Forty-six percent (46.0%) were between ages 42 and 50, while 27.0% were within the 51-60 age group. Nine percent (9.0%) of survey participants were over sixty (60) years of age.

On the issue of whether additional members within the household engaged in fishing as a profession, 73.0% of respondents indicated that no other family member was involved, while 27.0% of interviewees confirmed that other household members were involved in fishing. These interviewees (27.0%) indicated that the household had one additional family member. When asked, it was stated that the additional family member was engaged in fishing (100.0%) and also fish vending (33.3%).

Percentages exceeded 100.0% as some household members were engaged in both fishing and vending.

Seventy-three percent (73.0%) of fishers confirmed that fishing was done on a full-time basis, while 27.0% stated that fishing was not pursued full-time. Of the 27.0% of interviewees, who indicated that fishing was done on a part-time basis, all of these persons (100.0%) stated that they were otherwise employed on a part-time basis.

On the issue of the highest level of education completed, 9.0% 0f of fishers stated college. This level of education was the highest attained by survey participants. Forty-six percent (46.0%) indicated high school as the highest level of education completed, 27.0% also stated the primary/all age level, while 9.0% stated that they did not attend any type of educational institution. Nine percent (9.0%) of interviewed fishers stated "some high school", as they did not complete secondary level education.

Regarding the number of years' fishers were engaged in the profession, it was realised that most fishers interviewed (73.0%) were engaged in fishing at least twenty-five years. Specifically, 9.0% were fishers for between 25 and 30 years while 64.0% stated that they have been fishing for more than 30 years. Eighteen percent (18.0%) of respondents stated they were fishers for between 12 and 17 years while 9.0% stated 6 to 11 years. No one (0.0%) interviewed indicated 18 to 24 years or between zero to five years.

All (100.0%) fishers interviewed stated that they sold their catch directly to customers.

As it pertained to the weekly income generated from fish sales, no one interviewed stated a weekly income of less than $8,000.00. Forty-six percent (45.0%) of respondents declined to disclose weekly income information. Thirty-six percent (36.0%) of fishers indicated that the weekly income earned was in excess of $10,000.00, while eighteen percent (18.0%) stated income was between $8,001.00 and $10,000.00.

Regarding the tool/implement used for fishing, 73.0% stated that the line was used, 73.0% stated that the fish pot was used for fishing. Fifty-five percent (55.0%) stated that they were line fishers, 27.0% stated that they were net fishers, and 18.0% of fishers indicated that they used the spear. Nine percent (9.0%) indicated that they fished using a large boat with a net trawler.

Percentages exceeded 100.0% as fishers used multiple implements/tools for fishing.

Of the 73.0% of fishers indicating that their fishing vessel was a canoe with an engine, all (100.0%) of them indicated that their vessel had one engine and further confirmed that they docked their vessel at the Whitehouse Fishing Beach. Specific to the size engines used by these fishers, engine sizes used were 40HP (used by 12.0%) and 60HP (used by 88.0%).

In response to whether fishing was done in nearshore or deep water:

- Fifty-five percent (55.0%) of fishers indicated that they fished in nearshore (inner harbour) waters not beyond 1.0 mile /1.6Km from shore.
- Thirty-six percent (36.0%) of fishers indicated that they did deep sea fishing more than 5.0 miles/8.0Km offshore.
- Nine percent (9.0%) of fishers indicated that they did deep sea fishing within 1.0 and 5.0 miles/ 1.6 and 8.0Km offshore.

When asked about the names of the fishing areas, fishers in general fished along the north coast from as far east as Portland, to Hanover in the west.

Although not quantitatively represented, it was explained that fishing was done in different areas based on:

- the prevailing weather conditions. In inclement weather, fishers remained nearshore close to safe harbour.
- the species of fish being sought. Species vary between nearshore and deep waters.
- the fishing tool/implement. Fish pots are set in shallow calm waters.

Regarding how many times per week fishers went fishing, 9.0% of fishers stated that on average they went fishing more than five times in any given week, 27.0% stated five times each week, 9.0% indicated three times per week while, 37.0% stated twice per week and 18.0% stated once weekly.

Seventy-four (74.0%) of fishers (with canoes) stated three persons worked on the vessel, 13.0% indicated two persons and a similar 13.0% indicated that one person worked on the fishing vessel (they were the only person).

On the issue of average pound catch of fish harvested on each fishing event, 64.0% of fishers indicated that the average pound catch was between (5.0 - 9.0 kg) 11 and 20 pounds, 18.0% stated (9.5 - 22.7 kg)

21 and 50 pounds, 9.0% stated (23.1 – 45.4 kg) 51 and 100 pounds, and 9.0% stated more than (45.4kg) 100 pounds.

In an effort to assess any possible changes in the income generated from the sale of fish and identify any time related changes in the sizes and types (species) harvested, fishers were asked to indicate their agreement or disagreement with the following statements:

- The money that I earn from fish sales has increased over time
- The size and type of fish that I catch has increased over time

Thirty-six percent (36.0%) of respondents agreed that the money earned from fish sales has increased over time. Eighteen percent (18.0%) expressed disagreement, while 46.0% neither agreed nor disagreed.

Of the 36.0% agreeing that fish sales income increased with time:

- 25.0% attributed the increase to harvesting more fish (increased catch),
- 75.0% offered no specific response.

For the 18.0% expressing disagreement, essentially stating that fish sales had decreased over time, none of these respondents offered any response as to what may have attributed to this decrease.

Thirty-six percent (36.0%) of respondents agreed that the size and type fish caught has increased over time. A similar thirty-six percent (36.0%) expressed disagreement, while 27.0% neither agreed nor disagreed.

Of the 36.0% agreeing that sizes and types of fish caught (harvested) increased with time:

- 25.0% attributed the increase to the increase in the size of the fish being sold,
- 75.0% offered no specific response.

For the 36.0% expressing disagreement, essentially stating that fish sizes and species diversity had decreased over time, none of these respondents offered any response as to what may have attributed to this decrease.

6.2.6.2 *Fisherfolk – Project Awareness*

On the issue of awareness, of a company named "Sandals Resorts International", all (100.0%) of fishers interviewed stated that were aware of the company.

As it pertained to whether interviewed fishers were aware of the proposal to construct the eighteen (18) single-storey overwater bungalows, seventy-three percent (73.0%) of fishers stated that they were not aware of the proposal, while 27.0% stated that they knew of the proposal (**Figure 6-18**).

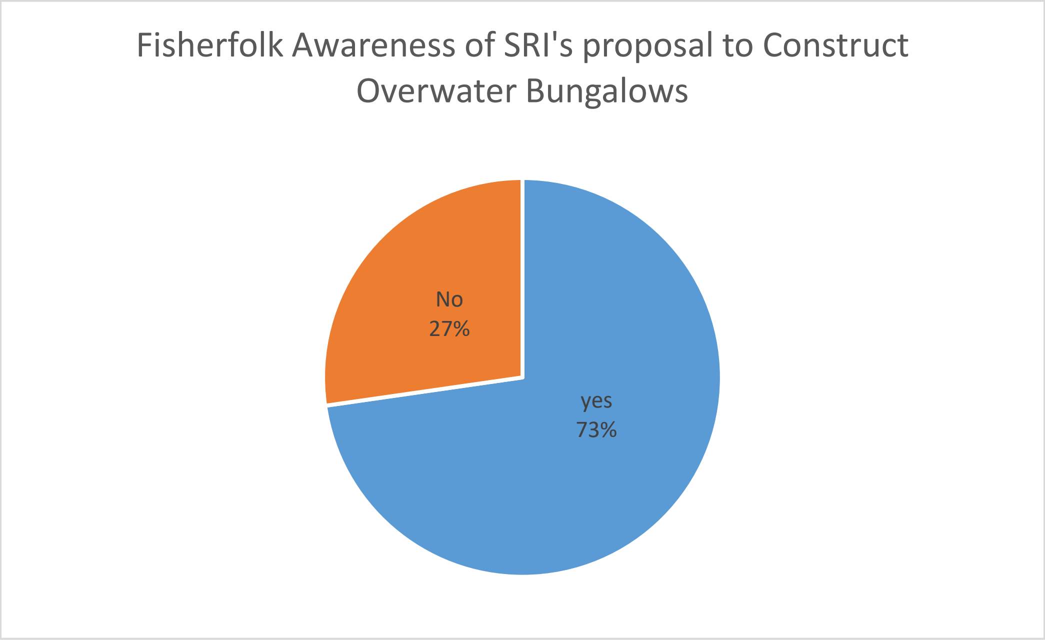


FIGURE 6-18: FISHERFOLK AWARENESS OF SRI'S PROPOSAL TO CONSTRUCT OVERWATER BUNGALOWS

The twenty-seven percent (27.0%) of fishers confirming awareness of the project were further asked about being aware of a swimming pool, bar area, boardwalks/linkways and the installation of piles being part of the overall overwater bungalows construction. Eighty-eight (88.0%) of these respondents stated that they were aware of these subcomponents while 12.0% stated that they had no prior knowledge.

Seventy-four percent (74.0%) stated that they were made aware of the project by "word of mouth" while 13.0% stated "other" and referenced the survey exercise done in 2022. A similar 13.0% stated social media as the medium through which they were made aware of the project.

As it regarded awareness of SRI's proposal to construct ten (10) single-storey bungalow-style units, 73.0% of interviewed fishers indicated that they were not aware of this proposal, while 27.0% of interview participants stated that they were aware of this aspect of the proposed project (**Figure 6-19**).

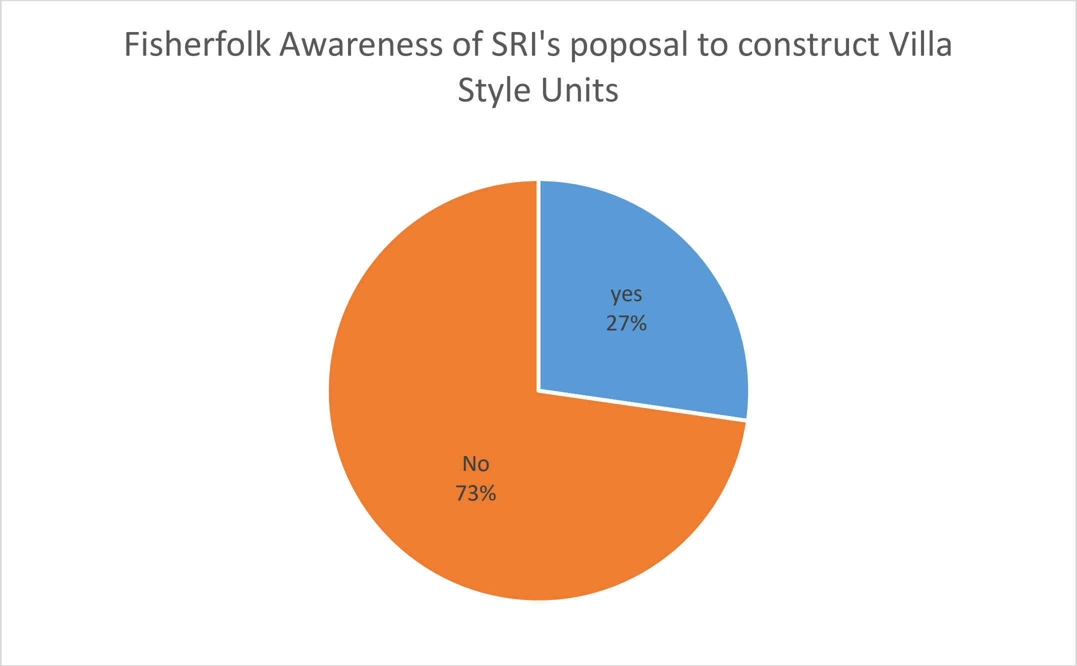


FIGURE 6-19: FISHERFOLK AWARENESS OF SRI'S PROPOSAL TO CONSTRUCT VILLA -STYLE UNITS

Of the twenty-seven percent (27.0%) of fishers confirming awareness of the proposal to construct the bungalow-style units, 33.0% indicated that they knew the project would include modifying a section of the existing wetland and coastal modification work, while 67.0% stated that they were unaware of these aspects of the project.

All fishers confirming awareness of the construction of the bungalow-style units stated that they were made aware of this aspect of the project by "word of mouth" as the medium through which they were made aware of the project.

6.2.6.3 Fisherfolk - Issues/Problems/Concerns at the Proposed Site

On the issue of whether there have been issues/problems at the proposed project site ninety-one percent (91.0%) of fishers indicated that there were no issues at the proposed project site while 9.0%

stated that they were issues/problems at the proposed site. Of these 9.0% of fishers, all of them (100.0%) stated that the proposed site experiences flooding caused by tidal surge.

Fifty-five percent (55.0%) of interviewed fisherfolk confirmed that they had general concerns with the project as proposed while 45.0% stated that they did not have any general concern. (**Figure 6-20**).

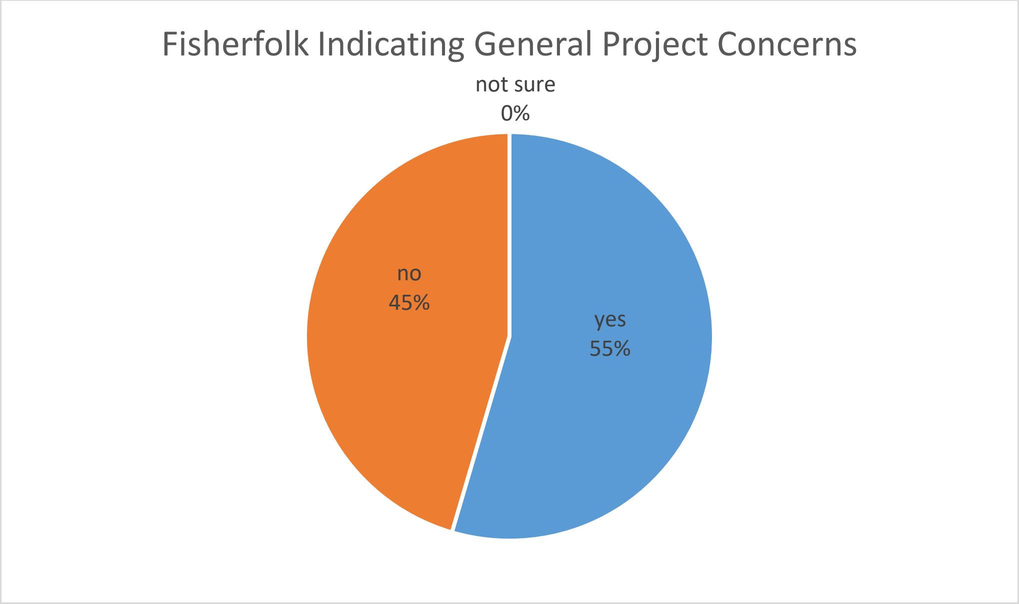


FIGURE 6-20: PERCENTAGE OF FISHERFOLK INDICATING GENERAL PROJECT CONCERNS

Of the 55.0% of fishers who indicated that they had concerns about the project, the following concerns were expressed:

- Loss of fishing area and livelihood of fisherfolk - 67.0%
- Loss of the fish population and associated habitat – 17.0%
- Loss of beach/recreation area – 17.0%
- Pollution of the marine environment – 17.0%
- Loss of Mangroves – 17.0%
- Whether dredging would be a part of the project – 17.0%

Percentages exceeded 100.0% as some fishers expressed multiple concerns.

In response to having concerns specific to the bungalows being built overwater, 55.0% of interviewees stated that they had concerns while 45.0% indicated that they had no concerns specifically relating to the bungalows being built overwater. Concerns expressed were:

- Loss of the fishing area/Destruction of the fish habitat – (50.0%)
- Migration of fish – (33.0%)
- Increased turbidity – (17.0%)
- Loss of beach access/recreation area – (17.0%)
- Fishing boat channel will be blocked – (17.0%)

Percentages exceeded 100.0% as some fishers expressed multiple concerns.

As it regarded respondents having specific concerns relating to the installation of piles to facilitate construction, 27.0% of interviewed fishers indicated that they did not have any concern while 18.0% expressed uncertainty. Fifty-five percent (55.0%) of fishers indicated that they had specific concerns relating to the installation of piles. Concerns expressed were:

- Increased turbidity – (50.0%)
- Increased sludge – (33.0%)
- Fish Migration – (33.0%)
- Disturbance of the sea floor (17.0%)

Percentages exceeded 100.0% as some fishers expressed multiple concerns.

When asked, 36.0% of fishers surveyed indicated that they did not have any concern relating to the construction of bungalow-style units being a part of the proposed project while 18.0% expressed uncertainty. Forty-six percent (46.0%) of participants indicated that they had concerns specifically relating to bungalow-style units being a part of the project. Specific concerns highlighted were:

- Loss of Mangroves – (40.0%)
- Loss of the fishing area/Destruction of the fish habitat – (40.0%)
- Effluent discharge into the marine environment – (20.0%)
- Disruption of the natural marine ecosystem balance – (20.0%)

Percentages exceeded 100.0% as some fishers expressed multiple concerns.

With regards to fishers having specific concerns relating to wetland and coastal modification being a part of the proposed project, 27.0% of survey participants indicated that they did not have any concerns, while 9.0% of participants expressed uncertainty. Sixty-four percent (64.0%) of interviewed fisherfolk indicated that they had concerns about wetland and coastal modification being a part of the project. Concerns expressed were as follows:

- There will be a loss of fish habitat – (72.0%)
- Increased turbidity – (14.0%)
- No suggestion offered – (14.0%)

On the issue of the project's proximity to the runway of the airport, 91.0% of fishers indicated that they did not have any concerns regarding the proximity of the proposed project to the airport runway, while 9.0% expressed uncertainty.

To address the highlighted concerns, it was suggested by fisherfolk expressing general and/or specific concerns that:

- Leave a section of the mangrove undisturbed to serve as a fish nursery/habitat.
- Do not disturb/remove the mangroves.
- Replant mangroves in a suitable location.
- Allow access to the beach for recreational purposes.

Percentages have not been presented for the suggestions presented above. Suggestions presented are for respondents who expressed concern in one or multiple areas and therefore repeat in some instances.

6.2.6.4 Fisherfolk – Dependence on Proposed Project Location

When asked about dependence on the location proposed for the overwater bungalows and bungalow-style units, fifty-five percent (55.0%) of interviewed fishers stated that they depended on the proposed location, while 45.0% stated that they did not depend on any of the areas.

Of the 55-.0% fishers confirming dependence on the area, respondents stated they depended on the area for:

- Fishing – (83.0%)
- Boat tours – (17.0%)

As it pertained to fishers knowing of any other person who depended on the location of the overwater bungalows and villa-style units for any type of activity, sixty-four percent (64.0%) of interviewees indicated that they knew other persons who depended on the area. Thirty-six percent (36.0%) of respondents stated that they did not know of anyone who depended on the areas.

Of the 64.0% of survey participants indicating that they knew of other persons who depended on the area, respondents stated they depended on the area for:

- Fishing – (86.0%)
- Accessing the beach for recreation – (57.0%)

Percentages exceeded 100.0% as fishers indicated some persons used the area for multiple purposes.

6.2.6.5 Fisherfolk - Impact on Lives/Livelihood & Removal of Mangroves

As it pertained to how fishers thought the project may impact their lives/livelihoods, 18.0% indicated that the proposed project would not impact their lives/livelihoods in any way, 27.0% stated that they were about unsure how the project may impact their lives. Nine percent (9.0%) of respondents anticipated a positive impact while 46.0% anticipated that their business would be negatively impacted from the project (**Figure 6-21**).

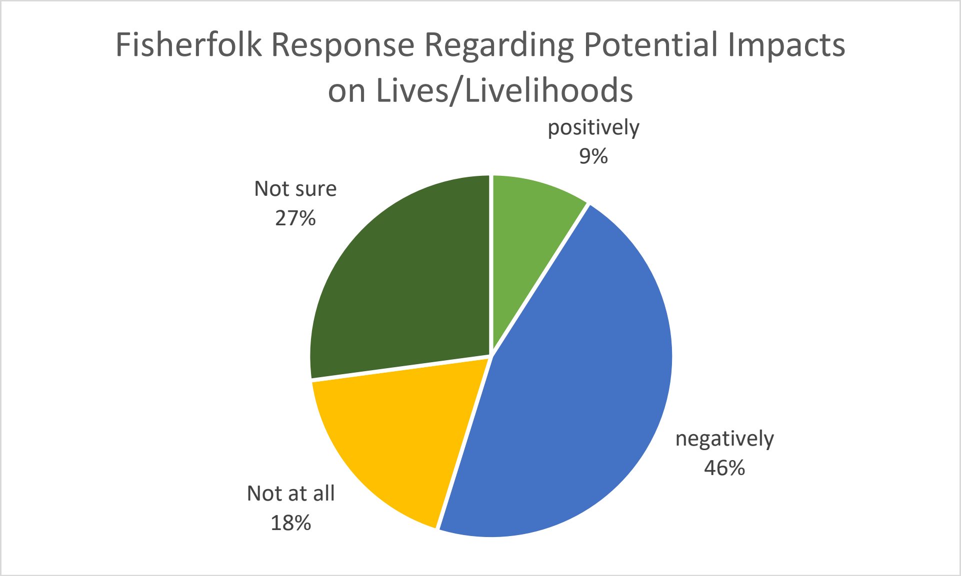


FIGURE 6-21: FISHERS RESPONSE REGARDING POTENTIAL IMPACTS ON LIVES/LIVELIHOODS.

Of the 9.0% of fishers indicating a positive impact on their lives/livelihoods from the project, all (100%) anticipated employment opportunities as the positive project benefit.

For the 46.0% of interviewed fishers who expected a negative impact on their lives/livelihoods from the project the following reasons were given:

- Loss of fishing livelihood – (80.0%)
- Increased costs to venture further out to sea for fishing – (20.0%)
- Anticipated reduction in potable water supply (low water pressure/service disruptions) – (20.0%).

Percentages exceeded 100.0% as multiple negative impacts were stated by some business participants.

As it pertained to possible solutions to address the highlighted concerns:

- Sandals should engage the fisherman's cooperative – (20.0%)
- Fisherfolk should be compensated for loss – (20.0%)
- No construction should be done in the area – (20.0%)
- Effluent should not be discharged into the marine environment – (20.0%)
- No further suggestions – (20.0%)

6.2.6.6 Fisherfolk - Impact of Mangrove Removal

When asked about the type of impact that would be caused by removing mangroves, 9.0% of fishers stated that the removal of mangroves would not cause an impact in any way. Ninety-one (91.0%) percent of interviewed fishers stated that there would be a negative impact (**Figure 6-22**).

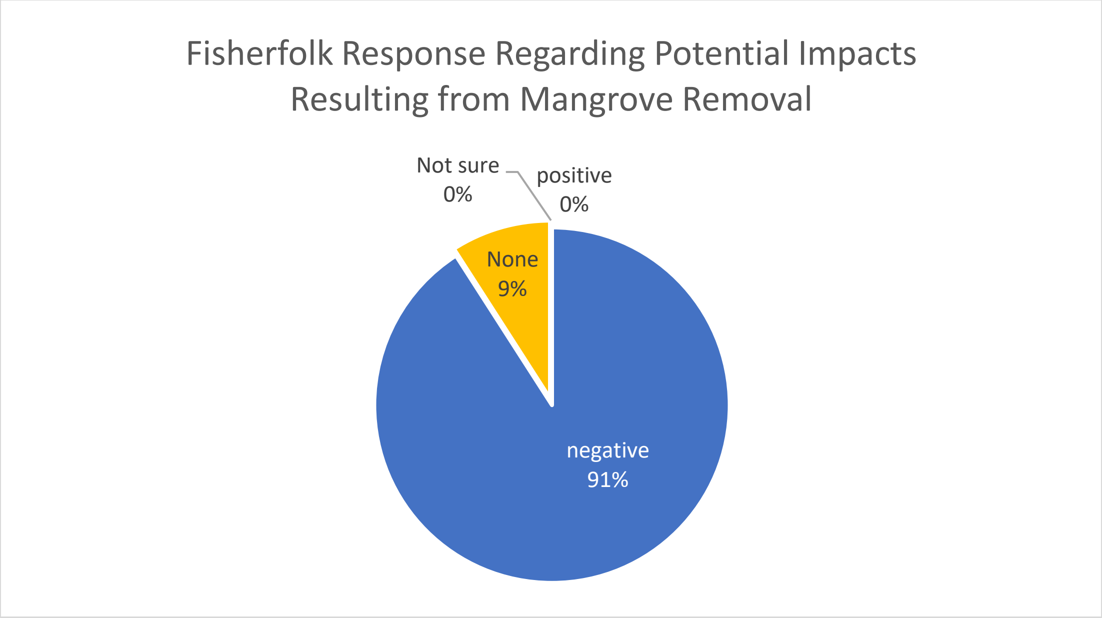


FIGURE 6-22: FISHERFOLK RESPONSE REGARDING POTENTIAL IMPACTS RESULTING FROM MANGROVE REMOVAL

For those anticipating a negative impact caused by mangrove removal (91.0%), the following negative impacts were stated:

- Destruction of fish habitat and nursery area – (70.0%)
- Increased turbidity – (20.0%)
- Migration of fish species – (10.0%)

In response to these concerns fishers suggested:

- Do not remove mangroves – (20.0%)
- Replant mangroves in a suitable location – (10.0%)
- Create a fish breeding ground in a suitable alternative location nearby – (10.0%)
- No further suggestion – (60.0%)

6.2.6.7 Fisherfolk Impact During and After Construction

Fisherfolk were asked about the extent to which the project would impact the following variables during project construction and after construction:

- Marine Water Quality

- Marine Wildlife/Fish Population
- Air Quality
- Noise Levels
- Fisherfolk
- Flooding
- Businesses and Services nearby the project area
- Residential Communities nearby the project area
- Employment Opportunities
- The Tourism Product

Irrespective of whether it was during or post construction, business survey participants did not anticipate a positive impact on:

- Marine Water Quality
- Air Quality
- Noise Levels
- Fisherfolk
- Flooding

Fisherfolk – Impact During Construction

Table 6-23 presents the summary of perceived impacts during construction and **Table 6-24** presents the summary of the perceived impacts after construction.

Table 6-23: Fisherfolk Perceived Impacts – During Construction

Perceived Impacts During Construction					
	Positively	**Negatively**	**No Impact**	**Not Sure**	**Total**
Marine Water quality	0.0	91.0	1.0	0.0	92.0
Marine Wildlife/Fish Population	9.0	91.0	0.0	0.0	100.0
Air Quality	0.0	46.0	18.0	36.0	100.0
Noise Levels	0.0	27.0	55.0	18.0	100.0
Fisherfolk	0.0	91.0	9.0	0.0	100.0
Flooding	0.0	9.0	36.0	55.0	100.0

Businesses & Services Nearby the Project Area	19.0	27.0	27.0	27.0	100.0
Residential Communities Nearby the Project Area	10.0	27.0	27.0	36.0	100.0
Employment Opportunities	46.0	18.0	27.0	9.0	100.0
The Tourism Product	27.0	10.0	36.0	27.0	100.0
Average	**11.1**	**43.7**	**24.4**	**20.8**	

Survey data revealed that in general fisherfolk anticipated negative project impacts during construction when asked about specific variables (**Table 6-23**). On average 43.7% of fishers interviewed anticipated a negative impact. This was followed by 24.4% of interviewees who perceived that there would be no impact on the specific variables during the construction phase of the project. Approximately Twenty-one percent (20.8%) of fisherfolk expressed uncertainty, while 11.1% (on average) anticipated a positive impact.

It should be noted that respondents anticipated some positive impacts during construction on the following variables:

- Marine Wildlife and fish population – (9.0%)
- Businesses and Services nearby the project area - (19.0%)
- Residential Communities nearby the project area – (10.0%)
- Employment Opportunities – (46.0%)
- The Tourism Product – (27.0%)

It was perceived by business respondents that the areas to realise the greatest negative impact were:

- Marine Water Quality – (91.0%)
- Marine Wildlife/Fish Population – (91.0%)
- Fisherfolk – (91.0%)
- Air Quality – (46.0%)

Fisherfolk – Impact After Construction

When asked about specific variables, survey data revealed that on average, the greater percentage of fisherfolk were unsure of the project's impacts after construction (**Table 6-24**).

On average 40.0% of fishers interviewed expressed uncertainty. This was followed by 27.2% of interviewees who perceived that there would be negative impact on the specific variables after construction. Approximately twenty-three percent (22.6%) of fishers anticipated no impact post construction while 10.2% (on average) anticipated a positive impact.

It should be noted that respondents anticipated some positive impact post construction on the following variables:

- Businesses and Services nearby the project area - (10.0%)
- Residential Communities nearby the project area – (9.0%)
- Employment Opportunities – (28.0%)
- The Tourism Product – (55.0%)

It was perceived by respondents that the areas to realise the greatest negative impact were:

- Marine Water Quality – (36.0%)
- Marine Wildlife/Fish Population – (64.0%)
- Fisherfolk – (73.0%)

TABLE 6-24: FISHERFOLK PERCEIVED IMPACTS – AFTER CONSTRUCTION

Perceived Impacts After Construction (During Operations)					
	Positively	**Negatively**	**No Impact**	**Not Sure**	**Total**
Marine Water quality	0.0	36.0	9.0	55.0	100.0
Marine Wildlife/Fish Population	0.0	64.0	0.0	36.0	100.0
Air Quality	0.0	18.0	36.0	46.0	100.0
Noise Levels	0.0	18.0	55.0	27.0	100.0
Fisherfolk	0.0	73.0	9.0	18.0	100.0
Flooding	0.0	9.0	36.0	55.0	100.0
Businesses & Services Nearby the Project Area	10.0	18.0	36.0	36.0	100.0
Residential Communities Nearby the Project Area	9.0	9.0	27.0	55.0	100.0
Employment Opportunities	28.0	18.0	18.0	36.0	100.0
The Tourism Product	55.0	9.0	0.0	36.0	100.0
Average	**10.2**	**27.2**	**22.6**	**40.0**	

6.2.6.8 *Fisherfolk – Impact on Beach Erosion, Beach Alteration, Mangrove Relocation/Replanting*

In an effort to gauge how fisherfolk perceived the project's potential impact on beach erosion, beach alteration and the potential impact on seagrass beds, as well as the potential acceptance of mangrove removal with associated restoration/replanting, respondents were asked to indicate the extent to which they agreed or disagreed with the following statements:

- The project as proposed will increase the chance of beach erosion.
- I would be more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting.
- Any alteration of the beach will negatively affect seagrass beds and the environmental purpose they serve.

The results are summarised in **Table 6-25** below.

TABLE 6-25: FISHERFOLK PERCEPTION OF BEACH EROSION, BEACH ALTERATION ON SEAGRASS BEDS, AND MANGROVE RELOCATION/REPLANTING

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Sure	Total
The project as proposed will increase the chance of beach erosion	55.0	45.0					100.0
I would be more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting	10.0	27.0	9.0	27.0	27.0		100.0
Any alternation of the beach will negatively affect seagrass beds and the environmental purpose they serve	64.0	36.0					100.0

All fishers (100.0%) agreed that the project as proposed would increase the chance of beach erosion (55.0% - strongly agreed and 45.0% - agreed).

On the issue of fisherfolk being more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting, thirty-seven percent (37.0%) of respondents indicated that they would be more accepting if mangrove restoration/replanting was a component of the project (10.0% - strongly agreed and 27.0% - agreed). Fifty-four percent (54.0%) expressed disagreement (27.0% - strongly disagreed and 27.0% - disagreed) and essentially indicating that they would not tolerate mangrove removal irrespective of whether replanting was a project component, while 9.0% neither agreed nor disagreed.

Pertaining to whether any alteration of the beach would negatively affect seagrass beds and the environmental purpose they serve, all fishers (100.0%) interviewed agreed that altering the beach would cause a negative impact on seagrass beds and their purpose (64.0% - strongly agreed and 36.0% - agreed).

6.2.7 Stakeholder Perception

The updated survey instrument was emailed to The Montego Bay Marine Park Trust and MBJ Airports Limited. Both organisations participated in the second consultation exercise. Both organisations are private non-government entities and heard of Sandals Resorts International (SRI).

6.2.7.1 MBJ Airports Limited

One survey instrument was received from MBJ Airports Limited (MBJ). Representatives advised that consultations were held internally with the relevant representatives in completing the instrument.

MBJ Awareness

MBJ indicated that the organisation was made aware of the proposal by SRI to construct the eighteen (18) single-storey overwater bungalows at the time of the 2022 stakeholder survey exercise. Regarding the proposal to construct the ten (10) single-storey villa-style units at the Sandals Montego Bay property, MBJ Airports advised that they were not aware of this proposal.

MBJ - Issues/Problems/Concerns at the Proposed Site

Regarding knowledge of any issues or problems at the proposed site, MBJ advised that the organisation was not aware of any issues at the proposed location.

As it pertained to having general concerns with the project as proposed, MBJ Airports expressed concern relating to the overall conservation and sustainable use of mangroves and the associated ecosystem. This concern was also expressed when asked about concerns regarding wetland and coastal modification being a part of the project. However, the concern was extended to include the need for mitigating measures.

On the issue of the bungalows being built overwater as well as the construction of the bungalow-style units, it was indicated that concern centered around aviation safety and ensuring that the Obstacle Limitation Surface (OLS) was not breached. This concern was also shared when asked about the proximity of the project to the airport runway.

It should be noted that from the 2022 exercise, MBJ Airports highlighted that equipment such as cranes would be of concern during the construction phase of the project.

Pertaining to the installation of piles to facilitate construction, MBJ highlighted the concerns of:

- Increased debris/silt
- Disturbance of the sea-floor and the resulting
- Disturbance/loss of marine life

In response to suggestions that could address the highlighted concerns, MBJ suggested the following:

- Conduct and Environmental Impact Assessment (EIA) to ensure that appropriate mitigation measures are identified to address environmental concerns
- Engage the Airports Authority of Jamaica (AAJ) and the Jamaica Civil Aviation Authority (JCAA) to ensure that elevations are acceptable for flight safety
- Engage the JCAA to address aviation safety concerns.

MBJ – Impact on MBJ Airport Limited

In response to how the proposed project would in general affect the Airport and specifically affect the Airport's core functions, a similar sentiment was shared. In both instances MBJ Airports anticipated both positive and negative impacts. It was indicated that the positive impact was the possibility of the Airport serving to enhance Jamaica's tourism Product offerings. The negative impacts anticipated related to aviation safety and the Obstacle Limitation Surface (OLS) and associated potential flight risk and potential negative environmental impacts and how these impacts may in turn affect the airport's operations. AS mentioned above, it was re-iterated that consultations should be held with the JCAA and the AAJ.

MBJ - Impact of Mangrove Removal

When asked about the type of impact that removing mangroves would have, it was expressed that the impact would be negative and related to the degradation of ecosystems associated with and dependent on mangroves. Increased sedimentation/siltation was also highlighted as a negative impact associated with mangrove removal. As stated above, it was recommended that an EIA should be conducted to ensure that environmental impacts are identified, and appropriate mitigation measures are implemented.

MBJ – Impact on Beach Erosion, Beach Alteration, Mangrove Relocation/Replanting

Regarding the project's perceived potential impact on beach erosion, beach alteration and the potential impact on seagrass beds, as well as the potential acceptance of mangrove removal with associated restoration/replanting, MBJ indicated:

- Uncertainty regarding whether the project would increase the chance of beach erosion.
- Strong Agreement in relation to being more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting.
- Agreement that any alteration of the beach would negatively affect seagrass beds and their environmental purpose.

MBJ – Impact During Construction

In response to anticipated impacts on specific variables during the project's construction phase MBJ Airports indicated that during construction:

- Negative Impact was anticipated on:
  - Marine Water Quality – (siltation during pile construction)
  - Marine Wildlife/Fish Population – (migration caused by siltation and human activity)
- Positive Impact on:
  - Businesses and Services Nearby the Project Area - (possible increased patronage)
  - Residential communities Nearby the Project Area – (possible employment of community members)
  - Employment Opportunities – (increase in job opportunities)
- No Impact on:
  - Air Quality
  - Noise Levels
  - The Tourism Product

- Uncertainty of impact on:
  - Flooding
  - Fisherfolk

MBJ – Impact After Construction

In response to anticipated impacts on specific variables after construction (during operations) MBJ Airports indicated that after construction:

- Negative Impact was anticipated on:
    - Marine Wildlife/Fish Population – (human activity and newly built structures may deter re-establishment of marine wildlife)
- Positive Impact on:
    - The Tourism Product
- No Impact on:
    - Marine Water Quality
    - Air Quality
    - Noise Levels
    - Fisherfolk
    - Businesses and Services Nearby the Project Area
    - Residential communities Nearby the Project Area
    - Employment Opportunities
- Uncertainty of impact on:
    - Flooding

As it regarded MBJ Airports Limited being aware of issues of frequent flooding at or near the proposed site and the site being affected by tidal changes such as storm surge, it was indicated that MBJ did not know of the site being impacted by these issues.

6.2.7.2 Montego Bay Marine Park and Trust

One survey instrument was received from the management of the Montego Bay Marine Park and Trust.

Marine Park Awareness

The Marine Park Trust confirmed awareness of the company Sandals Resorts International (SRI), as well as the proposal by SRI to construct the over-water bungalows and villa-style units at the Sandals Montego Bay property located on Kent Avenue.

It was indicated that awareness of the project and its sub-components was via a community meeting.

Marine Park - Issues/Problems/Concerns at the Proposed Site Concerns

Regarding knowledge of any issues or problems at the proposed site, the Marine Park Trust advised that the organisation was not aware of any issues at the proposed location.

In response to the organisation having general concerns about the project as proposed, the Marine Park Trust expressed the following:

- Disturbing the wetland (during construction and operation) will negatively affect existing ecosystems and marine life.
- Surface run-off from construction, effluent discharge and chemically treated water (if discharged from the swimming pool) will destroy, remaining wetlands, coastal shallow areas and seagrass beds.

The Montego Bay Marine Park Trust indicated that the organisation's concern with the bungalows being built overwater related to the sea floor (marine substrate) being affected and the need for proper handling of construction debris and waste management.

In relation to piles being installed to facilitate construction of the overwater bungalows the concern was raised in relation to how pollution (in all forms) caused by construction activities will be prevented/mitigated.

When asked about concerns related to wetland and coastal modification being a part of the proposed project, The Marine Park Trust, indicated that marine wildlife and the natural filtering system of the marine ecosystem will be negatively affected, with any modification work to the wetland and coastline.

The Marine Park Trust further expressed uncertainty regarding the proximity of the proposed project to the airport runway.

To address highlighted concerns, it was recommended that:

- Measures should be implemented to prevent surface run-off during construction.
- Seagrass rehabilitation/restoration should be considered.

- Chlorinated water should not be used in the swimming pools.
- Saltwater purification should be considered for the swimming pool instead of chlorinated water.
- Consideration should be given to allowing public access to the beach.

Marine Park - Dependence on Proposed Project Location

As it pertained to whether the organisation used the proposed project area, The Marine Park Trust indicated that the organisation uses the area to access the beach and also indicated awareness of other entities that use the area to access the beach. It was further explained that the proposed project area falls within the boundaries of the fish sanctuary. It should however be noted that the project site falls outside the declared boundaries of the designated protected area of the Montego Bay Marine Park.

In response to how the proposed project would in general affect The Marine Park Trust and its core functions, it was expressed that the project would result in habitat loss (to include nursery areas) and loss of species through death and/or migration. It was indicated that there needed to be complete adherence to all environmental guidelines to address negative impacts.

Business - Impact of Mangrove Removal

When asked about the type of impact that removing mangroves would have, it was expressed that impacts would be negative and related to the loss of marine life and the loss/degradation of the natural filtration system to filter sediments out of surface run-off before discharge into the sea. It was stated by The Marine Park Trust that the mangrove plants should not be removed.

Marine Park – Impact on Beach Erosion, Beach Alteration, Mangrove Relocation/Replanting

Regarding the project's perceived potential impact on beach erosion, beach alteration and the potential impact on seagrass beds, as well as the potential acceptance of mangrove removal with associated restoration/replanting, The Marine Park Trust indicated:

- Strong agreement that the project would increase the chance of beach erosion.
- Disagreement in relation to being more accepting of mangrove removal or modification if the project incorporated mangrove restoration/replanting.
- Strong Agreement that any alteration of the beach would negatively affect seagrass beds and their environmental purpose.

Marine Park – Impact During Construction

In response to anticipated impacts on specific variables during the project's construction phase The Montego Bay Marine Park trust indicated that during construction:

- Negative Impact was anticipated on:
  - Marine Water Quality – (surface run-off)
  - Marine Wildlife/Fish Population – (surface run-off, solid waste pollution)
  - Flooding – (the natural buffer between land and sea is removed)
- Positive Impact on:
  - Employment Opportunities – (increase in job opportunities)
- Uncertainty of impact on:
  - Air Quality
  - Noise Levels
  - Fisherfolk
  - Businesses and Services Nearby the Project Area
  - Residential communities Nearby the Project Area
  - The Tourism Product

Marine Park – Impact After Construction

In response to anticipated impacts on specific variables after construction (during operations) The Montego Bay Marine Park trust indicated that after construction:

- Uncertainty of impact on:
    - Marine Water Quality
    - Marine Wildlife/Fish Population
    - Air Quality
    - Noise Levels
    - Fisherfolk
    - Flooding
    - Businesses and Services Nearby the Project Area
    - Residential communities Nearby the Project Area
    - Employment Opportunities
    - The Tourism Product

Regarding the occurrence of frequent flooding at or near the proposed site, The Marine Park Trust indicated that flooding occurred on average once per year and only in times of heavy rain. The Trust also confirmed that the site was affected by tidal changes such as storm surge.

The Airport Point Special Fisheries Conservation Area was identified by the Marine Park Trust as an area of environmental importance located near the proposed project site.

6.2.7.3 Stakeholder Perception of Natural Hazards (Combined Survey Cohorts)

An average of eighty-five percent (85.0%) of the total number of persons surveyed (fishers, community, business combined) stated there were no problems with frequent flooding near the proposed project site, while 6.0% (on average) stated that there were problems with frequent flooding near the site (**Table 6-26**). Nine percent (9.0%) expressed uncertainty. It should be noted that for all three sample cohorts more than 80.0% of interviewees indicated that the proposed site was not affected by flooding. Additionally, only 18.0% of fisherfolk interviewed indicated that the proposed site had flooding related issues.

TABLE 6-26: COMBINED SURVEY COHORTS RESPONSE REGARDING FLOODING PROBLEMS AT OR NEAR THE PROPOSED PROJECT AREAS

Flooding problems at near the proposed areas				
	yes	**no**	**not sure**	**Total**
Fishers	18.0	82.0	0.0	100.0
Business	0.0	84.0	16.0	100.0
Community	0.0	89.0	11.0	100.0
Average	**6.0**	**85.0**	**9.0**	

Of the 18.0% of fishers indicating that flooding was an issue, all respondents (100.0%) stated that flooding occurred only in times of heavy rain. Regarding the frequency of flood events these fishers further stated that flooding occurred once in three months. They also indicated that flood water depths ranged between 0.30 -1.5 meters (1.0-5.0ft). The section of the Kent Ave roadway leading to the Whitehouse community in the vicinity of the entrance gate to the Sandals Montego Bay Property was identified as being affected by flooding.

As it pertained to whether the proposed site is affected by tidal changes to include storm surge, 74.3% of the combined sample cohorts (fishers, business, community) stated that the area was not affected by tidal changes and 12.0% stated that the area was affected by tidal changes, while 13.7% were unsure (**Table 6-27**).

TABLE 6-27: COMBINED SURVEY COHORTS RESPONSE REGARDING WHETHER THE PROPOSED PROJECT AREA IS AFFECTED BY TIDAL CHANGE

Proposed area affected by tidal change				
	yes	**no**	**not sure**	**Total**
Fishers	27.0	73.0	0.0	100.0
Business	3.0	78.0	19.0	100.0
Community	6.0	72.0	22.0	100.0
Average	**12.0**	**74.3**	**13.7**	

It should be noted that for all three sample cohorts more than 70.0% of interviewees indicated that the proposed site was not affected by tidal changes. Additionally, the largest percentage of interviewees indicating that the site was affected by tidal changes, were fisherfolk (27.0%).

On the issue of whether there was any area located near to the proposed site thought to be of national, historical, or environmental importance, 67.0% (on average) of the total survey population (fishers, business, community) indicated that no area of national, historical, or environmental importance was located near to the site, while 12.7% expressed uncertainty (**Table 6-28**).

TABLE 6-28: COMBINED SURVEY COHORTS RESPONSE REGARDING AREAS OF NATIONAL/ ENVIRONMENTAL/HISTORICAL IMPORTANCE

Area of National/Environmental/Historical Importance				
	yes	**no**	**not sure**	**Total**
Fishers	36.0	55.0	9.0	100.0
Business	9.0	78.0	13.0	100.0
Community	16.0	68.0	16.0	100.0
Average	**20.3**	**67.0**	**12.7**	

Approximately twenty percent (20.3%) of respondents stated there was an area of national, historical, or environmental importance near to the site. The areas named included:

- The Montego Bay Marine Park
- The Bogue Lagoons

7 Natural Resource Valuation

7.1 Ecosystem Service Valuation (ESV) and Natural Resource Valuation (NRV) Scope

Ecosystem Service and Natural Resources Valuation at the site focused on demonstrating value in economic terms of coastal resources namely, Mangroves, Seagrass Beds and Coral Reefs. These resources are those within the wetland proposed for conversion for construction of bungalows on land, construction of overwater bungalows and structures to enhance coastal stability.

7.2 In situ ecosystem services

The ESV/NRV assessment is based on the understanding that demonstrating value in economic terms is useful for policy and decision-making, particularly with respect to determining the costs and benefits of the use of an ecosystem. This is in contrast to only considering the cost or values that enter traditional markets in the form of private goods.

Coastal ecosystems have particular ecosystem services of interest. Some of the ecosystem services of mangroves, seagrasses and coral reefs include:

- Surface water detention (mangroves);
- Nutrient transformation (mangroves, seagrass);
- Sediment and other particulate retention (mangroves, seagrass, coral reefs);
- Coastal storm surge detention (mangroves, seagrass, coral reefs);
- Shoreline stabilisation (mangroves, seagrass, coral reefs);
- Provision of fish and other shellfish habitat (mangroves, seagrass, coral reefs);
- Provision of waterfowl and other water-bird habitat (mangroves, seagrass);
- Provision of other wildlife habitat (mangroves, seagrass, coral reefs);
- Conservation of biodiversity (mangroves, seagrass, coral reefs);
- Carbon sequestration (mangroves, seagrass).

The concept is further illustrated in (**Table 7-1**)

TABLE 7-1: SOME OF THE ECOSYSTEM SERVICES OF MANGROVES SEAGRASSES AND CORAL REEFS

Coastal Ecosystem Function	**Associated Ecosystem Services**
Surface water detention	Flood control
Nutrient transformation	Water quality improvements
Sediment and other particulate retention	Water quality improvements
Coastal storm surge detention	Storm protection
Shoreline stabilisation	Storm protection
Fish/shellfish habitat	Commercial & recreational fishing and shellfish harvesting (Provisioning & Cultural services)
Waterfowl/waterbird habitat	Hunting, Wildlife viewing (Provisioning & Cultural)
Wildlife habitat	Wildlife viewing (Cultural services)
Conservation of biodiversity	Cultural services/existence value of biodiversity
Carbon storage and sequestration	Regulatory Services/ Climate stability

Table adapted using the Millennium Ecosystem Assessment framework. MEA (2005)

7.2.1 Mangroves, Seagrass Beds and Coral Reefs: Economic Values

For the purposes of this report the IPCC recommended median value of \$48/tC (~\$12 /tCO_2) is used. This is the SCC price estimated for Latin America and the Caribbean region (Kotchen et al 2014). An amount of CO_2 pollution is measured by the weight (mass) of the pollution. Sometimes this is measured directly as the weight of the carbon dioxide molecules. This is called a tonne of carbon dioxide and is abbreviated "tCO_2". Alternatively, the pollution's weight can be measured by adding up only the weight of the carbon atoms in the pollution, ignoring the oxygen atoms. This is called a tonne of carbon and is abbreviated "tC". Estimates of the dollar cost of carbon dioxide pollution is given per tonne, either carbon, \$X/tC, or carbon dioxide, \$X/tCO_2. One tC is equivalent to 3.67 (44/12) tCO_2 (Edwards, 2019). The examples above demonstrate the calculation of the monetary value of these carbon services, namely the combination of the stock of stored carbon (under existing vegetation) and the carbon that is actively removed (by the same vegetative cover) from the atmosphere over the course of one year. These are usually reported as the Net Present Value (NPV) of annually sequestering carbon at the rate estimated over a given time frame (25-100 years). The tier 1 assessment of a carbon stock within a project area is achieved by multiplying the area of an ecosystem by the mean carbon stock for that ecosystem type. The mean value of 386 MgC Ha^{-1} for Mangroves and 241 MgC Ha^{-1} for seagrasses are multiplied by the respective site areas to provide estimates of carbon stock (Edwards 2019, World Bank 2019).

These values are based on the assumption of fully functional, coastal ecosystems and the impacted nature of the mangrove at the site, should be taken into consideration as this would result in reduced ecological functionality.

The basic calculations are as follows:

Mean Carbon (MgC Ha^{-1}*) * Area (Ha) = Mg (or T) of Blue Carbon in Study Site*

Total Potential CO2 emissions per hectare ($MgCO_2$ *Ha-1) = Mg C * 3.67*

*Carbon sequestration value = MgC * X$/MgC = X$*

Table 7-2, Table 7-3 and **Table 7-4** show the calculation of Annual and (more importantly) Net Present Value (NPV) of annually sequestering carbon for a 25-year time frame. The sensitivity analysis of NPV compares discount rates ranging from 1% to 10%. The typical discount rates used for hotel and similar infrastructure development is 7-12%. These estimates are based on the Kotchen (2017) value of US$48 per tonne of Carbon. Using a social cost of carbon (SCC) of US$48 T^{-1} C the value of annual sequestration for the impacted site was estimated. The annual estimates can also be compared to the values estimated by Brander et al (2006). It should be noted that using global and regional carbon stock values for healthy coastal ecosystems, the estimated annual values presented below are what would be lost due to destruction or impairment, namely the seagrass and coastal wetlands.

TABLE 7-2: ANNUAL VALUES OF SEQUESTERED CARBON AT THE IMPACTED SITE

Average Carbon Stock (MgC Ha^{-1}***)***	**241**	**241**	**386**
	Overwater	**Groynes**	**Wetland**
Area (Ha)	**2.5**	**1.5**	**3**
Estimated Carbon Stock (MgC Ha^{-1})	604.5	361.5	1,158
Annual Value of Sequestered Carbon at impacted site			
Estimated Price T^{-1} **C**			
Market Rate - US$10	$6,045	$3,615	$11,580
Social Cost of Carbon (US$48)	$29,017	$17,352	$55,584

Table 7-3: Year Net Present Value (NPV) of Annual C Sequestration - Carbon Price

Carbon Market Rate (US$10 T^{-1}C)			
Discount Rates	**Overwater**	**Groynes**	**Wetland**
1%	$133,134.40	$79,613.71	$255,028.14
3%	$105,265.97	$62,948.53	$201,644.25
5%	$85,200.73	$50,949.61	$163,207.88
6%	$77,277.96	$46,211.83	$148,031.26
7%	**$70,448.25**	**$42,127.70**	**$134,948.49**
10%	$54,872.53	$32,813.50	$105,112.12

Table 7-4: 25 Year Net Present Value (NPV) of Annual C Sequestration – Social Cost of Carbon

Social Cost of Carbon (US$48 T^{-1}C)			
Discount Rates	**Overwater**	**Groynes**	**Wetland**
1%	$639,045.11	$382,145.80	$1,224,135.09
3%	$505,276.68	$433,794.36	$1,389,581.94
5%	$408,963.48	$433,794.36	$1,389,581.94
6%	$370,934.18	$221,816.80	$710,550.07
7%	**$338,151.60**	**$433,794.36**	**$1,389,581.94**
10%	$263,388.14	$433,794.36	$1,389,581.94

As we know the wetland areas at the site were already highly impacted - historically and more recently by the expansion. From the photos (**Figure 5-110**), it was evident that the wetland area was transitioning into a pioneer forest. This means the carbon and fisheries values applied here are over estimates given that the global values are based on healthy functioning mangroves.

Net Present Values were calculated for a 25-year time span. A sensitivity analysis using 6 different discount rates showed a range of estimated values for keeping carbon sequestered. Value estimates are influenced by the choice of discount rate. Two Carbon Prices are used for comparison. The first, an average current market price of US $10 per Metric Ton of Carbon and the Social Cost of Carbon (adjusted for the Latin America and Caribbean Region) of $48 T^{-1}C. It should be noted that the SCC represents the avoided costs to society of not releasing this stored carbon to the atmosphere. A typical range of discount rates for development projects such as this one is between 7-12%.

It is important to reiterate that in the absence of a functional carbon market these estimates of value (market or social cost) should be taken into context. The estimates of net present value over a 25-year time span should also be considered. If the developer is required to mitigate these losses with an equal or greater area of habitat, the lost economic value over time should be addressed. In addition, the calculations of areas to be impacted are over-estimates as per the proposed designs and thus should be considered an upper bound in potential annual lost values from carbon.

7.2.2 Nearshore Ecosystem Values (Wetlands and Seagrasses)

Mangrove fisheries' benefits are typically derived from two key ecological mechanisms. The first, is the high level of primary productivity from the mangrove trees and from other producers in the mangrove environment that support secondary consumers. This high level of primary productivity forms the basis of food chains that support a range of commercially important species. The second is the physical structure (habitat) that they provide, creating attachment points for species that need a hard substrate to grow on, as well as shelter from predation and the physical environment. These two mechanisms combine to make mangroves and seagrasses particularly effective as nursery grounds for juveniles of species that later move offshore or to adjacent habitats such as coral reefs (Hutchinson et al 2014).

In addition to nursery services, these coastal ecosystems also support commercial harvest of fin and shellfish species. These include mullets, crabs, oysters and other nearshore and estuarine species. While some species use mangroves only at certain life history stages; for example, species such as snapper may live in the mangrove as juveniles before moving to coral reefs as adults, other species live outside the mangrove but enter this habitat at high tide to feed. This highlights the potential importance of habitat linkages in enhancing fish productivity, while also making it challenging to isolate the role of mangroves in supporting fisheries in such mixed habitat systems. Estimating the economic value of mangrove-associated fisheries is challenging, particularly at regional or global scales (Hutchinson et al 2014). Data that allow for estimation of the proportional contribution to commercial (or subsistence) fish harvest are typically very limited. The additional challenge of deriving these estimates is the underlying complexity and variability of the types of fisheries.

Using a value transfer approach based on relevant global and Caribbean literature utilised in a 2019 World Bank study (Forces of Nature), an estimated value for the fisheries benefits associated with the potentially impacted seagrass and wetland ecosystems was determined. The value transfer approach relies on linking the area of mangrove to its potential contribution to nearshore fisheries. These value transfers are based on studies that utilised a production function-based approach, to derive estimates of fisheries value from mangroves. It is also dependent on objective measures of biophysical parameters that can then be tracked to corresponding changes in marketed output of the product. In this case, fish and seafood products.

The estimates of value per site outlined below (**Table 7-5** and **Table 7-6**) are based on a review of related literature and subsequent benefit (value) transfer. There are studies with broad range estimates of mangrove-associated fisheries economic values often in excess of US$1000 per hectare per year. Based on a comparison of a variety of studies that included a range of mangrove types and fisheries, the global median value of US $77/ha/yr. for (fin) fish, and US $213/ha/yr. for mixed species fisheries (Hutchinson et al. 2014) was used for this analysis. These median values are within the context of a wide variation value. For example, for mixed species fisheries the values ranged from $17.50 to $3,412 ha/yr using these median values we present value transfer estimates for the Jamaican mangrove sites. As a reminder the values presented below represent estimates of the existing value or what would be impacted if the ecosystems were severely impacted or completely destroyed. For details refer to the Natural Resource Valuation Report in Appendix 4 – Natural Resource Valuation.

TABLE 7-5: ESTIMATED ANNUAL ECONOMIC CONTRIBUTION OF MANGROVE TO SMALL-SCALE MIXED FISHERIES

	Overwater	**Groynes**	**Wetland**
Area	**2.5**	**1.5**	**3**
	$ Per Ha Per Annum		
Fin Fish ($77)	$193.15	$115.50	$231.00
Mixed Fisheries ($213)	$534.29	$319.50	$639.00

TABLE 7-6: NET PRESENT VALUE OF POTENTIALLY IMPACTED FISHERIES VALUES

	Overwater	**Groynes**	**Wetland**
Net Present Value (7%) $ Per Ha (25 Years)			
Fin Fish ($77)	$2,250.84	$1,345.990	$2,691.98
Mixed Fisheries ($213)	$6,226.34	$3,723.32	$7,446.64

These estimates show that the economic contribution from these sites have very modest annual contributions to fisheries values. This confirms the assumption that given the small area, the ecosystems are limited in their ability to contribute more significantly to fishers' incomes. It should also again be noted that the wetland area is severely impacted and does not appear to be functioning as a nursery area for juvenile fish (minimal presence of red mangroves) given limited tidal inundation.

7.2.3 Coral Reef Values

Coral reefs provide a diverse array of goods and services: for example, they buffer coastlines from storms and erosion; provide habitat for commercial, artisanal, and sport fisheries; attract local and international tourists to the coast; and are a source of cultural and spiritual significance to many people. However, the value of coral reefs is often not reflected in policy and development decisions. Site specific economic values for a small site such as the project site are not feasible or appropriate given the methods for estimating values. The purpose of Benefit and Value transfer is to use reasonable proxy values to inform decision making. Some of the values cited were based on Jamaican specific estimates (Edwards 2009 and Kushner et al 2011) that gave estimates for coral reef values important for Jamaica's tourism product namely on the country's north coast. In a sense the Jamaican estimates are highly relevant to the Montego Bay beach tourism recreational values estimated in those studies. The main difficulty is the infeasibility and excessive cost of assigning a specific per unit area estimate for the specific coastal ecosystems at the site because of the aggregate approach of consumer surplus estimates. The studies referenced had a valuation context of "Jamaica's coral reefs" primarily tourism areas but more broadly speaking. Two examples of economic values are presented below.

Edwards (2009) conducted a non-market valuation survey of the recreational value of coral reefs and their associated ecosystems (seagrass beds and beaches). Using a contingent choice approach, an annual value of US$217 Million was estimated. The study was based on the value of the coral reefs located on the northern coast of Jamaica, in other words, those reefs that directly and indirectly support the coastal tourism product. Another study (Kushner et al. 2011), examined the value of coastal protection services of coral reefs and demonstrated that coral reef decline and expected beach degradation would cause a loss in economic value. The study modelled the loss in economic value due to erosion and derived estimates of US$19 million value for the three major tourism locations on the north coast of Jamaica (Ocho Rios, Montego Bay and Negril). The study showed that additional erosion caused by further reef degradation, is estimated to increase the loss in value to US$33 million after 10 years. This represents an additional US$13.5 million loss of consumer welfare if the reef degrades further.

The relatively small coastline represented in this study and the patchy reef complex does not allow for a per unit area coral reef valuation exercise. The studies referenced above demonstrate that there are significant values associated with coral reef and beach ecosystem services. This is particularly so for the near shore coral reef ecosystems of Jamaica's north coast given the recreational ecosystem services of reefs and their associated beaches. Although not easily "traded in the marketplace" it is important to consider these values when making development decisions including trade-offs. Notably the project seeks to enhance the recreational attributes associated with the existing coastline which would effectively result in an increase in economic value of the coastal asset. Of note, most of these benefits will accrue to the developer of this project.

7.2.4 Trade-Off Considerations for the Proposed Project

The developers of this project, have proposed several activities that are expected to mitigate the negative impacts to the nearshore coastal ecosystems (corals, seagrasses and mangroves), from construction of the overwater structures. Firstly, the construction will negatively impact seagrass cover as a result of removal and construction of the overwater structures. This therefore will result in a conversion of seagrass areas to bare sand and silt. The expected ecosystem services lost will include;

- loss of sequestered carbon, loss of future sequestration of carbon
- decreased habitat complexity, reduced recruitment and juvenile habitat, reduced productivity
- reduced nutrient and detritus conversion rates, productivities
- lost coastal protection services (wave attenuation and sediment accumulation)

However, there are proposed activities that, if implemented successfully, could lead to some beneficial ecosystem services. These can also be considered a set of trade-offs, that is, some deleterious impacts compared to beneficial ecosystem improvements.

Mitigation and offsetting activities such as the replanting of seagrass beds and creation of additional wetland areas (offsite) could lead to benefits such as improved fish and shellfish nursery habitat leading to increased productivity. Increased rates of carbon sequestration through mangrove biomass (e.g. replanting mangrove offsite) could potentially mitigate the loss in Carbon sequestration from seagrass removal. It should be noted that a newly created wetland area with replanted mangroves will take approximately 15-20 yrs. to regrow and thus optimal sequestration benefits would not be achieved until such time. Seagrass relocation/restoration is typically recommended for ecosystem service recovery or habitat enhancement (e.g., fish habitat, reduction in coastal erosion) or as a means of mitigating habitat loss (Rezek et al. 2019). Details of a typical seagrass relocation/restoration plan are presented in **Appendix 8.**

Another trade-off for consideration is the conversion of seagrass beds to reef structure. The benefits being the creation of new habitat leading to increased fin fish and shellfish productivity. Other benefits could include increased (habitat and species) diversity within the fishery thus building ecological and fishery resilience that can address impacts of global change.

Mitigation activity in response to the removal of live coral from the construction areas and incorporation into a bio-integrating reef structure (setting living coral to artificial reef) is another proposed activity. Some of the expected benefits from this action include: improved recruitment, improved habitat quality over time with coral growth, improved fishery diversity with habitat-specific species, improved hydrodynamic effects with growth through time, including sea level rise. Other ancillary benefits would include increased recreational activity such as snorkeling and glass bottom boat tourism related opportunities.

8 Environmental Impacts and Mitigation

8.1 Summary of Impacts of Overwater Bungalow Construction

8.1.1 Rapid Impact Assessment of Overwater Bungalow Construction

An assessment of present and potential impacts identified during the field study of the Sandal's Montego Bay property was carried out using the Rapid Impact Assessment Matrix (RIAM),

See **13.7 Appendix RIAM Methodology by Pastakia and Jensen (1998).**

The assessment considered impacts associated with the following phases of the project:

- Baseline impacts reflecting the current state of the coastal area, without overwater bungalows.

- Impacts before and during the construction phase of the overwater suites (without and with mitigation)
- Impacts during the operational phase
- Impacts from decommissioning of the overwater structures

8.1.1.1 Baseline Conditions Without Overwater Structures

The baseline conditions at Sandals Montego Bay, without overwater structures, present a scenario with both positive and negative impacts. While the area benefits from employment opportunities at the resort, which has a positive social impact, it is also affected by intermittent water quality issues, including nutrient loading, total suspended solids, and turbidity from drain discharge, primarily affecting the property's eastern edge. Additionally, noise levels from air traffic have a notable negative impact. Furthermore, the existing environmental stressors, particularly to the seagrass beds and coastal area, resulting from chronic exposure to elevated suspended solids and turbidity, negatively impact marine flora and fauna. Overall, the baseline conditions reflect a mix of both positive and negative aspects, highlighting the need for careful consideration of the site's environmental and social impact and mitigation measures.

Figure 8-1 represents a graphical summary of the baseline analysis of impacts for Sandal's Montego Bay. The figure shows that out of the 32 environmental components (**Table 8-1**) used to assess the baseline conditions at the Sandals MB grounds, 21 are neutral, reflecting the status quo in the coastal area (beach and seagrass) at the time of the survey; 2 are positive, and 9 are negative.

Negative impacts associated with Physical/Chemical (P/C) components are indicative of the water quality conditions, including nutrient loading, total suspended solids and turbidity from drain discharge, primarily on the eastern edge of the property. The noise level, due primarily to air traffic, is also a notable impact.

- P/C2 Hydrogeology: Runoff [existing drain discharge] (-2)
- P/C3 WQ: TSS/TUR (-1)
- P/C4 WQ: Nutrients (N,P) (-1)
- P/C6 BOD (-1)
- P/C10 Noise (-1)

Negative ecological impacts stem from existing habitat alteration primarily to the seagrass beds and the coastal area, and specifically the impact of chronic exposure to persistent elevated suspended solids and turbidity on marine flora and fauna:

- B/E5 Marine: impact of WQ and TSS/TRU on coastal ecosystem (-1)
- B/E6 Marine: Loss of seagrass (smothering due to elevated TSS/TUR) (-1)

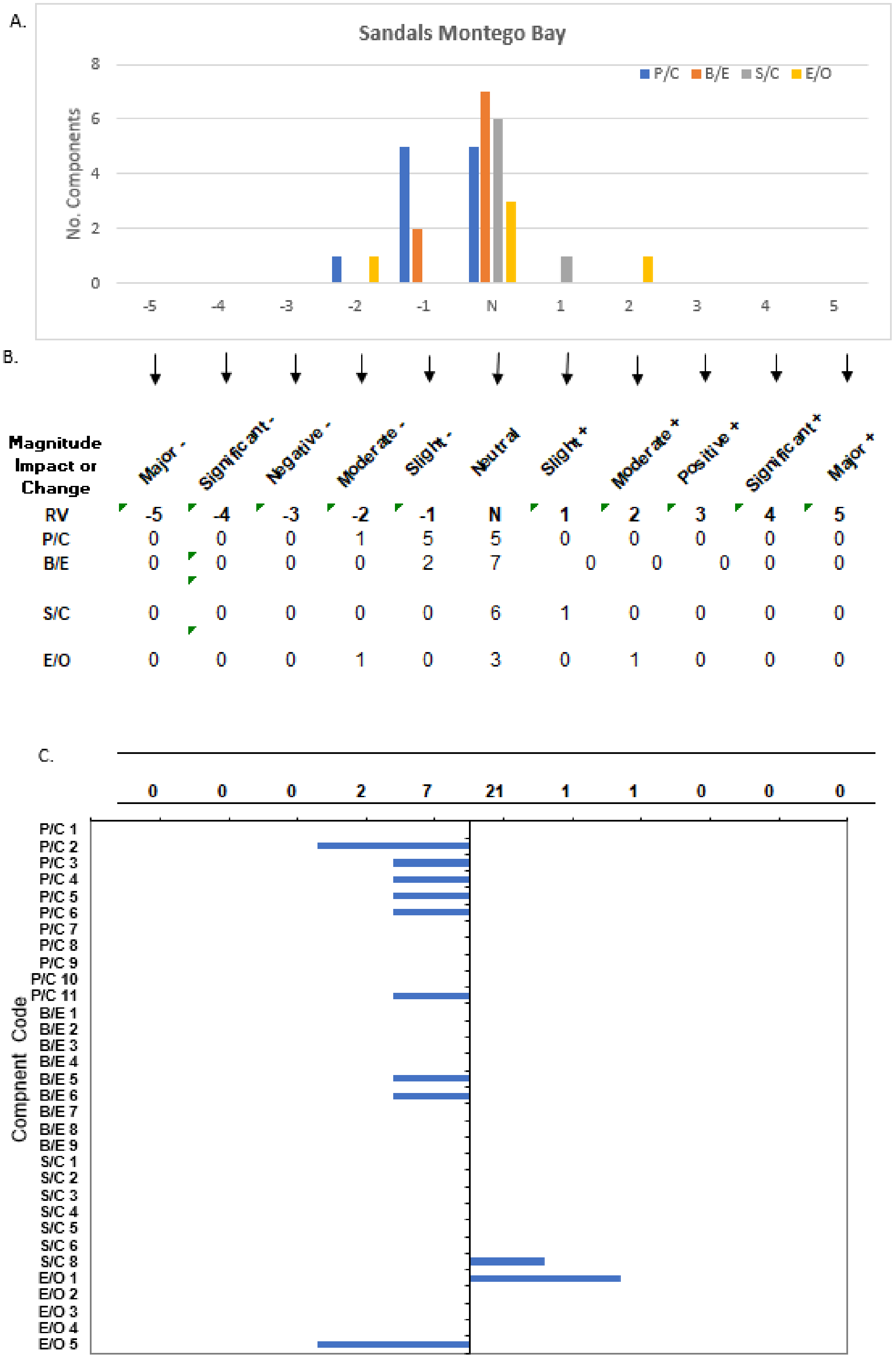
From a social/cultural (SC) perspective, the baseline conditions observed during the site assessment are neutral reflecting the existing conditions.

The baseline condition (i.e., at the time of the survey) that had a positive social impact, which can be attributed to employment opportunities at the Sandal's resort.

- E/O Employment and Income (+2)

Negative economic factors include the limited or restricted access of the local fisher folk to the area.

- E/O5 Fisher folk/Marine Park stakeholders (livelihoods and access/use of site) (-2)



Magnitude Impact or Change	Major -	Significant -	Negative -	Moderate -	Slight -	Neutral	Slight +	Moderate +	Positive +	Significant +	Major +
RV	-5	-4	-3	-2	-1	N	1	2	3	4	5
P/C	0	0	0	1	5	5	0	0	0	0	0
B/E	0	0	0	0	2	7	0	0	0	0	0
S/C	0	0	0	0	0	6	1	0	0	0	0
E/O	0	0	0	1	0	3	0	1	0	0	0

Figure 8-1: Summary Of RIAM Analysis For Sandals Montego Bay Baseline Conditions Without Overwater Suites: (A) Range Values For All Impacts Assessed; (B) Range Values Broken Down By Component Groups; And (C) Range Values For Individual Components.

TABLE 8-1. BASELINE IMPACT ANALYSIS IMPACT ANALYSIS FOR SANDALS MONTEGO BAY, WITHOUT OVERWATER STRUCTURES AT SANDALS MONTEGO BAY.

Baseline Condition - Without Overwater Structures			
Component Code	**Component Description**	**Magnitude of impact**	**Impact Description**
P/C 1	Coastal dynamics	0	Status quo
P/C 2	Hydrology: Runoff (existing drain discharge)	-2	Moderate negative
P/C 3	WQ: DO	-1	Slight negative
P/C 4	WQ: TSS/TUR	-1	Slight negative
P/C 5	WQ: Nutrients (P)	-1	Slight negative
P/C 6	WQ: BOD	-1	Slight negative
P/C 7	WQ: pH	0	Status quo
P/C 8	WQ: Faecal Coliform	0	Status quo
P/C 9	Safety: Accidents (Oil spill)	0	Status quo
P/C 10	Waste Management: Solid waste/debris	0	Status quo
P/C 11	Noise	-1	Slight negative
B/E 1	Terrestrial: Habitat destruction, fragmentation and alteration (altered microclimate)	0	Status quo
B/E 2	Terrestrial: Loss of biodiversity(flora)	0	Status quo
B/E 3	Terrestrial: Loss of biodiversity (fauna)	0	Status quo
B/E 4	Marine: Shoreline alteration/habitat degradation	0	Status quo
B/E 5	Marine: Impact of WQ degradation (sedimentation/eutrophication) on marine flora/fauna	-1	Slight negative
B/E 6	Marine: Loss of seagrass (smothering, physical damage [prop scars])	-1	Slight negative
B/E 7	Marine: Loss of seagrass (operational [shading])	0	Status quo
B/E 8	Marine: Loss of coral species (reef crest)	0	Status quo
B/E 9	Marine: Loss of fauna (macroinvertebrates, fish)	0	Status quo
S/C 1	Land Use	0	Status quo
S/C 2	Community Services and Infrastructure	0	Status quo
S/C 3	Perception of Crowding	0	Status quo
S/C 4	Perception of Risk and Safety	0	Status quo
S/C 5	Perception of Natural Resources	0	Status quo
S/C 6	Perception of Amenities and Services	0	Status quo
S/C 8	Visual Aesthetics	1	Slight positive
E/O 1	Employment and Income	1	Slight positive
E/O 2	Business Opportunities tourism business operators (water sports)	0	Status quo
E/O 3	Traffic (land)	0	Status quo
E/O 4	Community Development	0	Status quo
E/O 5	Fisher folk (livelihoods and access/use of site)	-2	Moderate negative

8.1.1.2 Construction of Overwater Structures

During the construction of the overwater walkway and bungalows, significant environmental impacts can arise from using construction equipment and the processes involved in building infrastructure, such as piling. The operation of heavy machinery generates considerable noise and disturbance, which can disrupt the natural behaviors of both terrestrial and marine wildlife and degrade their habitats, including sensitive seagrass beds. Furthermore, the movement of equipment and installation of underwater structures cause increased water turbidity, blocking sunlight crucial for the photosynthesis of marine plants and corals. This increased turbidity can lead to lower oxygen levels in the water, adversely affecting aquatic life. Additionally, contaminants like oils and chemicals from the construction machinery can deteriorate water quality, presenting long-term ecological risks. Runoff and effluent from the construction site can compound these issues, introducing more pollutants into the marine environment and amplifying the negative impacts.

Figure 8-2 shows a graphical summary of the RIAM analysis for Sandals Montego Bay during the construction of the overwater bungalows. Of the 41 components (**Table 8-2**) considered, 4 are neutral (no impact)/, 27 are negative, and 10 are positive and include proposed mitigation measures to offset or minimise some of the negative impacts of construction activities.

Negative impacts reflect the disruptive nature of construction on the physical (P/C) and ecological (B/E) components:

- P/C1 Coastal dynamics (-1)
- P/C 2 Hydrogeology: Runoff (Existing drain) (-3)
- P/C 4 WQ: Stormwater/runoff TSS/TUR (-4)
- P/C 9 WQ: Nutrients (N/P) (-2)
- P/C 8 WQ: Coliform (-3)
- P/C 9 Safety: Accidents. The score reflects the use barges and heavy machinery for driving pilings (potential for oil/ hydraulic fluid spills, barge grounding) (-3)
- P/C 10 Solid Waste Management: Site and construction waste (-2)
- P/C 11 Noise (-3)
- B/E 1 Terrestrial: Habitat destruction, fragmentation and alteration (staging area) (-3)
- B/E 2 Terrestrial: Loss of biodiversity/loss of native floral species (-1)
- B/E 3 Terrestrial: Loss of biodiversity (avifauna, other fauna) (-4)

- B/E 4 Marine: Shoreline alteration/habitat degradation (-4)
- B/E 5 Marine: Eutrophication/Water Quality (-3)
- B/E 6 Marine: loss of seagrass (construction, installation of pilings, removal of seagrass, smothering due to increased TSS/TUR) (-4)
- B/C 8 Marine: Loss of coral (-2)
- B/C 9 Marine: Loss of motile macrofauna (fish, macrofauna) (-2)

In terms of social/cultural indicators the negative impacts during construction of the overwater villas are attributed to the temporary effect on public perception of the impacts on the site's natural resources.

Negative social impacts include:

- S/C 1 Land use (-1)
- S/C Strain on community services and infrastructure (-2)
- S/C 4 Perception of Risk and Safety (-1)
- S/C 5 Perception of Natural Resources (degradation) (-2)
- S/C 8 Visual Aesthetics (-1)
- E/O Traffic (land/sea) (-2)
- E/O Fisher folk (livelihoods and access/use of site) (-3)

Positive impacts are attributed to job opportunities during the construction phase and the positive "spillover" into neighbouring communities

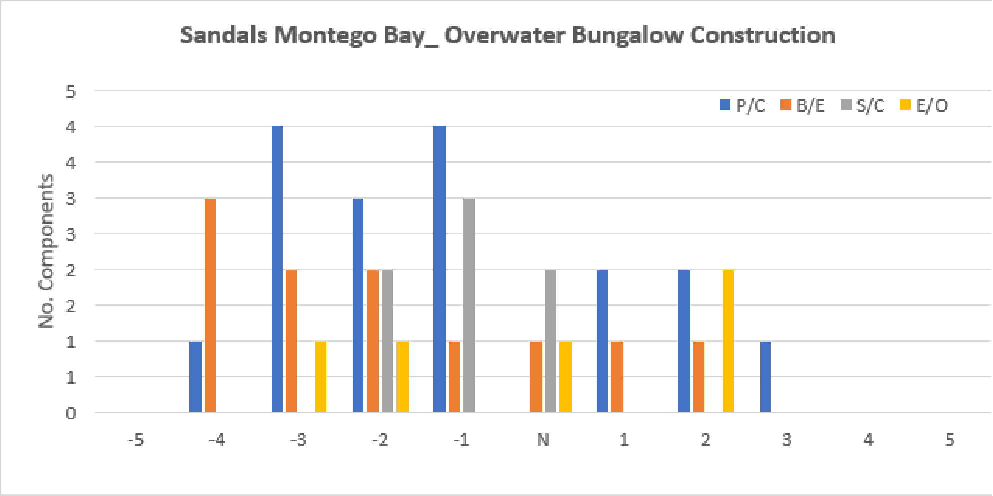
- E/O 1 Employment and Income (2)
- E/O 4 Community Development (2)

Recommended mitigation strategies include using silt curtains to contain sediment, scheduling construction activities to avoid sensitive wildlife periods, and implementing strict protocols for handling and disposing of hazardous materials.

- P/C 2M Mitigation Hydrology (Runoff/Existing drain): Restrict construction to fair weather conditions/ Construction of groyne (P12)
- P/C 3M Mitigation Hydrology (Stormwater management OW structures, including downspouts equipped with dispersal fixtures) (1)
- P/C 4M Mitigation: WQ: TSS/TUR: use of screens around piling installation site (2)

- P/C 9M Mitigation Accidents (Oil spill): onsite equipment (e.g., Emergency preparedness, containment plan, sorbent pads, etc.) (1)
- P/C 10M Mitigation: Site Waste Management strategy: Appropriate storage and provision of waste bins for construction material and for rubbish generated by workers, toilets, dedicated staff to collect rubbish that accumulates on the beach) (2)
- B/E 3M Mitigation Terrestrial: Use of native floral species to attract avifauna and macrofauna (2)
- B/E 6M Mitigation Marine: Seagrass transplantation to recipient site (3)
- B/E 8&9M Mitigation Marine:
    - Relocation of any macroinvertebrates in the seagrass bed
    - Turtle-friendly lights directed away from beach; turtle monitoring program (e.g., collaboration with Montego Bay Marine Park, NEPA)
    - Training and outreach for staff and visitors (turtle conservation program)

A.



B.

Magnitude Impact or Change	Major -	Significant -	Negative	Moderate-	Slight -	Neutral	Slight +	Moderate +	Positive +	Significant +	Major
RV	-5	-4	-3	-2	-1	N	1	2	3	4	5
P/C		1	4	3	4	0	2	2	1	0	0
B/E		3	2	2	1	1	1	1	0	0	0
S/C		0	0	2	3	2	0	0	0	0	0
E/O		0	1	1	0	1	0	2	0	0	0
Total	0	4	7	8	8	4	3	5	1	0	0

C.

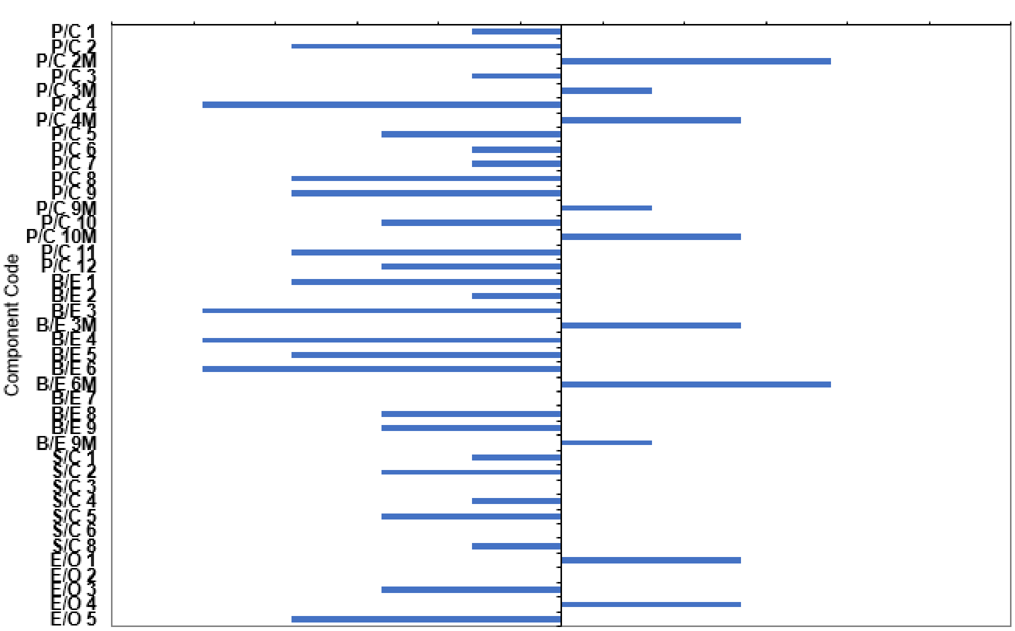


FIGURE 8-2. SUMMARY OF RIAM ANALYSIS FOR SANDALS MONTEGO BAY IMPACTS DURING THE CONSTRUCTION OF OVERWATER STRUCTURES: (A) RANGE VALUES FOR ALL IMPACTS ASSESSED; (B) RANGE VALUES BROKEN DOWN BY COMPONENT GROUPS; AND (C) RANGE VALUES FOR INDIVIDUAL COMPONENTS.

TABLE 8-2. IMPACT ANALYSIS DURING THE CONSTRUCTION PHASE OF OVERWATER SUITES AT SANDALS MONTEGO BAY

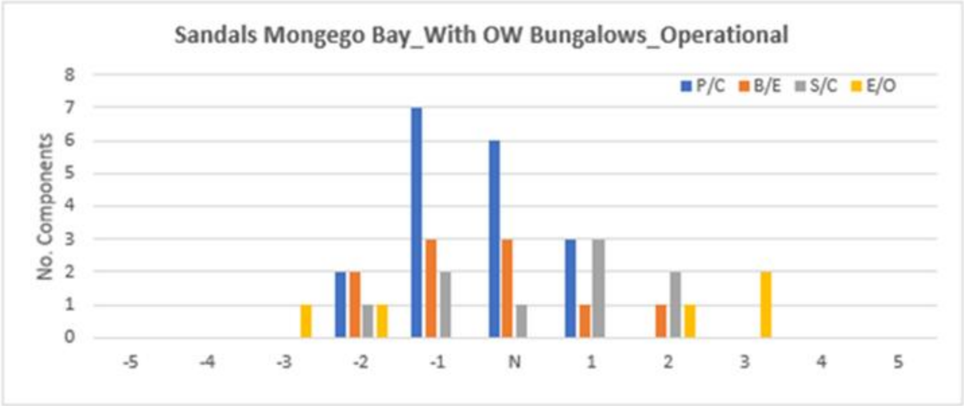
Impacts During Construction of Overwater Bungalows			
Component Code	**Component Description**	**Magnitude of impact**	**Impact**
P/C 1	Coastal dynamics	-1	Slight negative
P/C 2	Hydrology: Runoff (existing drain discharge, staging area)	-3	Negative
P/C 2M	Mitigation Hydrology: Restrict construction to fair weather conditions	3	Negative
P/C 3	Hydrology: Stormwater management (overwater structures)	-1	Slight negative
P/C 3M	Mitigation Hydrology: Use downspouts with dispersal fixture at base to disperse freshwater	1	Slight positive
P/C 4	WQ: TSS/TUR	-4	Significant negative
P/C 4M	Mitigation: WQ: TSS/TUR: use of screens around piling installation site	2	Moderate positive
P/C 5	WQ: Nutrients (N/P)	-2	Moderate negative
P/C 6	WQ: BOD	-1	Slight negative
P/C 7	WQ: pH	-1	Slight negative
P/C 8	WQ: Faecal Coliform	-3	Negative
P/C 9	Safety: Accidents (Oil spill, pools and pumps)	-3	Negative
P/C 9M	Mitigation Accidents (Oil spill): onsite equipment (e.g., Emergency preparedness, containment plan, sorbent pads, etc.)	1	Slight positive
P/C 10	Site Waste Management: Solid waste/construction waste	-2	Moderate negative
P/C 10M	Mitigation Site Waste Management Strategy: Appropriate storage and provision of waste bins for construction material and for rubbish generated by workers, toilets, dedicated staff to collect rubbish that accumulates on the beach)	2	Moderate positive
P/C 11	Noise	-3	Negative
P/C 12	Air quality	-2	Moderate negative
B/E 1	Terrestrial: Habitat destruction, fragmentation and alteration (altered microclimate)	-3	Negative
B/E 2	Terrestrial: Loss of biodiversity (flora)	-1	Slight negative
B/E 3	Terrestrial: Loss of biodiversity (fauna, avifauna)	-4	Significant negative
B/E 3M	Mitigation Terrestrial: Use of native floral species to attract avifauna and macrofauna	2	Moderate positive
B/E 4	Marine: Shoreline alteration/habitat degradation (wetland, turtle nesting grounds)	-4	Significant negative

Impacts During Construction of Overwater Bungalows			
Component Code	**Component Description**	**Magnitude of impact**	**Impact**
B/E 5	Marine: Impact of WQ degradation-sedimentation/eutrophication on marine flora/fauna	-3	Negative
B/E 6	Marine: Loss of seagrass (construction [removal, smothering])	-4	Significant negative
B/E 6M	Marine: Mitigation: Seagrass transplantation to recipient site	3	Positive
B/E 7	Marine: Loss of seagrass (operational [shading])	0	Neutral/No change
B/E 8	Marine: Loss of coral species (reef crest tourist traffic, boat damage)	-2	Moderate negative
B/E 9	Marine: Loss of fauna (macroinvertebrates, fish, turtles,)	-2	Moderate negative
B/E 9M	Mitigation Marine: 1) Relocation of any macroinvertebrates in the seagrass bed 2) Turtle-friendly lights directed away from beach; turtle monitoring program (e.g., collaboration with Montego Bay Marine Park, NEPA) 3) Training for staff and visitors (turtle conservation program)	1	Slight positive
S/C 1	Land Use	-1	Slight negative
S/C 2	Community Services and Infrastructure	-2	Moderate negative
S/C 3	Perception of Crowding	0	Neutral/No change
S/C 4	Perception of Risk and Safety	-1	Slight negative
S/C 5	Perception of Risk to Natural Resources	-2	Moderate negative
S/C 6	Perception of Amenities and Services	0	Neutral/No change
S/C 8	Visual Aesthetics	-1	Slight negative
E/O 1	Employment and Income	2	Moderate positive
E/O 2	Business Opportunities for tourism business operators	0	Neutral/No change
E/O 3	Traffic (land)	-2	Moderate negative
E/O 4	Community Development	2	Moderate positive
E/O 5	Fisher folk (livelihoods and access/use of site)	-3	Negative

8.1.1.3 *Operation of Overwater Bungalows*

Regularly scheduled monitoring and management of the overwater bungalows will be essential to reduce or mitigate any adverse impacts on the biophysical environment and the local community while the overwater bungalows are in operation. Implementing effective waste management, resource-efficient and responsible tourism practices, and the implementation of adaptive management strategies can mitigate these impacts and support the sustainable use of surroundings.

A.



B.

Magnitude Impact or Change	Major -	Significant -	Negative -	Moderate -	Slight -	Neutral	Slight +	Moderate +	Positive +	Significant +	Major +
RV	**-5**	**-4**	**-3**	**-2**	**-1**	**N**	**1**	**2**	**3**	**4**	**5**
P/C	-5	-4	-3	-2	-1	N	1	2	3	4	5
B/E	0	0	0	2	3	3	1	1	0	0	0
S/C	0	0	0	1	2	1	3	2	0	0	0
E/O	0	0	1	1	0	0	0	1	2	0	0
Total		**0**	**1**	**6**	**12**	**10**	**7**	**4**	**2**	**0**	**0**

C.

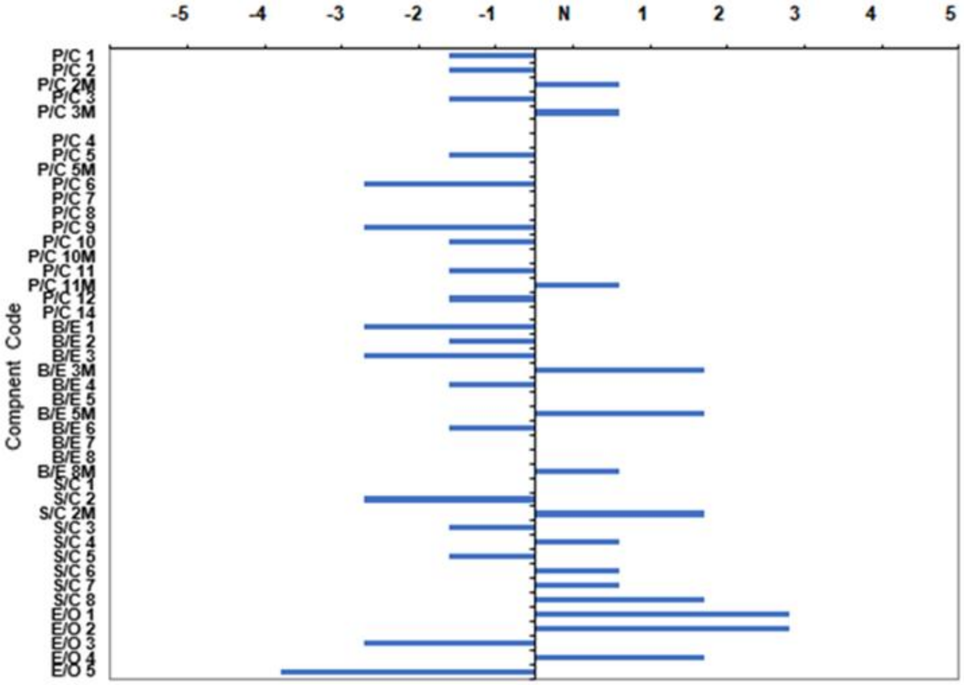


Figure 8-3 shows a graphical summary of the RIAM analysis for the Sandals Montego Bay. The figure shows that out of the 43 components (**Table 8-3**), 11 are neutral, 19 are negative.

Negative impacts are primarily associated with biophysical (P/C and B/E) components including:

- P/C 1 Coastal Dynamics: Longshore transport (-1)
- P/C 2 Hydrology: Stormwater management on land, existing gully (-1)
- P/C 3 Hydrology: Stormwater management (overwater structures) (-1)
- P/C 5 WQ: TSS/TUR (-1)
- P/C 6 WQ: Nutrients (N/P) (-2)
- P/C 9 WQ: Faecal Coliform (-2)
- P/C 10 Safety: Accidents (Burst sewage pipes, pools and pumps) (-2)
- P/C 11 Site Waste Management: Solid waste generated by resort/guests (-2)
- P/C 12 Noise (-1)

The construction of overwater structures along with the proposed expansion on the landside east of the current resort will result in permanent alteration of the habitat which will alter the natural dynamics of the coastal ecosystem.

- B/E1 Terrestrial: Habitat destruction, fragmentation and alteration (-1)
- B/E2 Terrestrial: Loss of biodiversity (loss of wetland, landscaping with exotic & invasive floral species) (-1)
- B/E3 Terrestrial: Loss of biodiversity (migratory avifauna, other fauna) (-2)
- B/E4 Marine: Eutrophication/Water Quality: issues with nutrient loading from increased tourist traffic/ potential for spills/ sewage pipe bursting/chemical spills from pools and associated equipment [pumps]
- B/E5 Marine: Water quality (Impact of elevated TSS/TUR on seagrass beds and associated fauna) (-1)
- B/E7 Marine: Impact of shading on seagrass beds (-1)

Positive socio/cultural and economic impacts can be attributed to the:

- S/C4 Perception of Risk and Safety (1)
- S/C Perception of amenities and services (1)
- S/C User Level of Satisfaction (1)
- S/C Visual Aesthetics (2)
- E/O Employment and Income (3)

- E/O Business opportunities for tourism business operators. Income and business opportunities (3)
- E/O Community Development (2)

Negative social /cultural impacts are minimal and can be mitigated by implementing appropriate rules for guests and by implementing services in support of the local communities:

- S/C Community Services and Infrastructure (-2)
- S/C Perception of Crowding (-1)
- S/C Perception of Natural Resources (-1)
- E/O Traffic (land and sea / boat traffic by the overwater structures) (-2)
- E/O) Fisher folk/Marine Park stakeholders (livelihoods and access/use of site) (-3)

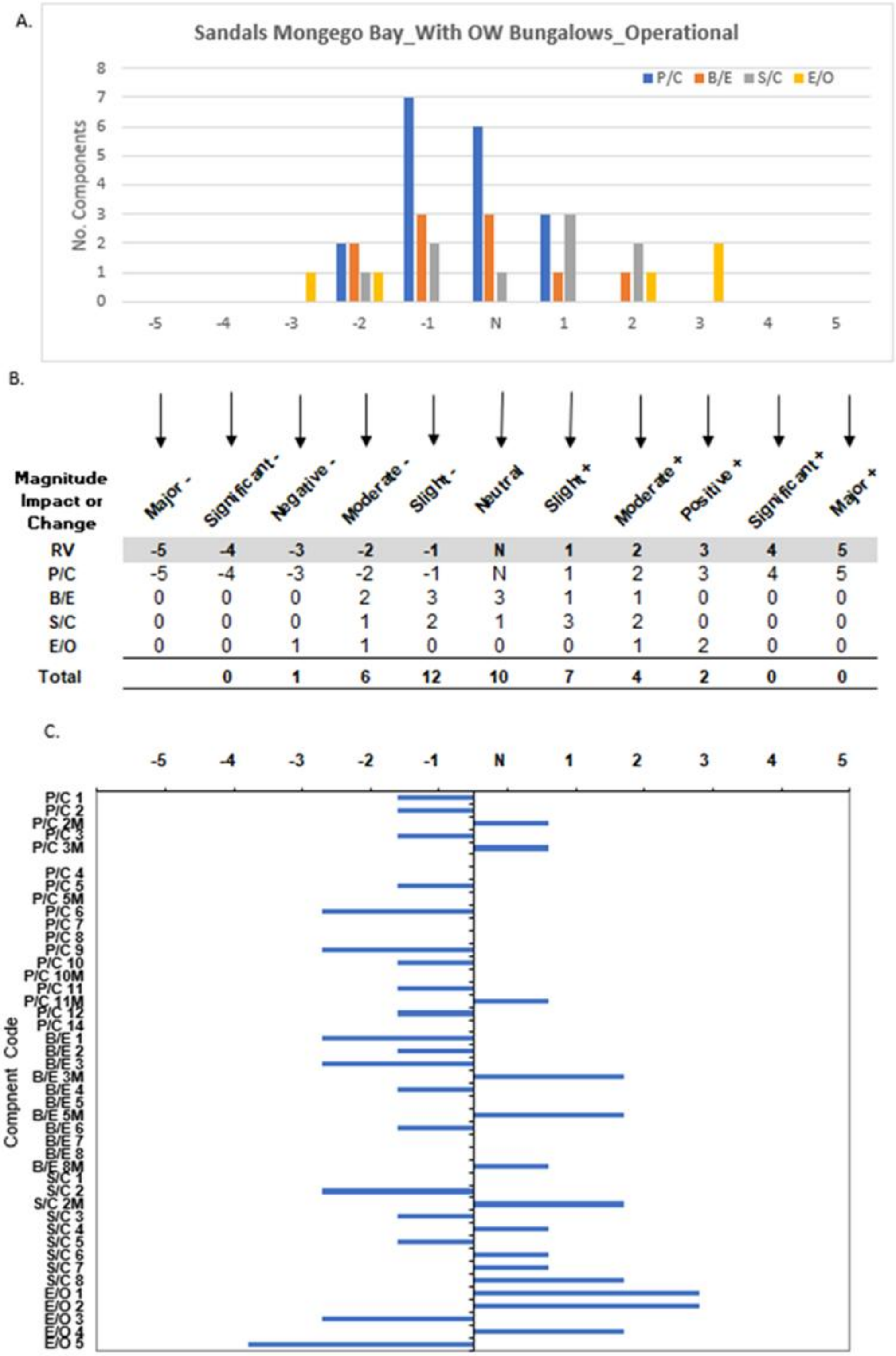
To mitigate potential environmental impacts during the operational phase, a comprehensive approach focusing on preventative measures and ecological enhancement is recommended. Regular maintenance protocols should be implemented to prevent inadvertent chemical spills, while a robust waste management program will ensure that rubbish does not contaminate coastal waters. The landscaping of the property presents an excellent opportunity to reintroduce native flora, which can help attract and support local avifauna. Additionally, the installation of turtle-friendly lighting systems can significantly reduce the project's impact on marine life, particularly sea turtles that are sensitive to artificial illumination.

- P/C 2M Mitigation Hydrology: Stormwater retention ponds, landscaping with pervious surfaces to help with drainage
- P/C 3M Mitigation Hydrology: Use downspouts with dispersal fixture at base
- P/C 5M Mitigation WQ TSS/TUR: Stormwater management on premises
- P/C 10M Mitigation Accidents: Regular inspection and maintenance; strategic placement of shut-off valves; contingency plans
- P/C 11M Mitigation Site Waste Management strategy: Appropriate storage and provision of waste bins for rubbish generated by visitors, dedicated staff to collect rubbish that accumulates on the beach); use of licenced garbage collectors; prohibit use of single-use plastics
- B/E 3M Mitigation Terrestrial biodiversity: Use of native floral species to attract avifauna

- B/E8M 1) Working with marine biologists to monitor coastal habitats and implement adaptive strategies that promote biodiversity;

2) Turtle-friendly lights directed away from beach; turtle monitoring program (e.g., collaboration with Montego Bay Marine Park, NEPA); sensitisation training for staff and visitors (turtle conservation program)

- S/C 2M Mitigation: Community Services and Infrastructure/Coordinate with local authorities to improve infrastructure and services to accommodate increasing demand from patrons



Magnitude Impact or Change	Major -	Significant -	Negative -	Moderate -	Slight -	Neutral	Slight +	Moderate +	Positive +	Significant +	Major +
RV	**-5**	**-4**	**-3**	**-2**	**-1**	**N**	**1**	**2**	**3**	**4**	**5**
P/C	-5	-4	-3	-2	-1	N	1	2	3	4	5
B/E	0	0	0	2	3	3	1	1	0	0	0
S/C	0	0	0	1	2	1	3	2	0	0	0
E/O	0	0	1	1	0	0	0	1	2	0	0
Total		**0**	**1**	**6**	**12**	**10**	**7**	**4**	**2**	**0**	**0**

Figure 8-3. Summary of RIAM analysis for Sandals Montego Bay impacts during the operation of overwater structures: (A) Range values for all impacts assessed; (B) Range values broken down by component groups; and (C) Range values for individual components.

TABLE 8-3. IMPACT ANALYSIS DURING THE OPERATIONAL PHASE OF OVERWATER SUITES AT SANDALS MONTEGO BAY

Impacts During Operation of Overwater Bungalows			
Component Code	**Component Description**	**Magnitude of impact**	**Impact**
P/C 1	Coastal Dynamics: Longshore transport	-1	Slight negative
P/C 2	Hydrology: Stormwater management (on land)	-1	Slight negative
P/C 2M	Mitigation: Hydrology: Stormwater retention ponds, native landscaping, pervious surfaces	1	Slight positive
P/C 3	Hydrology: Stormwater management (overwater structures)	-1	Slight negative
P/C 3M	Mitigation Hydrology: Use downspouts with dispersal fixture at base	1	Sightly positive
P/C 4	WQ: DO	0	Neutral
P/C 5	WQ: TSS/TUR	-1	Slight negative
P/C 5M	Mitigation: WQ: TSS/TUR: ensure proper storm management on land	0	Neutral
P/C 6	WQ: Nutrients (N/P)	-2	Moderate negative
P/C 7	WQ: BOD	0	Neutral
P/C 8	WQ: pH	0	Neutral
P/C 9	WQ: Faecal Coliform	-2	Moderate negative
P/C 10	Safety: Accidents (Burst sewage pipes, pools & pumps)	-1	Slight negative
P/C 10M	Mitigation Accidents: regular inspection and maintenance; strategic placement of shut-off valves	0	Neutral
P/C 11	Site Waste Management: Solid waste generated by resort/guests	-1	Slight negative
P/C 11M	Mitigation Site Waste Management: Appropriate storage and provision of waste bins for rubbish generated by visitors, dedicated staff to collect rubbish that accumulates on the beach; use of licenced garbage collectors; prohibit use of single-use plastics	1	Slight positive
P/C 12	Noise	-1	Slight negative
P/C 14	Air quality	0	Neutral
B/E 1	Terrestrial: Habitat destruction, fragmentation and alteration	-2	Moderate negative
B/E 2	Terrestrial: Loss of biodiversity (flora)	-1	Slight negative
B/E 3	Terrestrial: Loss of biodiversity (fauna)	-2	Moderate negative
B/E 3M	Mitigation Terrestrial: Use of native floral species to attract avifauna and macrofauna	2	Moderate positive
B/E 4	Marine: Impact of WQ degradation-sedimentation/eutrophication on marine flora/fauna	-1	Slight negative
B/E 5	Marine: Loss of seagrass (construction [removal, smothering])	0	Neutral
B/E 5M	Marine: Mitigation: Seagrass transplantation to recipient site	2	Moderate positive
B/E 6	Marine: Loss of seagrass (operational [shading])	-1	Slight negative

Impacts During Operation of Overwater Bungalows			
Component Code	**Component Description**	**Magnitude of impact**	**Impact**
B/E 7	Marine: Loss of coral species (reef crest tourist traffic, boat damage)	0	Neutral
B/E 8	Marine: Loss of fauna (turtles, macroinvertebrates, fish)	0	Neutral
B/E 8M	Marine: Mitigation:1) Working with marine biologists to monitor coastal habitats and implement adaptive strategies that promote biodiversity. 2) Turtle-friendly lights directed away from beach; turtle monitoring program (e.g., collaboration with Montego Bay Marine Park, NEPA); sensitisation training for staff and visitors (turtle conservation program)	1	Slight positive
S/C 1	Land Use	0	Neutral
S/C 2	Community Services and Infrastructure	-2	Moderate negative
S/C 2M	Mitigation Community Services and Infrastructure; Coordinate with local authorities to improve infrastructure and services to accommodate increasing demand from patrons	2	Moderate positive
S/C 3	Perception of Crowding	-1	Slight negative
S/C 4	Perception of Risk and Safety	1	Slight positive
S/C 5	Perception of Natural Resources	-1	Slight negative
S/C 6	Perception of Amenities and Services	1	Slight positive
S/C 7	User Level of Satisfaction	1	Slight positive
S/C 8	Visual Aesthetics	2	Moderate positive
E/O 1	Employment and Income	3	Positive
E/O 2	Business Opportunities for craft vendors, concessionaires, tourism business operators	3	Positive
E/O 3	Traffic (land)	-2	Moderate negative
E/O 4	Community Development	2	Moderate positive
E/O 5	Fisher folk/Marine Park stakeholders (livelihoods and access/use of site)	-3	Negative

8.1.2 Summary of Potential Impacts and Mitigation During Construction of Overwater Structures

Overwater structures are expected to impact approximately 0.35 to 0.4 hectares (3,500 to 4,000 m^2) of seagrass, with both direct and indirect effects. Direct impacts during construction include potential damage from pile installation and heavy equipment, affecting about 150 to 200 m^2 of seagrass, which necessitates mitigation measures like relocation. Indirect impacts during the operation of the bungalows, such as shading, will affect over 3,300 m^2 of seagrass, but these are considered minimal and do not require mitigation. Shading may lead seagrasses (*Thalassia testudinum)* to elongate their blades to optimise photosynthesis.

The use of barges and heavy machinery poses threats through physical disturbances, requiring careful planning of barge placement and operations to minimise damage. While barge footings do not necessarily require seagrass relocation, unforeseen losses should be considered in the final relocation plan. The contractor must confirm the affected area to ensure the project minimises damage and implements appropriate mitigation strategies.

8.1.2.1 Mitigation- Seagrass Relocation

Given the role of seagrass beds in providing vital ecosystem services, the recommended mitigation would entail seagrass relocation (transplantation) in advance of any construction activity. Seagrass removal and transplantation can mitigate potential damage by relocating vulnerable seagrass to safer areas before construction begins. Furthermore, to minimise damage to seagrass beds in the immediate vicinity of the construction works, it will be essential to employ various mitigation strategies, ranging from silt curtains to using appropriate equipment, training personnel, and implementing stringent monitoring throughout the construction phase. It is advisable to conduct continuous monitoring to assess the condition of the seagrass beds and implement adaptive management strategies as required to ensure the seagrass beds remain healthy.

To mitigate the loss and where damage cannot be averted, seagrass should be relocated to nearby recipient sites that have been approved by NEPA. (See **13.8 Appendix 8 – Seagrass Relocation**). An estimated ~150-200 m^2 (to be confirmed before construction commences) of seagrass would have to be transplanted to designated recipient site(s) in the project's vicinity.

It is also recommended that a low-impact technique for installing pilings be used to avoid or minimise damage to the seagrass beds and the associated marine flora and fauna.

8.1.2.2 Impacts and Mitigation During Construction of Overwater Bungalows

The rapid impact assessment (RIAM) for the construction of overwater bungalows at Sandals Montego Bay, highlighted a number of negative environmental impacts. In addition to seagrass relocation, several additional mitigation measures can be implemented before construction commences to minimise environmental impacts during the construction of the proposed overwater bungalows. These measures are intended to protect sensitive coastal ecosystems and reduce water pollution and turbidity from construction activities. Regular monitoring and adaptive management are integral to ensuring the effectiveness of mitigation strategies. To address potential impacts (before and during construction), the following interventions should be considered, including any additional criteria stipulated by the regulatory agency.

The rapid impact assessment (RIAM) for constructing overwater bungalows at Sandals Montego Bay, Jamaica, identified several negative environmental impacts for which mitigation measures are suggested. These include:

I. **Increased Sediment Loading and Turbidity**: In-water construction, pile installation, and equipment maneuvering, can increase the concentration of suspended solids in the water column, which can be detrimental to seagrass beds and marine fauna.

   Mitigation: Use silt curtains around the construction zone to contain suspended sediments and implement strict protocols for all heavy machine equipment, especially over seagrass beds. Implement erosion control measures on shore (staging and storage areas) to prevent runoff during storm events, which can also contribute to the turbidity/high sedimentation over seagrass beds.

II. **Water Quality and Pollutants**: Contaminants from construction machinery can deteriorate water quality, presenting long-term ecological risks.

   Mitigation: Apply strict protocols for handling and disposing of hazardous materials. Develop and implement a spill prevention and response plan to minimise the risk of water pollution incidents. This plan should include proper storage and handling of materials and protocols for containment and cleanup in case of spills or leaks.

III. **Solid Waste Management**: Construction site waste can introduce pollutants into the marine environment.

   Mitigation: Implement a site waste management strategy with appropriate storage and provision of waste bins.

IV. **Damage to seagrass beds and seafloor during construction.** Installing pilings for the overwater structures will cause unavoidable loss of seagrass (~100-150 m^2) and disturb the sediments in the project area. This will result in turbid conditions, which, if not mitigated, can decrease light availability across the seagrass beds and further contribute to smothering seagrass beds adjacent to the project site.

Mitigation: The seagrass relocation plan calls for the relocation/ transplantation of seagrass that would otherwise be destroyed during piling installation and construction of overwater bungalows (See **Appendix 8 – Seagrass Relocation**)

V. **The presence of a deck barge, landing craft, boats, and other heavy equipment** required to install pilings poses a risk of inadvertently damaging seagrass areas in shallow inshore waters from grounding or scouring of the sea floor. Barge operations, particularly the use of stabilisation footings, can cause direct physical damage, sediment disturbance (i.e., increased turbidity), and habitat fragmentation in seagrass meadows (Luff et al., 2019).

Mitigation: Prioritise avoidance of seagrass beds whenever possible. This can be achieved by strategically adjusting the deployment of construction equipment, such as barges and cranes, to areas without seagrass. Stabilisation footings can be placed in sandy areas to avoid direct contact with seagrass beds. Consider alternative low-impact construction methods that minimise or eliminate the need for heavy equipment over seagrass areas (e.g., for installation of nearshore piles, consider using the crane from shore). Where it is not possible to avoid works over seagrass areas, implement monitoring and adaptive management strategies, for instance:

- Educate boat operators and construction crews about the importance of seagrass ecosystems and proper practices to minimise impact.
- Implement sediment control measures to reduce turbidity and sedimentation during construction.
- Develop and enforce regulations that limit the size and number of vessels in sensitive seagrass areas.
- Monitor seagrass health before, during, and after construction activities to assess impact and recovery.

VI. **Damage to marine flora and fauna resulting from accidental spills.** During construction, heavy machinery in coastal waters presents a risk of fuel or oil spills over seagrass areas. Petroleum-based products can damage seagrass beds, causing mortality due to smothering, fouling, poisoning, destruction of habitat, and killing fauna that use seagrass beds as nursery and foraging grounds.

Mitigation: To minimise potential damage to the marine habitat and fauna, barges and associated equipment must be properly anchored at depths that prevent scouring of the seafloor and seagrass beds. An Oil Spill Protocol should also be implemented to ensure preparedness and response capacity to oil spills. This includes keeping spill kits at storage sites and on barges, wherever there is potential for fuel spills. Furthermore, barges, boats, decks, and heavy equipment used during construction must, be in a good state of repair to prevent oil, fuel, or hydraulic liquid leaks or spills into coastal waters and onto seagrass beds. Finally, work crews must be trained and sensitised to the importance of seagrass beds and how to identify activities that can have deleterious effects on seagrass beds and associated fauna, and how to prevent these impacts.

8.1.2.3 Impacts and Mitigation During Operations of Overwater Bungalows

I. **Shading**: Overwater structures limit the amount of photosynthetically available radiation (PAR) from reaching the sea floor, which can negatively impact the primary productivity of seagrass beds and the diversity of marine organisms that depend on these for food and habitat. Permanent shading may contribute to the post-construction decrease in seagrass shoot density and cover under the overwater bungalows.

Mitigation: Mitigation measures such as installing transparent materials (e.g., along the walkways) that allow light to penetrate, can be implemented to minimise the impact of shading on seagrass. Similarly, increasing the height of the structures to 2m above the water level would allow more sunlight to reach the seagrass beds throughout the day.

II. **Loss of turtle nesting grounds:** Overwater bungalows will permanently alter the coastal habitat, which may deter female Hawksbill turtles from returning to beaches near SMB. In addition to habitat alteration and degradation, increased noise and light from the overwater structures may also deter turtles from returning to the area. While no turtle sightings were reported during the site visits, the historical use of the area as breeding grounds for Hawksbill turtles must be considered.

The permanent habitat alteration due to overwater structures may negatively impact Hawksbill nesting behaviour during the construction and operational phases. Factors such as equipment, operational noise, increased beach traffic, lighting and debris on beaches highlight the need for mitigation measures that protect Hawksbill turtles and their breeding grounds. Applying the precautionary principle, all viable steps should be taken to avoid actions that would deter turtles from returning to their nesting grounds on or near SMB.

Mitigation: Hawksbill Turtles are critically endangered, and as such, every measure should be taken during construction and operational phases to protect their habitat in the vicinity of SMB.

- Construction workers and staff need to be sensitised to the Hawksbill turtles' *critically endangered* status, and given clear instructions on what activities should be avoided so as to not interfere with nesting turtles, should they encounter them.
- One of the most crucial steps is to implement turtle-friendly lighting. Artificial lights can disorient hatchlings, leading them away from the ocean. The recommendation is to use long-wavelength lights, such as amber, orange, or red LEDs, which are less disruptive to turtles. These lights should be shielded and directed downward to prevent them from being visible from the beach.[15]
    - Planting or maintaining vegetation between the resort and the beach can help shield lights and reduce noise, creating a more natural environment for nesting turtles
- It is also recommended to work with the Montego Bay Marine Park and NEPA to determine how to protect Hawksbill turtles and their breeding grounds (e.g., implement a monitoring program and building awareness among tourists).

III. **Impacts of pools and pumps on overwater bungalows**: The installation of pools and associated pool pumps in marine environments, such as are proposed for the overwater bungalows, can have

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[15] Fish and Wildlife Conservation Commission (2018). Sea Turtle Lighting Guidelines. (Retrieved August 2, 2024, from https://myfwc.com/wildlifehabitats/wildlife/sea-turtle/lighting/)

significant implications for local ecosystems. Without proper containment, leaks or spills from these systems can introduce harmful chemicals, including chlorine, algaecides, and pH balancers, into surrounding waters, damaging marine life and disrupting delicate ecological balances. Additionally, improper maintenance or system failures can lead to the release of untreated or partially treated water, further degrading water quality and negatively affecting marine ecosystems.

The use of chlorinated freshwater, common in pool maintenance, poses additional risks to marine life, including vulnerable species like sea turtles (Dyc et al., 2015), and potentially disrupting aquatic ecosystem functioning. To mitigate these risks, stringent safeguards and responsible management practices are essential to protect the surrounding marine environment while still providing amenities for guests.

Mitigation

To mitigate risks to marine ecosystems, it is recommended to implement containment systems that include secondary containment (i.e., bunding), impermeable barriers, and effective collection mechanisms[16]. It's essential to use corrosion-resistant materials to withstand the marine environment and to design systems that prevent pool-related pollutants from contaminating surrounding waters. Regular maintenance is essential to avoid system failures and chemical leaks. Additionally, ensuring proper management of pool pumps will help maintain a safe and sustainable aquatic environment, ultimately protecting marine biodiversity while enhancing the guest experience.

Implement best practices for monitoring and maintaining the overwater bungalow pools and pumps such as:

- Ensure proper personnel training through regular drills and exercises, so that responders are prepared to deploy and operate containment equipment effectively.
- Implement preventive maintenance and routine checks and repairs to prevent system failures and chemical leaks. This includes maintaining storage containers, transport vehicles, and other equipment.

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[16] Bund Design & Maintenance: Ensuring a Safe and Effective Bund. (Accessed 18-Aug-2024)

- Integrate multiple containment/ recovery products and procedures for a more effective approach. This may include sorbents, and other specialised equipment (e.g., booms, skimmers).

8.2 Summary of Potential Impacts and Mitigation During Groyne Construction and Beach Nourishment

In the unique case of this particular project in which there are existing groynes situated on site, the potential negative and positive impacts of the construction process involved in the new groyne construction and the subsequent impacts within the marine environment are considered (**Table 8-4**).

8.2.1 Impacts Related to Seagrass Removal

The construction of new groynes will inevitably involve removing and losing seagrass and benthic organisms within the planned footprint of each groyne. The combined effects of the groyne installation and sand filling are expected to impact approximately 0.7 to 1.0 hectares (7,000 to 10,000 m^2) of seagrass habitat, mainly between groynes P9, P10, and P11.

Given the low diversity of organisms observed within the seagrass zone, it is anticipated that the associated loss within this area during construction will be moderate; however, this will be highly dependent on whether mitigation measures are adhered to. Seagrass disturbance can result in changes to the ecological community such that there may be shifts towards the growth and dominance of other opportunistic or resilient species that take advantage of the bare sandy substrate surrounding the groynes upon the completion of construction works. Therefore, the seagrass may not recolonise the sandy areas immediately surrounding the groynes. In this case, the survey conducted indicated relatively high seagrass biomass within the immediate region of the existing groynes, alongside several macroalgal species growing throughout the area.

Mitigation

The impacts on marine ecology from the loss of seagrass beds during construction of groynes may impact ecosystem processes and services typically provided by the seagrass zone, for example, sand accretion, carbon sequestration, habitat for ecologically sensitive or commercially important species, and foraging grounds (e.g., Thalassinidean shrimps, and sea urchins observed). To mitigate habitat and biodiversity loss, a suitable site for relocation activities should be identified before the commencement of works. This process should be further guided and approved by the National Environment and Planning Agency (NEPA). Before relocation, it will be necessary to determine (i) if relocation is a viable mitigation measure and (ii) the acreage of seagrass to be relocated. If no appropriate site is available, then alternative compensation mechanisms should be considered.

8.2.2 Impacts on Benthic and Pelagic Organisms

The displacement of coarse and fine sediments during construction along the seafloor can impact both benthic and pelagic organisms. The survey showed that the diversity in the organisms was greater in the vicinity of the existing groynes. Therefore, the resuspension of sediment and subsequent deposition which are inevitable processes that form a part of this type of construction activity will not only affect seagrass, but also all fish and benthic dwellers. With increased turbidity in the water column during construction, fish that used the crevices of the groynes as a habitat will likely move away to more pristine waters. The larvae and eggs of marine organisms will also likely become smothered, and the growing conditions for all photosynthetic organisms (i.e., corals and seagrass) may become compromised. The deposition of sediments unto the seafloor may also smother sessile or slow-moving fauna (e.g., sea cucumber, sea anemone etc.). Similarly, the organisms living on the hard substrate of the existing groynes may also be affected.

Mitigation

The extent of the impact of increased sediment suspension in the water column will depend on how well it is contained in the immediate construction area. The use of silt screens/sediment barriers is recommended to contain or restrict sediment dispersion and settlement, accompanied by real time turbidity measurements to monitor suspension levels. Should turbidity in the water column adjacent to areas protected by nets exceed values specified by licences granted by NEPA, construction should be paused. It is recommended that these screens be deployed parallel to the reef crest to prevent the smothering of coral colonies and other reef organisms growing on the backreef. Screens may also be installed along the border of each groyne while construction is taking place. However, to maximise the efficiency of these screens, their placement should also be guided by the hydrodynamics of the project area.

Failing this, or if the silt screens are not appropriately deployed, the impact area could potentially be amplified. Activities should also be suspended during unfavourable weather conditions, or when anticipated. Where seagrass and important invertebrates need to be relocated based on the projected footprint and estimated impacts, an area for consideration could be the adjacent backreef areas located outside of the project footprint. Any benthic habitat lost in adjacent areas will likely recover within one (1) to three (3) years after the cessation of construction.

8.2.3 Impacts Due to Discharges into the Sea

If fuel leaks or spills from equipment used for groyne construction or beach nourishment during refueling or operation are not contained as soon as they occur, this could potentially result in wide-scale impacts on water quality and the benthic and pelagic environments.

Mitigation

Appropriate refueling equipment (for example, funnels) and techniques should be used at all times and appropriate equipment for containment and clean-up of any spills should be kept on site. With effective mitigation, impacts will be minor.

8.2.4 Impacts due to Increased Boat Traffic

Potential impacts of minor significance from machine/equipment noise, lighting and movements on benthic fauna and fish are likely during the construction phase.

Mitigation

Noise levels should be monitored throughout the construction phase to ensure standards for marine wildlife are not exceeded.

8.2.5 Benefits of Groynes

Despite the potential impacts that the proposed project can have on the marine ecosystems during the construction phase, the surveys indicated that the hard substrate and crevices provided by the groynes appeared to be highly beneficial to a variety of marine organisms, thus contributing to the marine biodiversity of the area. The construction of the groynes may also result in physical and social impacts on the environment which should also be considered. The extent of these impacts should be analysed with additional related assessments as guided by NEPA.

TABLE 8-4. SUMMARY IMPACT ASSESSMENT MATRIX

Component Code	Description	Baseline/Without		During Construction		During Operation	
		Magnitude of Impact	Impact Description	Magnitude of Impact	Impact Description	Magnitude of Impact	Impact Description
P/C 1	Coastal dynamics	-	-	-1	Slight negative	-1	Slight negative
P/C 2	Hydrology: Runoff/Stormwater management	-2	Moderate negative	-3	Negative	-1	Slight negative
P/C 2M	Mitigation: Hydrology: Stormwater retention ponds, placement of berms at key locations	-	-	3	Positive	1	Slight positive
P/C 2M	Mitigation: Groyne P12	-	-	2	Moderate positive	-1	Slight negative
P/C 3	Hydrology: Stormwater management (overwater	-	-	-1	Slight negative	-1	Slight negative
P/C 3M	Mitigation:Hydrology: Use downspouts with dispersal fixture at base to disperse freshwater	-	-	1	Slight positive	1	Slight positive
P/C 4	WQ: TSS/TUR	-1	Slight negative	-4	Significant negative	-3	Negative
P/C 4M	Mitigation: WQ: TSS/TUR: use of screens around piling installation site	-	-	2	Moderate positive	1	Slight positive
P/C 5-7	WQ: Stormwater impacts: Nutrients (N/P)	-1	Slight negative	-2	Moderate negative	-2	Moderate negative
P/C 8	WQ: Faecal Coliform	0	Neutral/Status quo	-3	Negative	-2	Moderate negative
P/C 9	Safety: Accidents (Oil spill, pools & pumps)	0	Neutral/Status quo	-3	Negative	-1	Slight negative
P/C 9M	Mitigation Accidents: regular inspection and maintenance; strategic placement of shut-	-	-	1	Slight positve	1	Slight positve
P/C 10	Waste Management:Solid waste/construction debris	0	Neutral/Status quo	-2	Moderate negative	-1	Slight negative
P/C10M	Mitigation:Site Waste Management strategy:Appropriate storage and provision of waste bins for construction material and for rubbish generated by workers, toilets, dedicated staff to collect rubbish that accumulates on the beach) /Waste management during operational phase	-	-	1	Slight positive	1	Slight positive
P/C 11	Noise	-1	Slight negative	-3	Negative	-1	Slight negative
P/C 12	Air quality	0	Neutral/Status quo	-2	Moderate negative	0	Neutral/Status quo
B/E 1	Terrestrial: Habitat destruction, fragmentation and	0	Neutral/Status quo	-3	Negative	-2	Moderate negative
B/E 2	Terrestrial: Loss of biodiversity(flora)	0	Neutral/Status quo	-1	Slight negative	-1	Slight negative
B/E 3	Terrestrial: Loss of biodiversity (fauna, avifauna)	0	Neutral/Status quo	-4	Significant negative	-2	Moderate negative
B/E 3M	MitigationTerrestrial: Use of native floral species for landscaping to attract avifuana and macrofauna	-	-	2	Moderate positive	2	Moderate positive
B/E 4	Marine: Shoreline alteration/habitat degradation	0	Neutral/Status quo	-4	Significant negative	-2	Moderate negative
B/E 5	Marine: Impact of WQ degradation-	-1	Slight negative	-3	Negative	-1	Slight negative
B/E 6	Marine: Loss of seagrass (smotherin])	-1	Slight negative	-4	Significant negative	-3	Negative
B/E 6M	Mitigation Marine: Seagrass transplantation to recipient site	-	-	3	Positive	2	Moderate positive
B/E 7	Marine: Loss of seagrass (operational [shading])	0	Neutral/Status quo	0	No change/status quo	-1	Slight negative
B/E 8	Marine: Loss of coral species (reef crest)	0	Neutral/Status quo	-1	Slight negative	-1	Slight negative
B/E 8M	Mitigation marine: Coral transplantation to reef crest	-	-	1	Slight positive	1	Slight positive
B/E 9	Marine: Loss of Marine: Loss of fauna (macroinvertebrates, fish, turtles,)	-	-	-2	Moderate negative	0	No change
B/E 9M	Mitigation_Marine: 1) Relocation of any macroinvertebrates in the seagrass bed 2) Tutle-friendly lights directed away from beach; turtle monitoring program (e.g., collaboration with Montego Bay Marine Park, NEPA) 3) Training for staff and visitors (turtle conservation program)	0	Neutral/Status quo	1	Slight positive	1	Slight positive
S/C 1	Land Use	0	Neutral/Status quo	-1	Slight negative	0	No change
S/C 2	Community Services and Infrastructure	0	Neutral/Status quo	-2	Moderate negative	-2	Moderate negative
S/C 2M	Mitigation:Community Services and Infrastructure/Coordinate with local authorities to improve infrastructure and services to accommodate increasing demand from patrons	-	-	-	-	2	Moderate positive
S/C 3	Perception of Crowding	0	Neutral/Status quo	0	No change/status quo	-1	Slight negative
S/C 4	Perception of Risk and Safety	0	Neutral/Status quo	-1	Slight negative	1	Slight positive
S/C 5	Perception of Natural Resources	0	Neutral/Status quo	-2	Moderate negative	-1	Slight negative
S/C 6	Perception of Amenities and Services	0	Neutral/Status quo	0	No change/status quo	1	Slight positive
S/C 7	Visual Aesthetics	1	Slight positive	-1	Slight negative	2	Moderate positive
E/O 1	Employment and Income	2	Moderate positive	2	Moderate positve	3	Positive
E/O 2	Business Opportunities for craft vendors,	0	Neutral/Status quo	0	No change/status quo	3	Positive
E/O 3	Traffic (land)	0	Neutral/Status quo	-2	Moderate negative	-2	Moderate negative
E/O 4	Community Development	0	Neutral/Status quo	2	Moderate positve	2	Moderate positive
E/O 5	Fisher folk/Marine Park stakeholders (livelihoods and	-2	Moderate negative	-3	Negative	-3	Negative impact

9 Archeological Impact Assessment

Objectives of the Archaeological Impact Assessment (AIA) are to:

- ascertain the presence of historical and archaeological resources and describe the status of these resources, along with any other socio-economic attributes and appraise their worth in context of the proposed development, legislative and regulatory considerations;
- identify and predict any potential positive, negative, reversible, irreversible, short- and long-term impacts and to indicate possible mitigation to negative impacts, as well as make recommendations to enhance positive impacts;
- outline possible alternatives to the project and or aspects of it.

Scope of the assessment included the following tasks:

Task 1: Desk-Based Assessment

Task 2: Site Survey

Task 3. Description of Proposed Project

Task 4: Description of the Project Area

Task 5: Determination of Potential Impacts

DISCUSSION, RECOMMENDATION and CONCLUSION

The proposed development area has no historical structures although there are a few brick fragments and artefacts the sparse archaeological contexts present on the site are insignificant to the proposed development.

There is presently no evidence of occupation by Jamaica's indigenous population, the Taíno, in this area. With the exception of a wharf in the vicinity there is little evidence to show that the proposed development area was utilised much during the plantation era. The historical maps also show that morass or swamp was in this area, and this is still evident today.

The JNHT AIA concludes that based on the archaeological evidence available at this time it is not significant enough to warrant *in situ* preservation. As such the JNHT Archaeology Division has no objection to the proposed development.

10 Identification and Analysis of Alternatives

10.1 Overwater Structures

(1) No Action Alternative

The "no-action" alternative is a standard for comparing other potential actions. It involves examining the consequences of not building new overwater villas at the Sandals Montego Bay location. This alternative means no new overwater structures would be added; the resort would rely on existing facilities. This option helps preserve the current state of the natural environment and existing structures, minimising changes to the shoreline and protecting marine ecosystems like seagrass beds. While choosing this option would mean the resort misses out on the benefits of overwater villas, such as exceptional views and direct water access, it also avoids the potential environmental, social, or economic issues that could arise from their development.

(2) Option 1

This option would see the construction of overwater bungalows on the western side of the Sandals property where the structure would be better sheltered from storm surges. The environmental impacts would be similar in both locations, specifically loss of seagrass and habitat alteration.

10.2 Expansion of the SMB property to the East

The project objective is to provide for a minor expansion of the SMB property up to 230 m east of the existing resort and north of the Kent Avenue relocation for purposes of guest amenities and resort operations, subject to the air draft restrictions north of the pending runway extension of Sangster International Airport. Alternatives include the following:

(1) No-Action

This alternative is not viable because the existing shorefront and uplands are low in elevation (subject to flooding), chronically erosional, and features little to no recreational sand beach amenity, and is unlikely to achieve same in the absence of action.

(2) Seawall/Revetment Only

This alternative would construct a seawall or revetment along the existing shoreline, or seaward thereof to reclaim chronically eroded shoreline without a sand beach seaward thereof. It would provide for elevation and structural protection of the upland, but it would not provide any beach amenity or useful ocean access and would result in an armouring of the shoreline without a natural sand beach interface between the upland and the sea. This alternative does not meet the objectives and is not preferred.

(3) Beach Nourishment Only

Placement of sand fill with no stabilising structures or other shorefront modification cannot be expected to result in a near- or long-term viable beach improvement at this site, given its existing condition, prevailing currents and morphology. Given the observed chronic erosion of this shoreline, unstabilised beach nourishment is not a viable alternative.

(4) Beach Nourishment with Nearshore Breakwaters

This alternative is not viable because the existing morphology and pervasive alongshore currents would strip the sand from the beach between the breakwaters and the shoreline. Breakwaters are commonly used to diminish erosion from offshore wave energy, rather than alongshore stress (where the latter mostly dominates at this site).

(5) Beach Nourishment with Groyne Cells

This alternative is viable and recommended in that it creates pocket beach crenulated embayments that are stable in the face of offshore wave energy and alongshore currents. This approach follows from the demonstrated success of T-head groyne cells constructed along the 260-m long shoreline immediately west of the project area (c. 2017), which have stabilised the shoreline and expanded the beach amenity along the existing SMB shoreline. Subsets of this alternative include identification of the optimum number and size of groynes and beach cells. This is determined by the total shorefront length and the requisite seaward extent (and size) of the groyne structures, as described below.

The subject shorefront is about 230+ meters long. The western 180-m length of this shorefront has upland width >30 m and an air-draft limitation of >15 ft., and so this length is selected as the principal area for beach improvement. In accordance with accepted coastal engineering standards of practice for beach embayment design (Silvester and Hsu 1993, USACE 2008, Bodge 2003, among others), which relate the gap-opening between groyne heads to the location of the shoreline behind the groynes, the following is concluded:

- A single beach embayment of 180 m length (less 20+ m for groyne heads = 160 m) is impractically long and exceeds the maximum alongshore limit (~100 m) recommended for pocket beach improvements.
- Two beach embayment cells (with 3 groynes, including the existing west-end groyne) is viable, but requires that the structure heads be located further offshore and are greater in alongshore head-length to maintain the objective shoreline location. This increases the amount of structure on the horizon relative to open space and pushes the groyne lengths further offshore. It would result in a gap opening between T-head groynes of about 60+ m – which is significantly greater than the gap openings of 30 to 40 m that are successfully employed along the adjacent SMB shoreline.
- Three beach embayment cells (with 4 groynes, including the existing west-end structure), as proposed, creates three cells 60 m wide between groyne centerlines (ideal) and structures with minimum head lengths (10 m long T-head spurs, the ideal length) extending to not greater than about -1.2 m MSL existing depth contour. The gap openings between T-heads are approximately 38 m. That dimension is consistent with the gap openings along the adjacent SMB beach improvements (ranging from 17 to 40 m) -- which have performed successfully. The ratio of gap openings to total structure head-length is about 1.7:1 (i.e., 70% more open space than structure on the horizon) -- which is close to the practicable ideal design ratio.

Accordingly, three beach cells (with 4 groynes, including the existing westernmost groyne “P9”) is determined to be optimum in terms of minimising the seaward extent and size of the structural footprint relative to the required beach and shoreline geometry, and it is consistent with the scale of the beach cells that have performed satisfactorily along the adjacent SMB shoreline. The recommended improvement is therefore a 3-cell beach embayment along the western 180 meters of the shorefront, and a revetment with minor beach sand filling along the eastern 40 meters. The revetement (shoreline stabilisation) along the eastern end is anticipated to 'tie in' to the Kent Avenue revetment improvements, in order to avoid a gap – or flanking – of either structure.

11 Environmental Monitoring and Management

The proposed Environmental Monitoring and Management Plan is presented in Table 11-1The main objectives of this Environmental Monitoring Plan are to:

- Minimise the effects of the construction and operation of the project on the Physical, Biological and Socioeconomic environment.
- Comply with the regulatory and legislative requirements.

TABLE 11-1: PROPOSED ENVIRONMENTAL MONITORING AND MANAGEMENT PLAN

Monitoring	Frequency & Report	Responsible Parties
SEWAGE		
Construction		
Workers' toilet facilities need to be kept clean.	Facilities should be cleaned daily or as necessary.	Contractor and verified by Sandals Project Manager
The integrity of installed sewer pipelines with regards to leaks and functionality.	Pressure tests the sewer system prior to commissioning to ensure there are no leaks and it is functioning as designed.	Maintenance Department
Operation		
Maintain integrity of the sewer pipelines	Conduct monthly visual checks of the pipelines while the system is being flushed.	Maintenance Department
Flushing the sewer pipelines	The manholes should be checked weekly and cleaned as necessary.	Contractor and verified by Sandals Project Manager

Monitoring	**Frequency & Report**	**Responsible Parties**
Maintenance of the sewer system	The lift station should be checked daily as part of the Maintenance Department log.	Projects Department
In preparation for an approaching tropical weather system (Tropical storms, Hurricanes)	The system should be fully flushed after the evacuation of the rooms to ensure no sewage is in the sewer system.	
After the passage of a tropical weather system and natural hazard such as Tsunami, earthquake etc.	Visual inspection should be done to ensure the integrity of the system is intact, including the pipelines and infrastructure (brackets and hangers that secure the pipelines).	
	The system should be fully flushed after the evacuation of the rooms to ensure no sewage is in the sewer system.	
AIR QUALITY		
Construction		
Motorised equipment is in good working condition, not emitting additional pollutants nor excessive noise	Visual inspection of motorised equipment should be done while operating to ensure they are not emitting additional air pollutants (black smoke from exhaust), and corrective action should be taken.	Contractors
Dust suppression effectiveness	Ongoing visual inspection for fugitive dust	
Noise	Real-time noise measurements, once per month, vehicle inspection to verify effective noise suppression.	
OIL SPILL		
Construction		
Fuel bond on pontoon needs to be checked daily to ensure there is no fuel leakage.	Daily visual inspection	Contractor
Check spill kits for sorbents, sand or sawdust kept on the construction site and Pontoon.	Daily visual inspection	
Check to ensure obstacle barrier encircling the project site is	Daily visual inspection	

Monitoring	Frequency & Report	Responsible Parties
deployed effectively and serving its purpose		
Ensure that refueling is done on hardstanding, solid surfaces or materials that prevent absorption to the ground or any potential environmental contamination. Additionally, create containment areas around all fuel transfer points	Daily visual inspection. Clean up any spill on land and dispose of refuse at special disposal facilities at Retirement Disposal facility. Any marine spillage must be reported to NEPA, and clean-up activities start as soon as possible as directed by NEPA.	Contractor
WASTE MANAGEMENT		
At least two (2) 100-gallon garbage bins need to be on the project site, and one (1) garbage bin on the Pontoon for non-construction waste. General waste should be removed when the bin is full or every 3 days and be taken to NSWMA approved garbage site.	Daily visual inspection. Removal of waste should be logged and tickets from the dump site presented weekly.	Contractor
Operation		
Daily removal of solid waste from rooms and placement in secure receptacles.	Floating debris should be removed whenever seen.	Water sports
Solid waste that accidentally falls into the sea should be removed.	Monthly dive sessions should be done to check for waste	Water sports
CHEMICAL		
Construction		
Rust grip must generally be applied on land.	Daily visual observation	Contractor
Paint lacquers and varnishes, applied on the structure must be in bunded containers or rest on material that will absorb spill such as cloth, cardboard etc.	Daily visual observation	Contractor
Chemicals must be stored properly, in a well-ventilated area away from ignition source(s), and in their original container.	Daily visual observation	Contractor
Operation		

Monitoring	**Frequency & Report**	**Responsible Parties**
The Material Safety Data Sheet of every chemical used to clean rooms should be checked to ensure it is phosphate free.	Chemical approval form should be documented before any chemical is introduced. Chemical agents to be used as per manufacturers' instructions	EHS Dept.
WATER QUALITY		
<u>Construction & Operation</u> the following parameters should be monitored.	Once per month	EHS Dept.
√ pH		
√ Dissolve oxygen		
√ Turbidity		
√ BOD		
√ Salinity		
√ Faecal Coliform		
√ Nitrates		
√ O-Phosphates		
√ Temperature		
MARINE SANTUARY		
Monitor relocated seagrasses and associated organisms	Quarterly	Contractor(s)

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13 APPENDICES

13.1 Appendix 1 – Water Quality Wet Season Data

SMB 1:

LAT	LONG
18.514782	-77.903406

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO mg/L		FC (MPN/100ml)		pH		T (°C)	
	T	B	T	B	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0.006	0.003	0.032	0.007	0.96		5.7	5.4	<2		8.0	7.8	29.9	29.9
18-Oct-23	0.007	0.002	0.041	0.007	0.72	1.70	6.0	5.8	<2		8.1	8.1	31.2	31.2
25-Oct-23	0.003	0.003	0.020	0.011	3.70		5.9	6.0	13	8	8.1	8.1	30.6	30.6
STD	0.003(4)		0.014(4)		1.16(4)		4.8(4)		<2-13 (4)		8.1(3)			29.6(2)
AVERAGE	0.005	0.003	0.031	0.008	1.79	1.70	5.9	5.7	4	8	8.1	8.0	30.6	30.6
STD DEV	0.002	0.001	0.011	0.002	1.66		0.2	0.3	8		0.0	0.2	0.6	0.6
MAX	0.007	0.003	0.041	0.011	3.70	1.70	6.0	6.0	13	8	8.1	8.1	31.2	31.2
MIN	0.003	0.002	0.020	0.007	0.72	1.70	5.7	5.4	0	8	8.0	7.8	29.9	29.9

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)	
	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0	4	1.0	1.0	35.1	35.2	57400	58500	31570	32175
18-Oct-23	1	3	0.5	0.5	34.3	34.3	58533	58523	34033	34036
25-Oct-23	0	1	0.0	0.0	33.4	33.4	56516	56572	43870	44830
STD						35.6 (1)				
AVERAGE	0	3	0.5	0.5	34.3	34.3	57483	57865	36491	37014
STD DEV	1	2	0.5	0.5	0.9	0.9	1011	1120	6508	6833
MAX	1	4	1.0	1.0	35.1	35.2	58533	58523	43870	44830
MIN	0	1	0.0	0.0	33.4	33.4	56516	56572	31570	32175

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022

(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April

(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020

(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 2:

LAT	LONG
18.511117	-77.904262

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO mg/L		FC (MPN/100ml)		pH		T (°C)	
	T	B	T	B	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0.004		0.009		1.44		5.3	5.1	<2		8.1	8.1	29.9	29.9
18-Oct-23	0.003		0.003		1.10		4.3		<2		7.9		31.1	
25-Oct-23	0.002		0.004		0.12		5.3	5.3	<2		8.0	8.0	30.4	30.4
STD	0.003(4)	0	0.014(4)		1.16(4)		4.8(4)		<2-13 (4)		8.1(3)		29.6(2)	
AVERAGE	0.003		0.005		0.89		5.0	5.2	<2		8.0	8.1	30.5	30.2
STD DEV	0.001		0.003		0.69		0.6	0.1	<2		0.1	0.0	0.6	0.4
MAX	0.004		0.009		1.44		5.3	5.3	<2		8.1	8.1	31.1	30.4
MIN	0.002		0.003		0.12		4.3	5.1	<2		7.9	8.0	29.9	29.9

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)	
	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0		4.0	3.0	35.2	35.1	58500	58400	32175	32120
18-Oct-23	3		7.2		34.2		58313		43155	
25-Oct-23	8		7.12	7.6	33.3	33.3	56270	56229	43845	
STD						35.6 (1)				
AVERAGE	4		6.1	5.3	34.2	34.2	57694	57315	39725	
STD DEV	4		1.8	3.3	1.0	1.3	1237	1535	6548	
MAX	8		7.2	7.6	35.2	35.1	58500	58400	43845	
MIN	0		4.0	3.0	33.3	33.3	56270	56229	32175	

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022
(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April
(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020
(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 3:

LAT	LONG
18.511784	-77.903295

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO mg/L		FC (MPN/100ml)		pH		T (°C)	
	T	B	T	B	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0.003		0.011		0.72		4.9	5.0	<2		8.10	8.10	29.9	29.8
18-Oct-23	0.002		0.002		2.00		4.05		<2		7.89		31.1	
25-Oct-23	0.003		0.006		2.20		5.27	5.2	<2		8.03		30.4	
STD	0.003(4)	0	0.014(4)		1.16(4)		4.8(4)		<2-13 (4)		8.1(3)			29.6(2)
AVERAGE	0.003		0.006		1.64		4.74	5.1	<2		8.01	8.10	30.5	29.8
STD DEV	0.00		0.005		0.803		0.63	0.2	<2		0.11		0.6	
MAX	0.00		0.011		2.20		5.27	5.2	<2		8.10	8.10	31.1	29.8
MIN	0.00		0.002		0.72		4.05	5.0	<2		7.89	8.10	29.9	29.8

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)	
	T	B	T	B	T	B	T	B	T	B
10-Oct-22	3		7.0	2.0	35.2	35.2	58500	58400	32175	32120
18-Oct-23	19		10.9		34.2		58240		43330	
25-Oct-23	0		7.6		33.3		56292		33145.00	
STD						35.6 (1)				
AVERAGE	7		8.5	2.0	34.2	35.2	57677	58400	36217	
STD DEV	10		2.1		1.0		1207		6179	
MAX	19		10.9	2.0	35.2	35.2	58500	58400	43330	
MIN	0		7.0	2.0	33.3	35.2	56292	58400	32175	

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022
(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April
(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020
(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 4:

LAT	LONG
18.512457	-77.902264

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO mg/L		FC (MPN/100ml)		pH		T (°C)	
	T	B	T	B	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0.007		0.009		0.48		4.41	4.3	<2		8.10	8.10	29.7	29.8
18-Oct-23	0.005		0.003		2.50		3.56		8		7.84		31.0	
25-Oct-23	0.002		0.003		0.00		5.26		<2		8.03	8.03	30.5	30.5
STD	0.003(4)	0	0.014(4)		1.16(4)		4.8(4)		<2-13 (4)		8.1(3)			29.6(2)
AVERAGE	0.005		0.005		0.99		4.41	4.3	3		7.99	8.07	30.4	30.2
STD DEV	0.002		0.003		1.327		0.85		5		0.13	0.05	0.7	0.5
MAX	0.007		0.009		2.50		5.26	4.3	8		8.10	8.10	31.0	30.5
MIN	0.002		0.003		0		3.56	4.3	<2		7.84	8.03	29.7	29.8

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)	
	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0		11.0	2.0	35.2	35.2	58300	58400	32065	58400
18-Oct-23	28		27.0		34.2		58140		41850	
25-Oct-23	7		6.8		33.3		56310		56310	
STD						35.6 (1)				
AVERAGE	12		14.9	2.0	34.2	35.2	57583	58400	43408	
STD DEV	15		10.7		0.9		1106		12197	
MAX	28		27.0	2.0	35.2	35.2	58300	58400	56310	
MIN	0		6.8	2.0	33.3	35.2	56310	58400	32065	

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022

(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April

(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020

(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 5:

LAT	LONG
18.512715	-77.900687

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO mg/L		FC (MPN/100ml)		pH		T (°C)	
	T	B	T	B	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0.003		0.009		1.20		4.91	4.3	<2		8.10	8.10	29.9	29.9
18-Oct-23	0.001		0.003		0.96		4.60		7		7.98	7.98	31.1	
25-Oct-23	0.002		0.005		0.00		5.25	5.3	2		8.03	8.01	30.4	30.4
STD	0.003(4)	0	0.014(4)		1.16(4)		4.8(4)		<2-13 (4)		8.1(3)			29.6(2)
AVERAGE	0.002		0.006		0.72		4.92	4.8	3		8.04	8.03	30.5	30.2
STD DEV	0.001		0.003		0.63		0.33	0.7	4		0.06	0.06	0.6	0.4
MAX	0.003		0.009		1.20		5.25	5.3	7		8.10	8.10	31.1	30.4
MIN	0.001		0.003		0.00		4.60	4.3	<2		7.98	7.98	29.9	29.9

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)	
	T	B	T	B	T	B	T	B	T	B
10-Oct-22	0		11.0	2.0	35.2	35.2	58500		32175	
18-Oct-23	6		7.8		34.2		58380		42350	
25-Oct-23	4		7.9	3.6	33.3	33.3	56306	56267	33152	33148
STD						35.6 (1)				
AVERAGE	3		8.9	2.8	34.3	34.3	57729	56267	35892	33148
STD DEV	3		1.8	1.1	0.9	1.3	1234		5614	
MAX	6		11.0	3.6	35.2	35.2	58500	56267	42350	33148
MIN	0		7.8	2.0	33.3	33.3	56306	56267	32175	33148

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022

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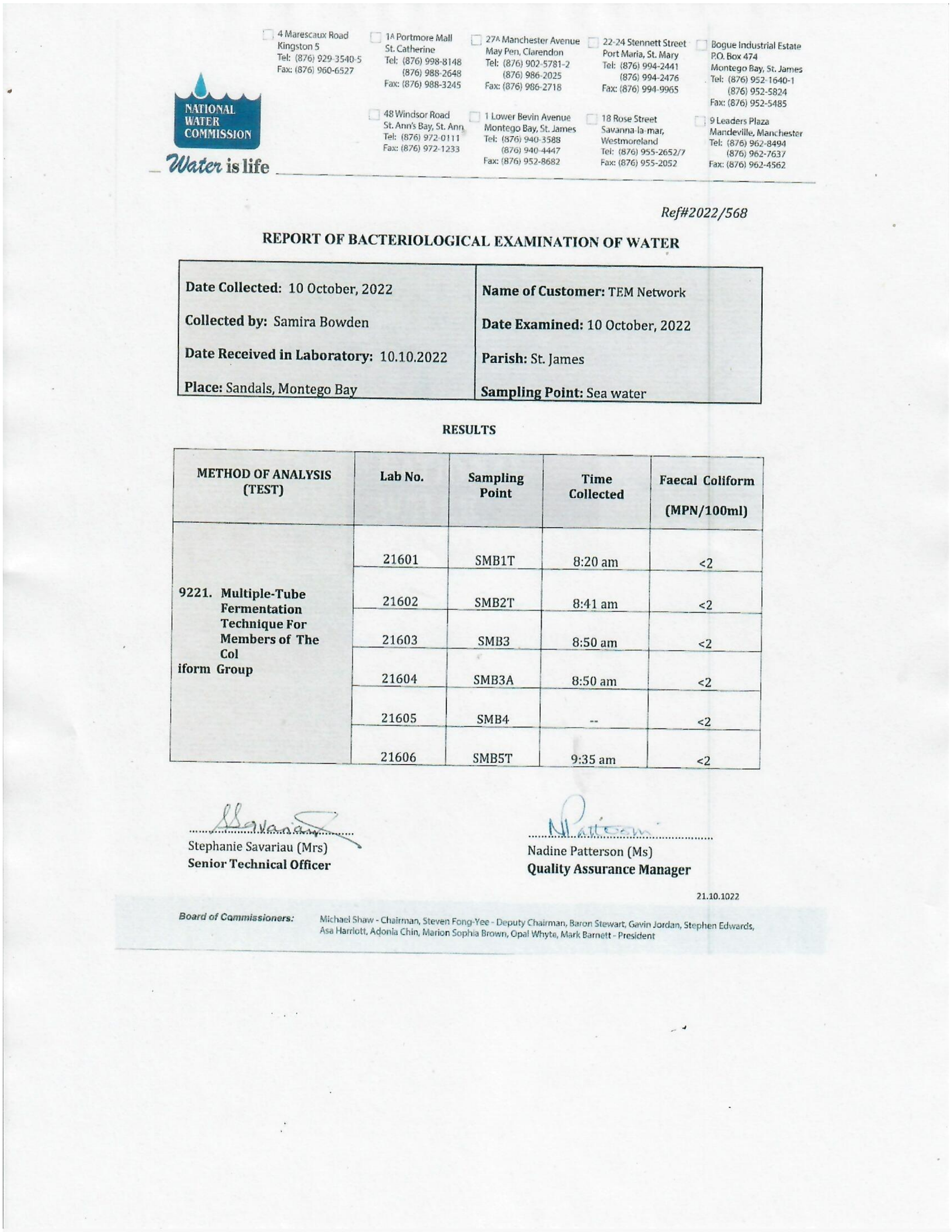
(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009



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Ref#2022/568

REPORT OF BACTERIOLOGICAL EXAMINATION OF WATER

Date Collected: 10 October, 2022	**Name of Customer:** TEM Network
Collected by: Samira Bowden	**Date Examined:** 10 October, 2022
Date Received in Laboratory: 10.10.2022	**Parish:** St. James
Place: Sandals, Montego Bay	**Sampling Point:** Sea water

RESULTS

METHOD OF ANALYSIS (TEST)	Lab No.	Sampling Point	Time Collected	Faecal Coliform (MPN/100ml)
9221. Multiple-Tube Fermentation Technique For Members of The Col iform Group	21601	SMB1T	8:20 am	<2
	21602	SMB2T	8:41 am	<2
	21603	SMB3	8:50 am	<2
	21604	SMB3A	8:50 am	<2
	21605	SMB4	--	<2
	21606	SMB5T	9:35 am	<2

SSavariau
Stephanie Savariau (Mrs)
Senior Technical Officer

NPatterson
Nadine Patterson (Ms)
Quality Assurance Manager

21.10.1022

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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden	**Name of Customer:** TEM Network
Date Collected: 10 October, 2022	**Place:** Sandals, Montego Bay
Date Received in Laboratory: 10 October, 2022	**Parish:** St. James
Date Examined: 10 October, 2022	**Sampling Point:** Sea water

RESULTS

Parameters	Analytical Results SMB5B	Units	Analytical Method	Analyzed By
Lab No.	**954/893**			
Turbidity	**3.0**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.017**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**0**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.04**	mg/L	SMWW 4110B	C. Samuels
BOD	--	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
Senior Technical Officer

N Patterson
Nadine Patterson (Ms)
Quality Assurance Manager

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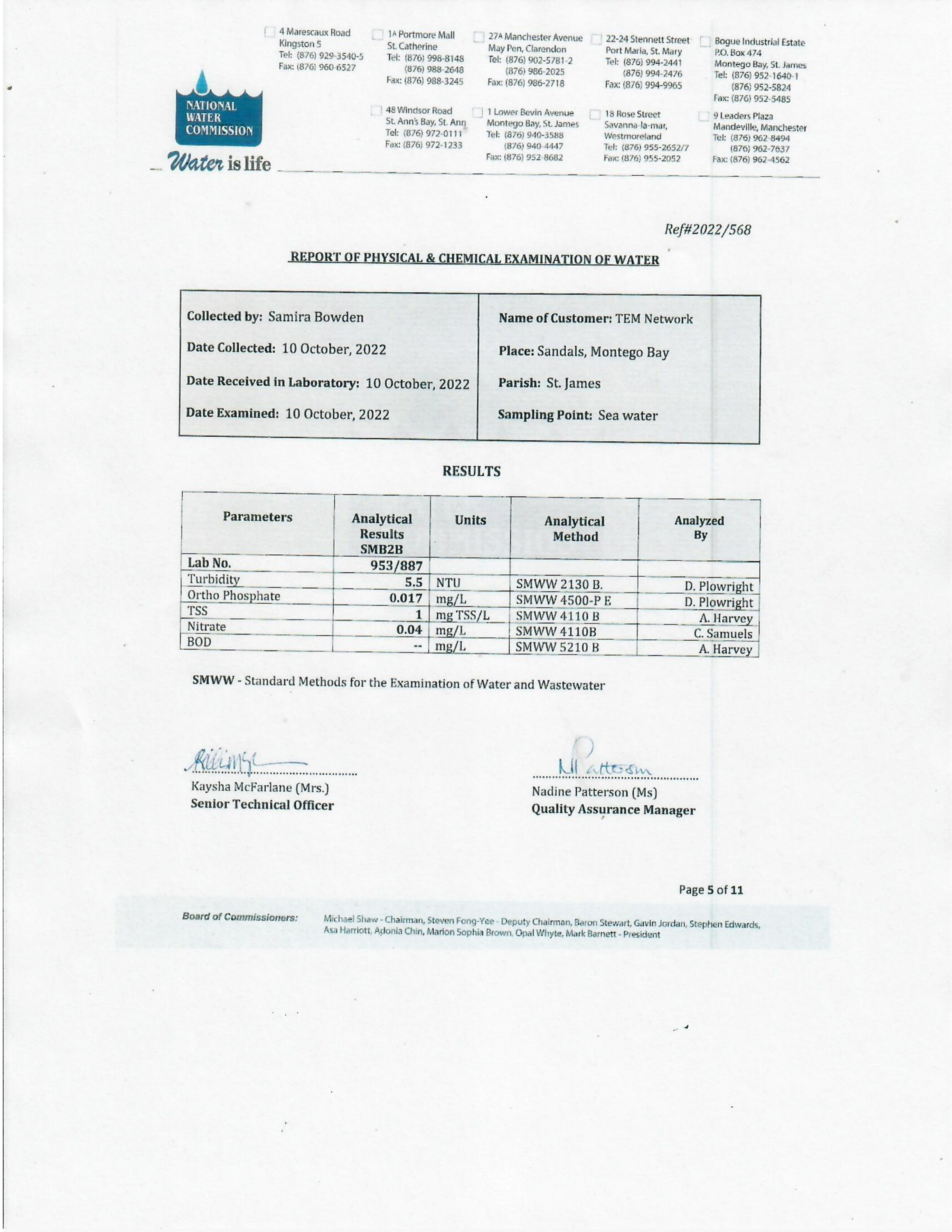

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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden

Date Collected: 10 October, 2022

Date Received in Laboratory: 10 October, 2022

Date Examined: 10 October, 2022

Name of Customer: TEM Network

Place: Sandals, Montego Bay

Parish: St. James

Sampling Point: Sea water

RESULTS

Parameters	Analytical Results SMB2B	Units	Analytical Method	Analyzed By
Lab No.	**953/887**			
Turbidity	**5.5**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.017**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**1**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.04**	mg/L	SMWW 4110B	C. Samuels
BOD	--	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
Senior Technical Officer

N Patterson
Nadine Patterson (Ms)
Quality Assurance Manager

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REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden	**Name of Customer:** TEM Network
Date Collected: 10 October, 2022	**Place:** Sandals, Montego Bay
Date Received in Laboratory: 10 October, 2022	**Parish:** St. James
Date Examined: 10 October, 2022	**Sampling Point:** Sea water

RESULTS

Parameters	Analytical Results SMB1B	Units	Analytical Method	Analyzed By
Lab No.	**952/885**			
Turbidity	**3.9**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.008**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**4**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.03**	mg/L	SMWW 4110B	C. Samuels
BOD	--	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

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REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden
Date Collected: 10 October, 2022
Date Received in Laboratory: 10 October, 2022
Date Examined: 10 October, 2022

Name of Customer: TEM Network
Place: Sandals, Montego Bay
Parish: St. James
Sampling Point: Sea water

RESULTS

Parameters	Analytical Results SMB5T	Units	Analytical Method	Analyzed By
Lab No.	**951/892**			
Turbidity	**7.2**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.008**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**0**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.04**	mg/L	SMWW 4110B	C. Samuels
BOD	**1.2**	mg/L	SMWW 5210 B	A. Harvey

NB*
1. **SMWW** - Standard Methods for the Examination of Water and Wastewater
2. Total Suspended Solids result is underestimated, however, no sample was available for repeat analysis.

Kaysha McFarlane (Mrs.)
Senior Technical Officer

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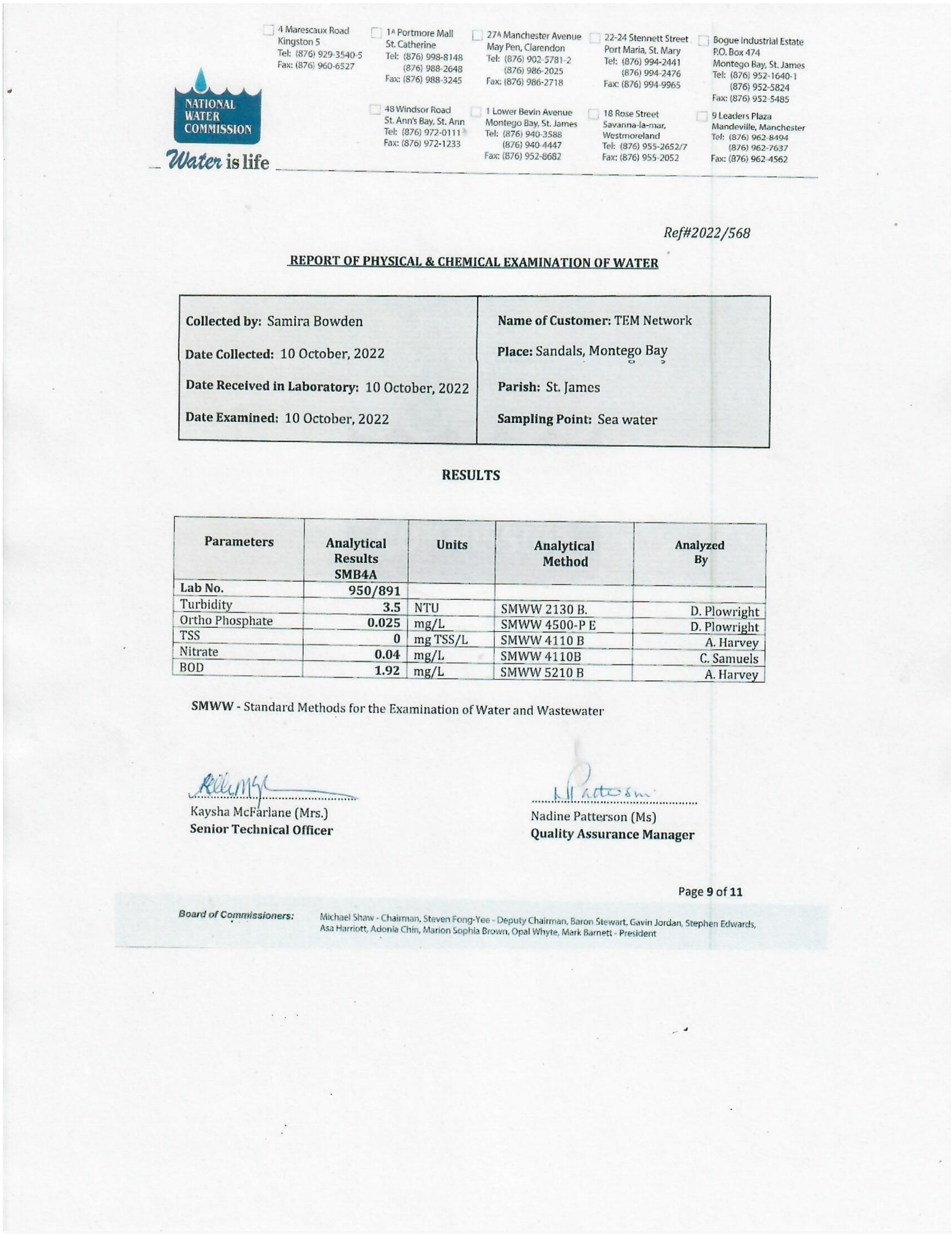
Quality Assurance Manager



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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden	**Name of Customer:** TEM Network
Date Collected: 10 October, 2022	**Place:** Sandals, Montego Bay
Date Received in Laboratory: 10 October, 2022	**Parish:** St. James
Date Examined: 10 October, 2022	**Sampling Point:** Sea water

RESULTS

Parameters	Analytical Results SMB4A	Units	Analytical Method	Analyzed By
Lab No.	**950/891**			
Turbidity	**3.5**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.025**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**0**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.04**	mg/L	SMWW 4110B	C. Samuels
BOD	**1.92**	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden

Date Collected: 10 October, 2022

Date Received in Laboratory: 10 October, 2022

Date Examined: 10 October, 2022

Name of Customer: TEM Network

Place: Sandals, Montego Bay

Parish: St. James

Sampling Point: Sea water

RESULTS

Parameters	Analytical Results SMB4	Units	Analytical Method	Analyzed By
Lab No.	**949/890**			
Turbidity	**2.2**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.021**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**0**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.04**	mg/L	SMWW 4110B	C. Samuels
BOD	**0.48**	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
Senior Technical Officer

Nadine Patterson (Ms)
Quality Assurance Manager

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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden

Date Collected: 10 October, 2022

Date Received in Laboratory: 10 October, 2022

Date Examined: 10 October, 2022

Name of Customer: TEM Network

Place: Sandals, Montego Bay

Parish: St. James

Sampling Point: Sea water

RESULTS

Parameters	Analytical Results SMB3A	Units	Analytical Method	Analyzed By
Lab No.	**948/889**			
Turbidity	**3.3**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.008**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**0**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.05**	mg/L	SMWW 4110B	C. Samuels
BOD	**1.92**	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden	**Name of Customer:** TEM Network
Date Collected: 10 October, 2022	**Place:** Sandals, Montego Bay
Date Received in Laboratory: 10 October, 2022	**Parish:** St. James
Date Examined: 10 October, 2022	**Sampling Point:** Sea water

RESULTS

Parameters	Analytical Results SMB3	Units	Analytical Method	Analyzed By
Lab No.	**947/888**			
Turbidity	**9.9**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.105**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**3**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.05**	mg/L	SMWW 4110B	C. Samuels
BOD	**0.72**	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

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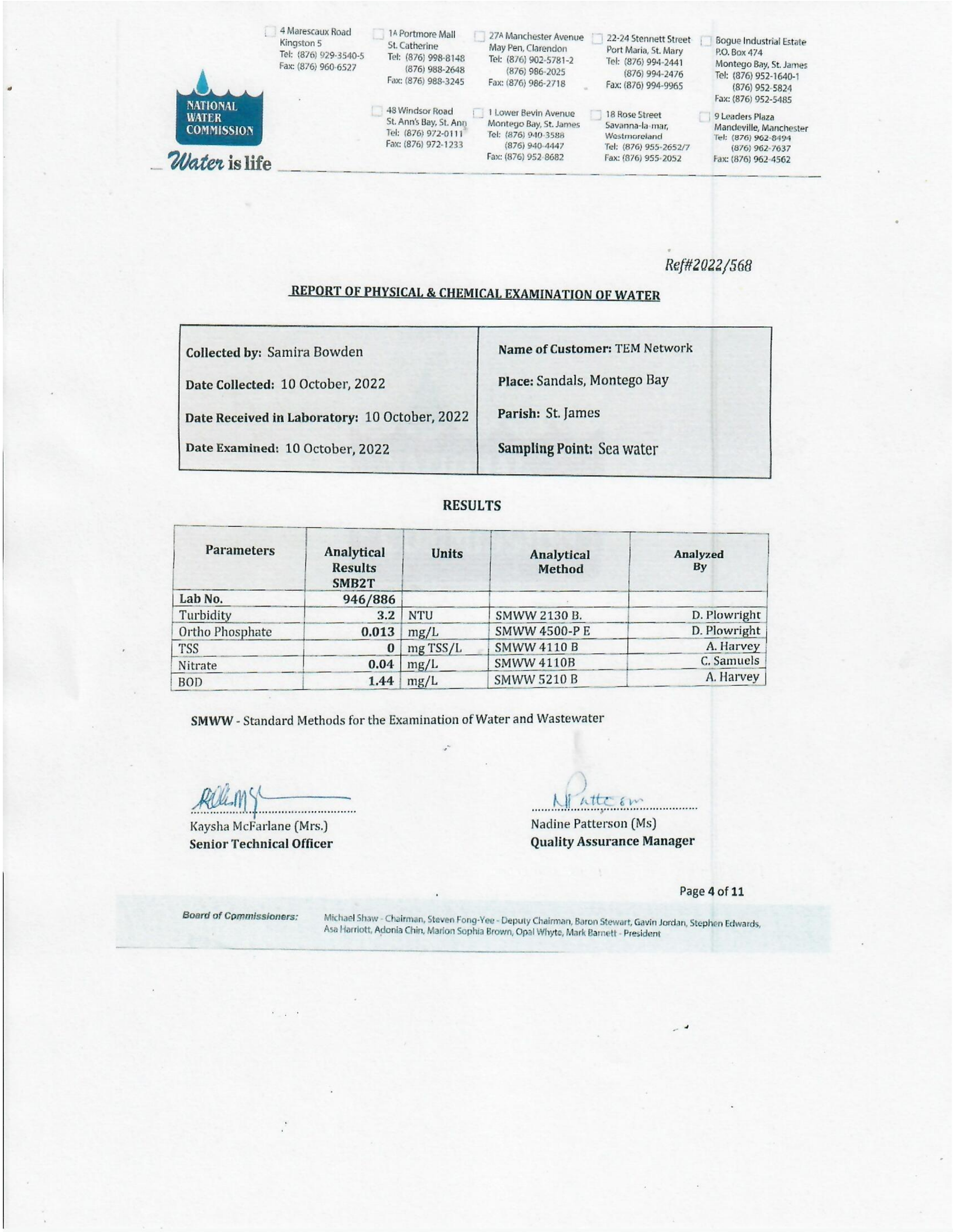

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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden	**Name of Customer:** TEM Network
Date Collected: 10 October, 2022	**Place:** Sandals, Montego Bay
Date Received in Laboratory: 10 October, 2022	**Parish:** St. James
Date Examined: 10 October, 2022	**Sampling Point:** Sea water

RESULTS

Parameters	Analytical Results SMB2T	Units	Analytical Method	Analyzed By
Lab No.	**946/886**			
Turbidity	**3.2**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.013**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**0**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.04**	mg/L	SMWW 4110B	C. Samuels
BOD	**1.44**	mg/L	SMWW 5210 B	A. Harvey

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
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Ref#2022/568

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Collected by: Samira Bowden

Date Collected: 10 October, 2022

Date Received in Laboratory: 10 October, 2022

Date Examined: 10 October, 2022

Name of Customer: TEM Network

Place: Sandals, Montego Bay

Parish: St. James

Sampling Point: Sea water

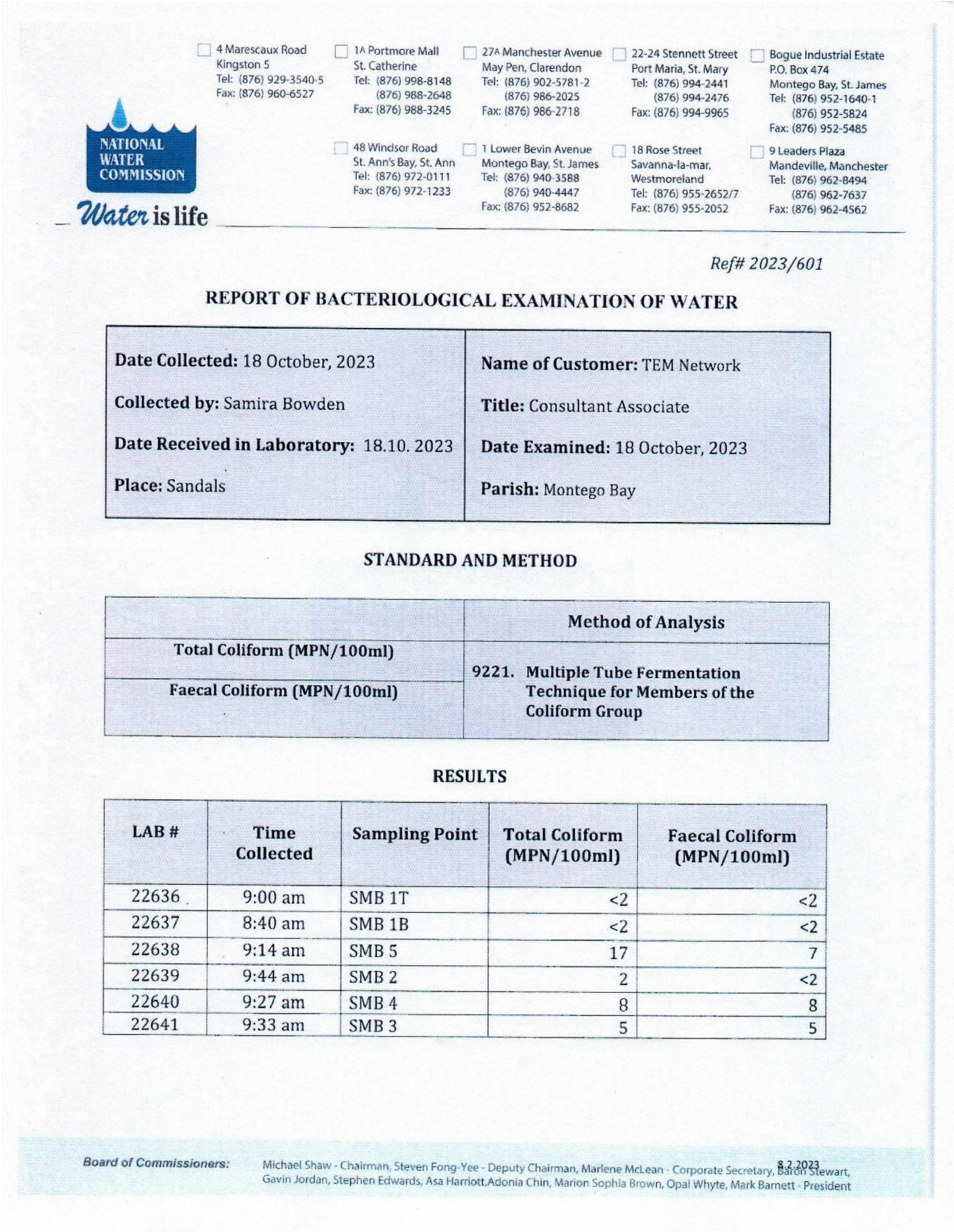
RESULTS

Parameters	Analytical Results SMB1T	Units	Analytical Method	Analyzed By
Lab No.	**945/884**			
Turbidity	**11.9**	NTU	SMWW 2130 B.	D. Plowright
Ortho Phosphate	**0.017**	mg/L	SMWW 4500-P E	D. Plowright
TSS	**0**	mg TSS/L	SMWW 4110 B	A. Harvey
Nitrate	**0.14**	mg/L	SMWW 4110B	C. Samuels
BOD	**0.96**	mg/L	SMWW 5210 B	A. Harvey

NB*
1. **SMWW** - Standard Methods for the Examination of Water and Wastewater
2. Total Suspended Solids result is underestimated, however, no sample was available for repeat analysis.

Kaysha McFarlane (Mrs.)
Senior Technical Officer

Nadine Patterson (Ms)
Quality Assurance Manager



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Ref# 2023/601

REPORT OF BACTERIOLOGICAL EXAMINATION OF WATER

Date Collected: 18 October, 2023	**Name of Customer:** TEM Network
Collected by: Samira Bowden	**Title:** Consultant Associate
Date Received in Laboratory: 18.10. 2023	**Date Examined:** 18 October, 2023
Place: Sandals	**Parish:** Montego Bay

STANDARD AND METHOD

	Method of Analysis
Total Coliform (MPN/100ml)	**9221. Multiple Tube Fermentation Technique for Members of the Coliform Group**
Faecal Coliform (MPN/100ml)	

RESULTS

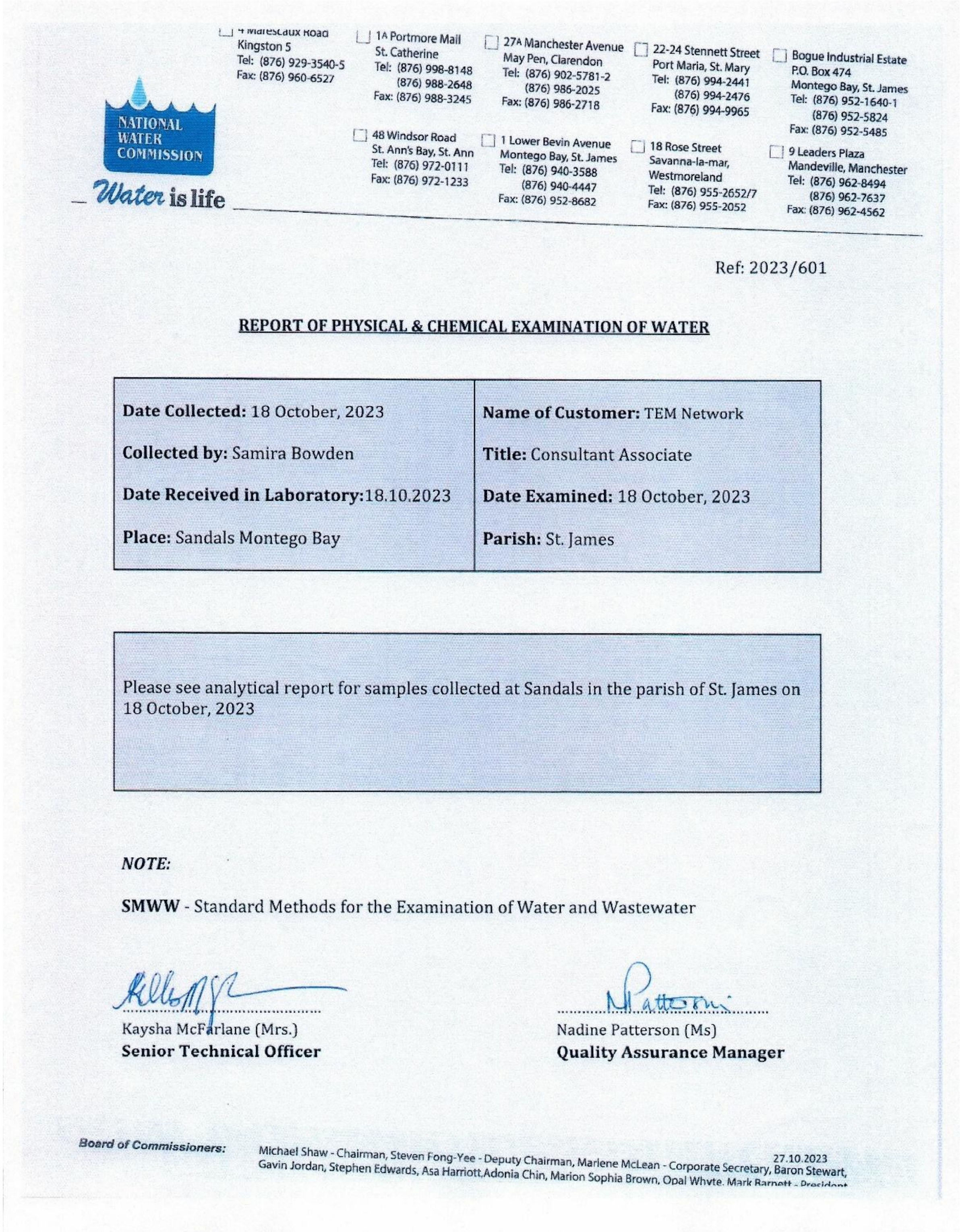
LAB #	Time Collected	Sampling Point	Total Coliform (MPN/100ml)	Faecal Coliform (MPN/100ml)
22636	9:00 am	SMB 1T	<2	<2
22637	8:40 am	SMB 1B	<2	<2
22638	9:14 am	SMB 5	17	7
22639	9:44 am	SMB 2	2	<2
22640	9:27 am	SMB 4	8	8
22641	9:33 am	SMB 3	5	5

SSavariau

Stephanie Savariau (Mrs.)
Senior Technical Officer

NPatterson

Nadine Patterson (Ms)
Quality Assurance Manager



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Ref: 2023/601

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Date Collected: 18 October, 2023	**Name of Customer:** TEM Network
Collected by: Samira Bowden	**Title:** Consultant Associate
Date Received in Laboratory:18.10.2023	**Date Examined:** 18 October, 2023
Place: Sandals Montego Bay	**Parish:** St. James

Please see analytical report for samples collected at Sandals in the parish of St. James on 18 October, 2023

NOTE:

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
Senior Technical Officer

N Patterson
Nadine Patterson (Ms)
Quality Assurance Manager

27.10.2023

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Parameters	SMB 1B	SMB 1T	SMB 2	SMB 3	SMB 4	SMB 5	Units	Analytical Method	Analyzed By
Lab No.	**1060/849**	**1061/848**	**1062/850**	**1063/851**	**1064/852**	**1065/853**			
Orthophosphate as P	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	mg /L	SMWW 4500-P.E.	M. Gordon
Total Dissolved Solids	**42,035**	**40,900**	**43,155**	**43,330**	**41,850**	**42,350**	mg TDS/L	SMWW 2540 C	C. Samuels
Total Suspended Solids	**3**	**1**	**2**	**19**	**28**	**6**	mg TSS/L	SMWW 2540 B	D. Christie
Nitrate as N	**0.01**	**0.04**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	mg /L	SMWW 4500-NO_3-E	C. Samuels
BOD as O_2	**1.7**	**0.72**	**1.1**	**2.0**	**2.5**	**0.96**	mg/L	SMWW 4500-O C	D. Christie
Total Coliform	<2	<2	2	5	8	17			
Faecal Coliform	<2	<2	<2	5	8	7			

27.10.2023

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Ref# 2023/617

REPORT OF BACTERIOLOGICAL EXAMINATION OF WATER

Date Collected: 25 October, 2023	**Name of Customer:** TEM Network
Collected by: Samira Bowden	**Title:** Consultant Associate
Date Received in Laboratory: 25.10. 2023	**Date Examined:** 25 October, 2023
Place: Sandals	**Parish:** Montego Bay

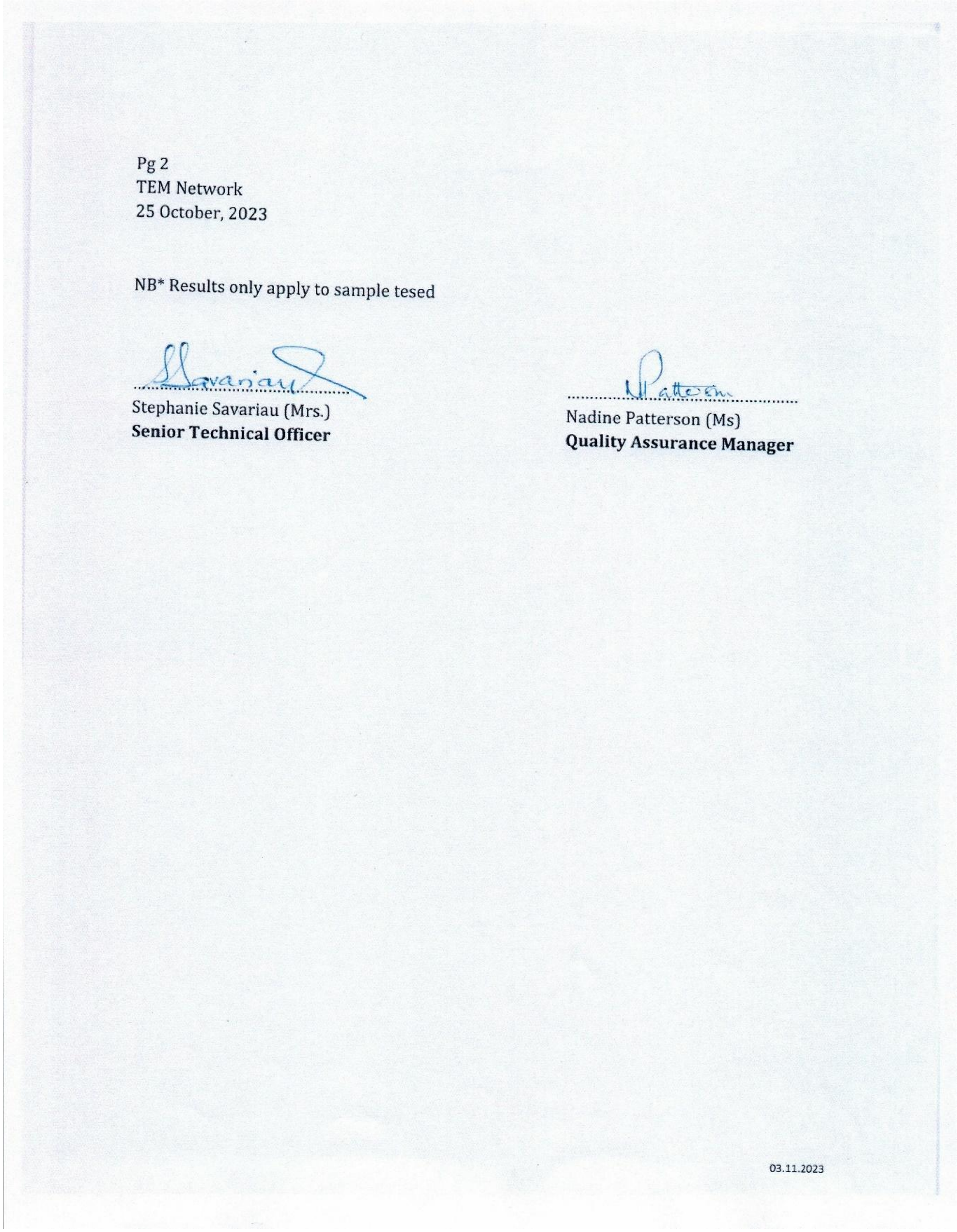
STANDARD AND METHOD

	Method of Analysis
Total Coliform (MPN/100ml)	**9221. Multiple Tube Fermentation Technique for Members of the Coliform Group**
Faecal Coliform (MPN/100ml)	

RESULTS

LAB #	Time Collected	Sampling Point	Total Coliform (MPN/100ml)	Faecal Coliform (MPN/100ml)
23241	8:37 am	SMB 1T	13	13
23242	8:26 am	SMB 1B	8	8
23243	9:30 am	SMB 2	<2	<2
23244	9:22 am	SMB 3	<2	<2
23245	9:13 am	SMB 4	<2	<2
23246	8:56 am	SMB 5	2	2

03.11.2023



Pg 2
TEM Network
25 October, 2023

NB* Results only apply to sample tesed

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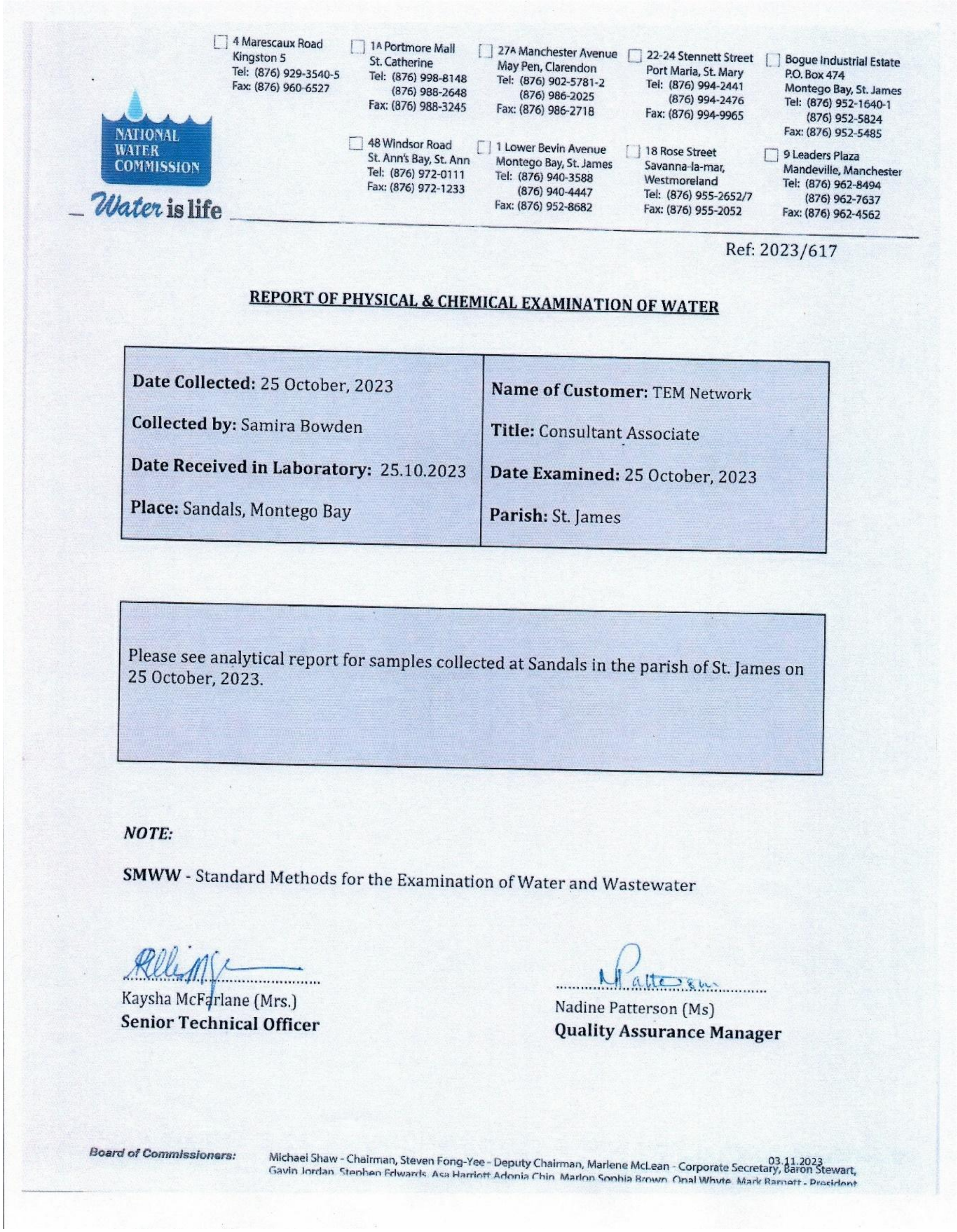
Stephanie Savariau (Mrs.)
Senior Technical Officer

N Patterson
Nadine Patterson (Ms)
Quality Assurance Manager

03.11.2023



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Ref: 2023/617

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Date Collected: 25 October, 2023	**Name of Customer:** TEM Network
Collected by: Samira Bowden	**Title:** Consultant Associate
Date Received in Laboratory: 25.10.2023	**Date Examined:** 25 October, 2023
Place: Sandals, Montego Bay	**Parish:** St. James

Please see analytical report for samples collected at Sandals in the parish of St. James on 25 October, 2023.

NOTE:

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
Senior Technical Officer

Nadine Patterson (Ms)
Quality Assurance Manager

03.11.2023

Pg 2
TEM Network
25 October, 2023

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Parameters	SMB 1T	SMB 1B	SMB 2	SMB 3	SMB 4	SMB 5	Units	Analytical Method	Analyzed By
Lab No.	**1091/866**	**1092/867**	**1093/868**	**1094/869**	**1095/870**	**1096/871**			
Orthophosphate as P	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	mg /L	SMWW 4500-P.E.	M. Gordon
Total Dissolved Solids	**43,870**	**44,830**	**43,845**	**44,495**	**45,470**	**44,820**	mg TDS/L	SMWW 2540 C	C. Samuels
Total Suspended Solids	**0**	**1**	**8**	**7**	**7**	**4**	mg TSS/L	SMWW 2540 B	D. Christie
Nitrate as N	**0.02**	**0.01**	**<0.01**	**0.01**	**<0.01**	**0.01**	mg /L	SMWW 4500-NO_3-E	C. Samuels
BOD as O_2	**3.7**	**<0.12**	**0.12**	**2.2**	**<0.12**	**<0.12**	mg/L	SMWW 4500-O C	D. Christie
Total Coliform	**13**	**8**	**<2**	**<2**	**<2**	**2**			
Faecal Coliform	**13**	**8**	**<2**	**<2**	**<2**	**2**			

03.11.2023

13.2 Appendix 2 – Water Quality Dry Season Data

SMB 1:	**LAT**	18.474621
	LONG	-77.903406

Description

Reef - Background (400M From Shore)

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO (mg/l)		FC (MPN/100ml)		pH	
	T	B	T	B	T	B	T	B	T	B	T	B
31-Jan-23	0.001	0.004	0.007	0.011	1.20		5.9	5.8	<2		8.1	8.1
12-Feb-24	0.002	0.001	0.002	0.003	1.80	2.1	6.8	6.8	<2	<2	8.1	8.1
11-Mar-24	0.002	0.002	0.006	0.01	1.50	0.27	6.62	6.75	<2	<2	8.1	8.1
STD	0.003(4)		0.014(4)		1.16(4)		4.8(4)		<2-13 (4)		8.1(3)	
AVERAGE	0.0018	0.002196	0.005	0.007	1.5	1.185	6.43	6.45	<2		8.1	8.1
STD DEV	0.000	0.001	0.003	0.004	0.300	1.294	0.465	0.525	<2		0.0	0.0
MAX	0.002	0.003587	0.007	0.011	1.8	2.1	6.77	6.75	<2		8.1	8.1
MIN	0.0013	0.001	0.002	0.003	1.2	0.27	5.90	5.84	<2		8.1	8.1

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)		T °C	
	T	B	T	B	T	B	T	B	T	B	T	B
31-Jan-23	9	3	8	8	36.50	34.90	56400	57500	31020	31625	28.0	29.2
12-Feb-24	1	1	0	0	36.08	36.08	56702	56701	35480	35485	27.0	27.0
11-Mar-24	0	1	0	0	36.54	36.55	55240.3	58239.8	35906	35912	27.9	27.8
STD					35.6 (1)						29.6(2)	
AVERAGE	3	2	3	3	36.37	35.84	56114	57480	34135	34341	27.6	28.0
STD DEV	5	1	5	5	0.25	0.85	772	770	2706	2362	0.5	1.1
MAX	9	3	8	8	36.54	36.55	56702	58240	35906	35912	28.0	29.2
MIN	0	1	0	0	36.08	34.90	55240	56701	31020	31625	27.0	27.0

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022
(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April
(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020
(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 2:	**LAT**	18.511117
	LONG	-77.904262
Description		
Westernmost Site		

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO (mg/l)		FC (MPN/100ml)	pH	
	T	B	T	B	T	B	T	B	T	T	B
31-Jan-23	0.001304		0.007		0.30		6.6	6.7	<2	8.2	8.2
12-Feb-24	0.001		0.005		0.60		6.7	7.0	<2	8.1	8.2
11-Mar-24	0.004		0.004		0.21		6.76	7.11	<2	8.11	8.13
STD	0.003(4)		0.014(4)		1.16(4)		4.8(4)		<2-13 (4)	8.1(3)	
AVERAGE	0.002		0.005		0.4		6.67	6.96	<2	8.2	8.2
STD DEV	0.002		0.001		0.2		0.09	0.19	<2	0.05	0.04
MAX	0.004		0.007		0.6		6.76	7.11	<2	8.20	8.2
MIN	0.001		0.004		0.2		6.58	6.74	<2	8.11	8.1

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)		T °C	
	T	B	T	B	T	B	T	B	T	B	T	B
31-Jan-23	8		18	18	35.2	35.1	57000	57500	31350.0	31295.0	28.5	28.5
12-Feb-24	4		0	0	36.1	36.1	56322	56299	35477.0	35471.0	26.7	26.7
11-Mar-24	0		0	0	36.5	36.5	58684.2	58711	35879	35881	28.3	28.3
STD					35.6 (1)						29.6(2)	
AVERAGE	4		6	6	35.93	35.89	57335	57503	34235.3	34215.7	27.83	27.82
STD DEV	4.000		10	10	0.66	0.72	1216	1206	2506.8	2537.7	1.00	1.01
MAX	8		18	18	36.50	36.50	58684	58711	35879.0	35881.0	28.50	28.50
MIN	0		0	0	35.20	35.10	56322	56299	31350.0	31295.0	26.67	26.66

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022

(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April

(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020

(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 3:	**LAT**	18.511784
	LONG	-77.903295

Description
Just east of the westernmost site

DATE	**PO4-P (mg/l)**		**NO3-N (mg/l)**		**BOD (mg/l)**		**DO (mg/l)**		**FC (MPN/100ml)**	**pH**	
	T	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**T**	**B**
31-Jan-23	0.003		0.007		1.40		6.9	6.9	<2	8.2	8.2
12-Feb-24	0.001		0.006		2.10		6.7	6.7	<2	8.1	8.2
11-Mar-24	0.003		0.00		0.42		6.6	6.8	2	8.1	8.1
STD	0.003(4)		0.014(4)		1.16(4)		4.8(4)		<2-13 (4)	8.1(3)	
AVERAGE	0.0022		0.006		1.3		6.8	6.8	1	8.2	8.2
STD DEV	0.001		0.001		0.8		0.2	0.1	1	0.0	0.0
MAX	0.003		0.007		2.1		6.9	6.9	2	8.2	8.2
MIN	0.001		0.004		0.4		6.6	6.7	<2	8.1	8.1

DATE	**TSS (mg/l)**		**TURB (NTU/FNU)**		**SAL (psu/ppt)**		**COND (µS/cm)**		**TDS (mg/l)**		**T °C**	
	T	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**B**
31-Jan-23	18		28	18	35.20	35.20	56600	56600	31130	31130	28.1	28.1
12-Feb-24	1		0	0	36.10	36.07	56417	55986	35489	35456	26.7	26.4
11-Mar-24	1		0	0	36.50	36.50	58644	58567	35884	35883	28.3	28.2
STD					35.6 (1)						29.6(2)	
AVERAGE	7		9	6	35.93	35.92	57220	57051	34168	34156	27.70	27.56
STD DEV	10		16	10	0.67	0.66	1236	1349	2638	2630	0.83	1.02
MAX	18		28	18	36.50	36.50	58644	58567	35884	35883	28.26	28.19
MIN	1		0	0	35.20	35.20	56417	55986	31130	31130	26.74	26.38

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022
(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April
(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020
(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 4:	**LAT**	18.512457
	LONG	-77.902264
Description		
120m west of easternmost site		

DATE	PO4-P (mg/l)		NO3-N (mg/l)		BOD (mg/l)		DO (mg/l)		FC (MPN/100ml)	pH	
	T	B	T	B	T	B	T	B	T	T	B
31-Jan-23	0.003		0.005		0.9		6.77	6.98	<2	8.20	8.2
12-Feb-24	0.005		0.005		0.6		6.44	6.79	<2	8.12	8.1
11-Mar-24	0.004		0.003		0.21		6.47	6.64	<2	8.10	8.11
STD	0.003(4)		0.014(4)		1.16(4)		4.8(4)		<2-13 (4)	8.1(3)	
AVERAGE	0.004		0.004		0.6		6.56	6.80		8.14	8.1
STD DEV	0.001		0.001		0.3		0.18	0.17		0.05	0.1
MAX	0.005		0.005		0.9		6.77	6.98		8.20	8.2
MIN	0.003		0.003		0.2		6.44	6.64		8.10	8.1

DATE	TSS (mg/l)		TURB (NTU/FNU)		SAL (psu/ppt)		COND (µS/cm)		TDS (mg/l)		T °C	
	T	B	T	B	T	B	T	B	T	B	T	B
31-Jan-23	3		8	8	35.20	35.20	56600	56500	35492	31075	28.1	28.0
12-Feb-24	11		0	0	36.10	36.10	56350	56426	35492	35485	26.8	26.7
11-Mar-24	1		0	1	36.44	36.50	58462	58467	35825	35880	28.1	28.1
STD					35.6 (1)						29.6(2)	
AVERAGE	5		3	3	35.91	35.93	57137	57131	35603	34147	27.7	27.6
STD DEV	5.292		5	4	0.64	0.67	1154	1157	192	2667	0.8	0.8
MAX	11		8	8	36.44	36.50	58462	58467	35825	35880	28.1	28.1
MIN	1		0	0	35.20	35.20	56350	56426	35492	31075	26.8	26.7

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022

(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April

(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020

(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

SMB 5:	**LAT**	18.512715
	LONG	-77.900687
Description		
Easternmost site		

DATE	**PO4-P (mg/l)**		**NO3-N (mg/l)**		**BOD (mg/l)**		**DO mg/L**		**FC (MPN/100ml)**	**pH**	
	T	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**T**	**B**
31-Jan-23	0.001		0.013		1.10		6.5	6.2	<2	8.1	8.1
12-Feb-24	0.008		0.005		2.10		6.2	6.2	<2	8.1	
11-Mar-24	0.002		0.003		1.60		5.5	6.6	<2	8.0	8.1
STD	0.003(4)		0.014(4)		1.16(4)		4.8(4)		<2-13 (4)	8.1(3)	
AVERAGE	0.004		0.0070		1.6		6.0	6.3		8.1	8.1
STD DEV	0.004		0.0053		0.5		0.5	0.3		0.0	0.0
MAX	0.008		0.0130		2.1		6.5	6.6		8.1	8.1
MIN	0.001		0.0030		1.1		5.5	6.2		8.0	8.1

DATE	**TSS (mg/l)**		**TURB (NTU/FNU)**		**SAL (psu/ppt)**		**COND (µS/cm)**		**TDS (mg/l)**		**T °C**	
	T	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**B**	**T**	**B**
31-Jan-23	6		18	8	35.1	35.2	57100	57000	31405		28.7	28.0
12-Feb-24	7	1	0		36.1		56140		35483		26.5	
11-Mar-24	1		0	1	36.4	36.5	58462.3	58510	35825	35873	28.2	28.2
STD					35.6 (1)						29.6(2)	
AVERAGE	5		6	4	35.9	35.8	57234	57755	34238	35873	27.8	28.1
STD DEV	3		10	5	0.7	0.9	1167		2459		1.1	0.1
MAX	7		18	8	36.4	36.5	58462		35825	35873	28.7	28.2
MIN	1		0	1	35.1	35.2	56140		31405		26.5	28.0

(1) - NOAA Coast Watch Sea Surface Salinity - Near Real Time - SMAP 2022

(2) - University of the West Indies Mona, The Climate Studies Group, The State of the Caribbean Climate Report Prepared for Caribbean Development Bank April

(3) - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification. Last updated April 1, 2020

(4) - Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009

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Ref: 2023/073

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Date Collected: 31 January, 2023

Collected by:

Date Received in Laboratory: 31.01.2023

Date Collected: 31 January, 2023

Place: Sandals Montego Bay & Dunn's River

Name of Customer: TEM Network

Title:

Date Examined: 31 January, 2023

Parish: St. James & St. Ann

Please see analytical report for samples collected at Sandals in the parishes of St. Ann an St. James on January 31, 2023.

NOTE:

Standard and Method for Bacteriological Examination of Water
9221. Multiple Tube Fermentation Technique for Members of the Coliform Group

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
Senior Technical Officer

Nadine Patterson (Ms)
Quality Assurance Manager

8.2.2023

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/Pg 2
TEM Network Ltd (Sandals)
31 January, 2023

RESULTS

Parameters	SDR WQ 1T	SDR WQ 1B	SDR WQ 2T	SDR WQ 3	SDR WQ 4	SDR WQ 5	SDR WQ 6	Units	Analytical Method	Analyzed By
Lab No.	**079/104**	**080/105**	**081/106**	**082/107**	**083/108**	**084/109**	**085/110**			
Orthophosphate as PO_4	**0.004**	**0.008**	**0.004**	**0.004**	**0.004**	**0.004**	**0.004**	mg PO_4-PO_4/L	SMWW 4500-P.E.	D. Plowright
Total Suspended Solids	**3**	**5**	**1**	**8**	**6**	**11**	**9**	mg TSS/L	SMWW 2540 B	A. Harvey
Nitrate as NO_3	**0.19**	**0.12**	**0.10**	**0.12**	**0.12**	**0.13**	**0.13**	mg NO_3/L	SMWW 4500-NO_3-E	C. Samuels
BOD as O_2	**0.3**	--	**1.1**	**0.3**	**≤0.1**	**0.8**	**1.5**	mg/L	SMWW 4500-O C	A. Harvey
Total Coliform (MPN/100ml)	**4,900**		**790**	**24**	**79**	**17**	**79**			
Faecal Coliform (MPN/100ml)	**<2**		**<2**	**<2**	**<2**	**<2**	**<2**			

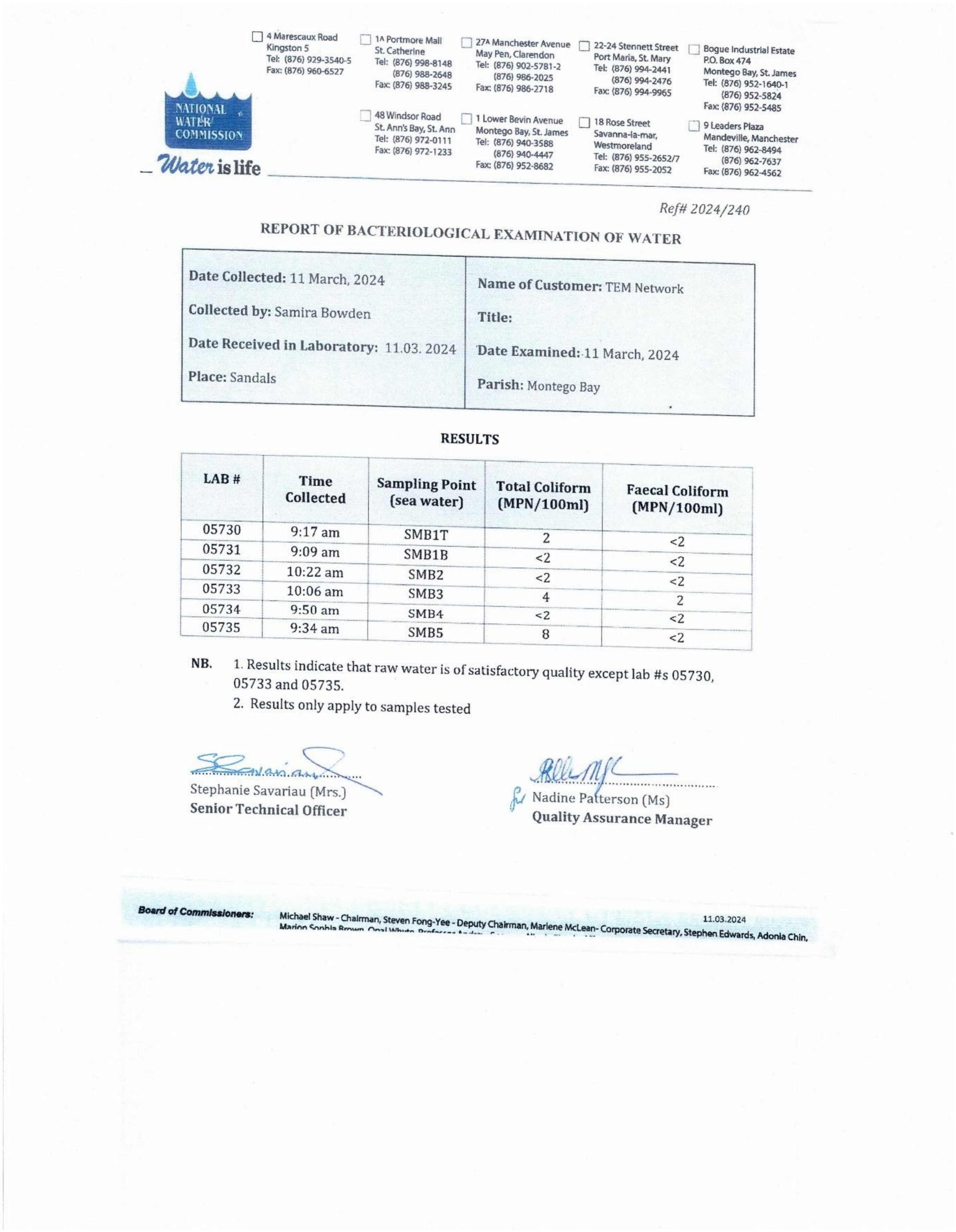
Parameters	SMB 1B	SMB 1T	SMB 2	SMB 3	SMB 4	SMB 5	Units	Analytical Method	Analyzed By
Lab No.	**086/111**	**087/112**	**088/113**	**089/114**	**090/115**	**091/116**			
Orthophosphate as PO_4	**0.011**	**0.004**	**0.004**	**0.008**	**0.008**	**0.004**	mg PO_4-PO_4/L	SMWW 4500-P.E.	D. Plowright
Total Suspended Solids	**3**	**9**	**8**	**18**	**3**	**6**	mg TSS/L	SMWW 2540 B	A. Harvey
Nitrate as NO_3	**0.05**	**0.03**	**0.03**	**0.03**	**0.02**	**0.04**	mg NO_3/L	SMWW 4500-NO_3-E	C. Samuels
BOD as O_2	--	**1.2**	**0.3**	**1.4**	**0.9**	**1.1**	mg/L	SMWW 4500-O C	A. Harvey
Total Coliform (MPN/100ml)		**130**	**31**	**<2**	**2**	**790**			
Faecal Coliform (MPN/100ml)		**<2**	**<2**	**<2**	**<2**	**<2**			

8.2.2023

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Parameters	SMB 1B	SMB 2T	SMB 3T	SMB 4T	SMB 5T	SMB 1T	Units	Analyt Meth
Lab No.	**169/166**	**170/167**	**171/168**	**172/169**	**173/170**	**168/171**		
Orthophosphate as P	**0.001**	**0.001**	**0.001**	**0.005**	**0.008**	**0.002**	mg /L	SMWW 450
Total Suspended Solids	**1**	**4**	**1**	**11**	**7**	**1**	mg TSS/L	SMWW 254
Nitrate as N	**0.003**	**0.005**	**0.006**	**0.005**	**0.005**	**0.002**	mg /L	SMWW 450
BOD as O_2	**2.1**	**0.6**	**2.1**	**0.6**	**2.1**	**1.8**	mg/L	SMWW 450
Total Coliform	<2	2	<2	<2	<2	<2	MPN/100ml	SMWW9221
Faecal Coliform	<2	<2	<2	<2	<2	<2	MPN/100ml	SMWW9221

NB* Please note that the SMWW indicates that the minimum detectable concentration for Method 4500-P E. is 0.010 mg^p/L and the applicab
Method 4500-NO_3^-E is 0.05-1.0 mg NO_3^--N/L.



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Ref# 2024/240

REPORT OF BACTERIOLOGICAL EXAMINATION OF WATER

Date Collected: 11 March, 2024	**Name of Customer:** TEM Network
Collected by: Samira Bowden	**Title:**
Date Received in Laboratory: 11.03. 2024	**Date Examined:** 11 March, 2024
Place: Sandals	**Parish:** Montego Bay

RESULTS

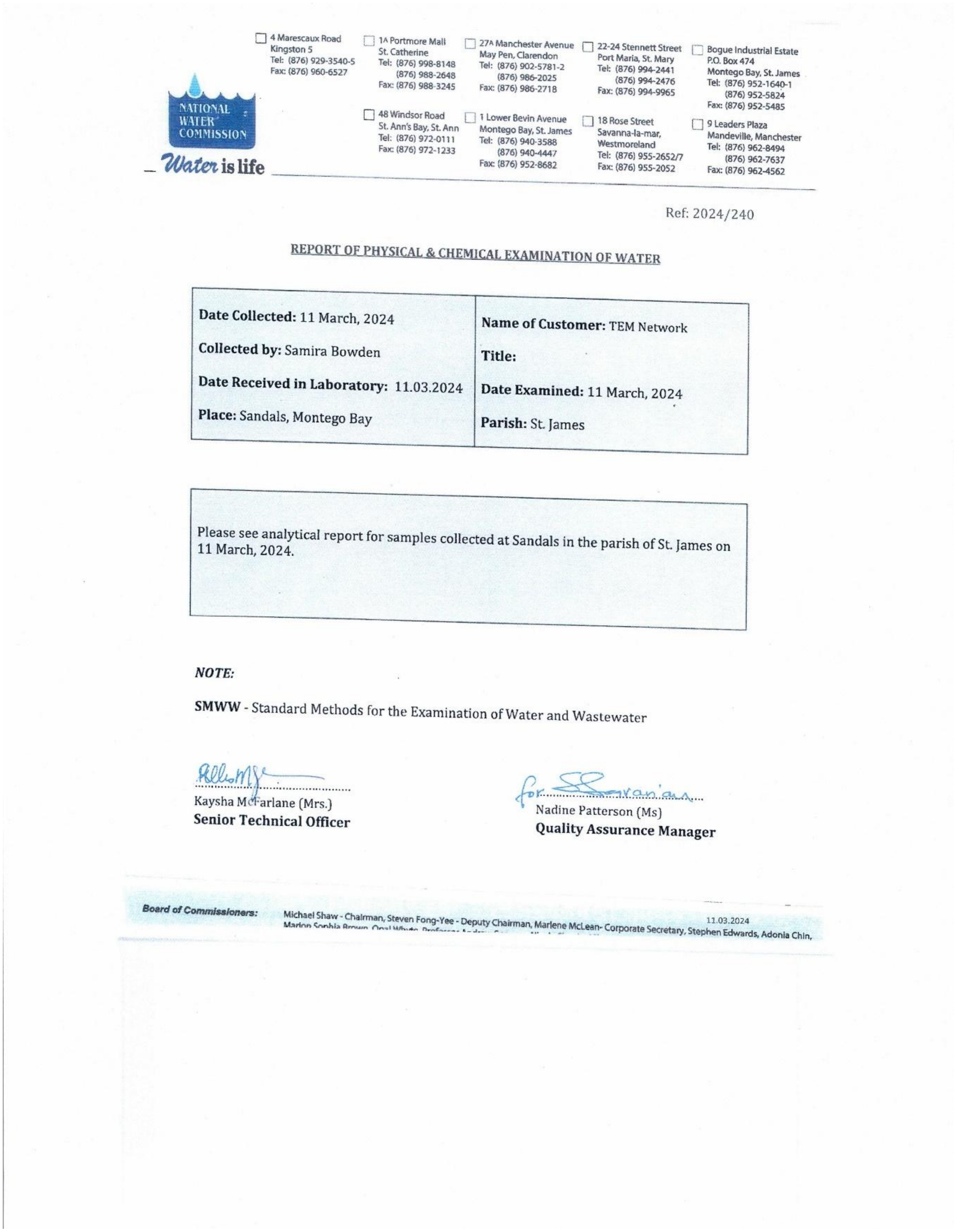
LAB #	Time Collected	Sampling Point (sea water)	Total Coliform (MPN/100ml)	Faecal Coliform (MPN/100ml)
05730	9:17 am	SMB1T	2	<2
05731	9:09 am	SMB1B	<2	<2
05732	10:22 am	SMB2	<2	<2
05733	10:06 am	SMB3	4	2
05734	9:50 am	SMB4	<2	<2
05735	9:34 am	SMB5	8	<2

NB.
1. Results indicate that raw water is of satisfactory quality except lab #s 05730, 05733 and 05735.
2. Results only apply to samples tested

Stephanie Savariau (Mrs.)
Senior Technical Officer

Nadine Patterson (Ms)
Quality Assurance Manager

11.03.2024



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Ref: 2024/240

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Date Collected: 11 March, 2024

Collected by: Samira Bowden

Date Received in Laboratory: 11.03.2024

Place: Sandals, Montego Bay

Name of Customer: TEM Network

Title:

Date Examined: 11 March, 2024

Parish: St. James

Please see analytical report for samples collected at Sandals in the parish of St. James on 11 March, 2024.

NOTE:

SMWW - Standard Methods for the Examination of Water and Wastewater

Kaysha McFarlane (Mrs.)
Senior Technical Officer

for
Nadine Patterson (Ms)
Quality Assurance Manager

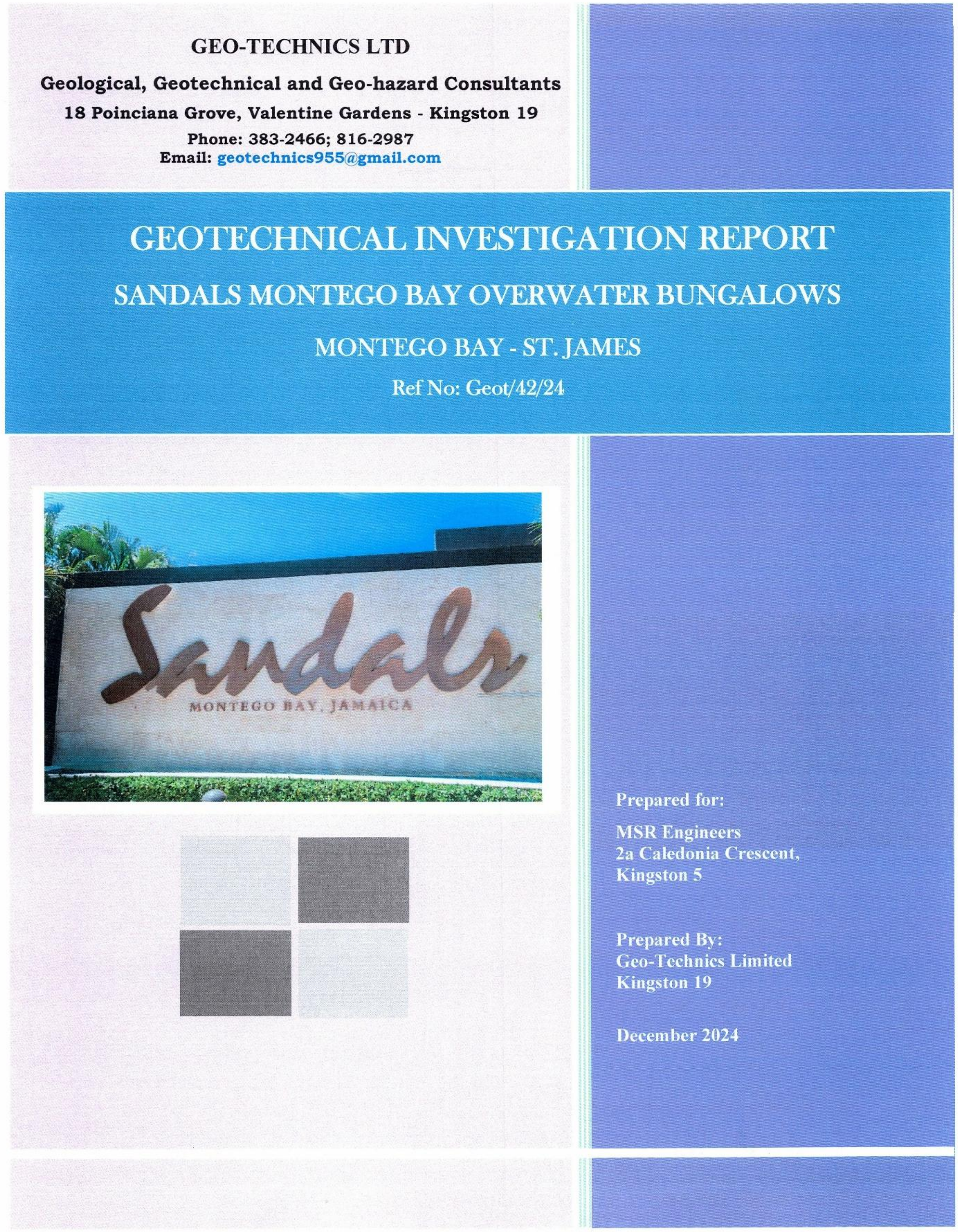
11.03.2024

REPORT OF PHYSICAL & CHEMICAL EXAMINATION OF WATER

Parameters	SMB 1B	SMB 1T	SMB 2	SMB 3	SMB 4	SMB 5T	Units	Analytical Method	Analyzed By
Lab No.	271/266	272/267	273/268	274/269	275/270	276/271			
Orthophosphate as P	0.002	0.002	0.004	0.003	0.004	0.002	mg /L	SMWW 4500-P.E.	C. Samuels
Total Suspended Solids	1	0	0	1	1	1	mg TSS/L	SMWW 2540 B	A. Harvey
Nitrate as N	0.007	0.006	0.004	0.004	0.003	0.003	mg /L	SMWW 4500-NO_3^-E	A. Lattibeaudiere
BOD as O_2	0.27	1.5	0.21	0.42	0.21	1.6	mg/L	SMWW 4500-O C	A. Harvey
Total Coliform	<2	2	<2	4	<2	8	MPN/100ml	SMWW9221	
Faecal Coliform	<2	<2	<2	2	<2	<2	MPN/100ml	SMWW9221	

NB* Please note that the SMWW indicates that the minimum detectable concentration for Method 4500-P E. is 0.010 mg^P/L and the applicable range for Method 4500-NO_3^-E is 0.05-1.0 mg NO_3^--N/L.

13.3 Appendix 3 – Geotechnical Survey



GEO-TECHNICS LTD

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GEOTECHNICAL INVESTIGATION REPORT

SANDALS MONTEGO BAY OVERWATER BUNGALOWS

MONTEGO BAY - ST. JAMES

Ref No: Geot/42/24

Prepared for:

MSR Engineers
2a Caledonia Crescent,
Kingston 5

Prepared By:
Geo-Technics Limited
Kingston 19

December 2024

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1 INTRODUCTION

1.1 Background/Project Description

Geo-Technics Limited has been given the contract to conduct geotechnical investigations for Sandals Overwater Bungalows at Sandals Resort, Montego Bay, St. James. The project involves the expansion of the resort, focusing on the addition of 18 overwater bungalows supported by piles, as well as a boardwalk that will carry utility pipes.

This document presents the **Draft Geotechnical Investigation Report for the Sandals, Montego Bay Overwater Bungalows in St. James.** It has been prepared at the request of MSR Engineers to conduct a geotechnical investigation for the project site.

The primary objective of this geotechnical study is to assess the engineering geology/ geotechnical characteristics of the subsurface rock/ soil at the project site. This investigation will explore the soil conditions to support the design of building foundations and associated infrastructure works for the development. The report will provide recommendations for foundation design, seismic design parameters, and other soil-related considerations, along with construction recommendations tailored to the site conditions.

The project objectives are as follows:

1. To provide a comprehensive geological assessment of the of the site including lithology, geology structures, rock mass quality variations etc.
2. To determine the geotechnical characteristics and engineering parameters of rock/soil on the site based on field investigation and laboratory analyses
3. To determine the bearing capacity of the rock/soil on the site
4. To estimate soil settlement characteristics of the soil for foundation purposes
5. To determine the depth of water above the seabed groundwater that would assist with the investigation for foundation design
6. To conduct seismic assessment and recommend seismic design parameters for design of structures
7. To prepare a geotechnical report that details the geological characteristics, rock mass quality, and engineering properties of soil and rock for foundation design and infrastructure development. The report will also provide recommendations on suitable foundation types for the proposed construction.

1.2 Authority and Access

Authority to proceed with the geotechnical investigation was received from Mr Stephen McMorris project manager of MSR Design Studio. Access to the site was gained from Kent Avenue in Montego Bay, St James.

1.3 Scope of Work

i. **Desk Study:** Review geology maps, remote sensing imagery, technical reports and plans/drawings for the site and surrounding areas. The purpose of the review is to provide background information on the site which would assist to guide the fieldwork and provide recommendations for the civil engineering works and construction.

ii. **Field Work:** Qualitative and quantitative information on the geological and geotechnical characteristics of the area will be collected and includes:

    - ***Subsurface Site Investigation***: Nine (9) boreholes will be drilled at the site to depths of 15.15m (50 ft) or to refusal. The borehole locations were previously determined by the Client. Standard Penetration Tests (SPT) will be performed in the boreholes using a drill rig mounted on a barge with split spoon sampler and auger stem attachment. Field data from SPT will be used to assist in determining bearing capacity of soil.

iii. **Laboratory Test:** Physical Test will be conducted on selected samples obtained and are described as follows:

    - ***The Grain Size Distribution Analysis***: an index test to classify coarse grain soils such as sand and gravel, which will be used to determine the type of soil grading for engineering purposes. The ASTM D422 test method will be used.
    - ***Atterberg Limits*** test: an index test used to classify the fine-grained soil to determine their plasticity and predict behaviour under loading conditions. The ASTM D4318 test method will be used.

iv. **Geotechnical Analysis:** Information from geological data, drilling exercise (including SPT test results) and laboratory tests will be analysed based on the impact of geological structures and surface features on the site and surrounding areas that could influence construction and infrastructure works. Where applicable, guidelines from the International Society for Rock Mechanics (ISRM) and British Standard BS 5930 (2015) will be applied, particularly in assessments within the limestone environment.

v. **Preparation of Geological and Geotechnical Report**: A geotechnical report will be prepared and shall include the following:

    - Geological and Geotechnical description of the site.
    - Bearing capacity of soils onsite for civil engineering purposes shall be indicated.

- Engineering parameters required for foundation design
- Construction difficulties arising from soil conditions onsite shall be assessed.
- Settlement characteristics shall be discussed
- Seismic potential of the site shall be assessed and seismic parameters for design purposes will be determined.
- Remedial measures to mitigate engineering challenges noted onsite will be documented.

1.4 Limitations and Liability

The conclusions and recommendations presented in this report are limited to those that can be made on the findings of the investigation. The conclusions and recommendations be viewed in the context of the range of data sources consulted and the number of locations where the investigation occurred. No liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made based on the information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by Geo-Technics Limited.

2 PROJECT SITE

2.1 Site Location and Description

Sandals, Montego Bay is located at Kent Ave, Montego Bay, St. James, Jamaica. The resort is situated on a relatively flat coastal property, encompassing an area of approximately 26 acres (10.52 ha) with an elevation close to sea level. It lies along the northern shoreline of Montego Bay, providing direct beach access and scenic ocean views (Figure 2.1). The resort is bordered by several other hospitality establishments including Snappaz Seafood Grill 0.6km to west and Tropical Bliss Beach 1.2km to the west. The property is located 1km northwest of the Sangster International Airport, and approximately 1km north of neighbouring communities such as Flankers and Providence Heights.

The proposed development site is comprised of 18 overwater bungalows which is located approximately 0.5 kilometres (500 metres) from the resort's shoreline, extending into the shallow waters of Montego Bay. The water depth at the site ranges from 2.4 metres (8 ft) to 3.4 metres (11 ft). The site is accessible from the resort's beach, with potential access points for construction located near the pier area.

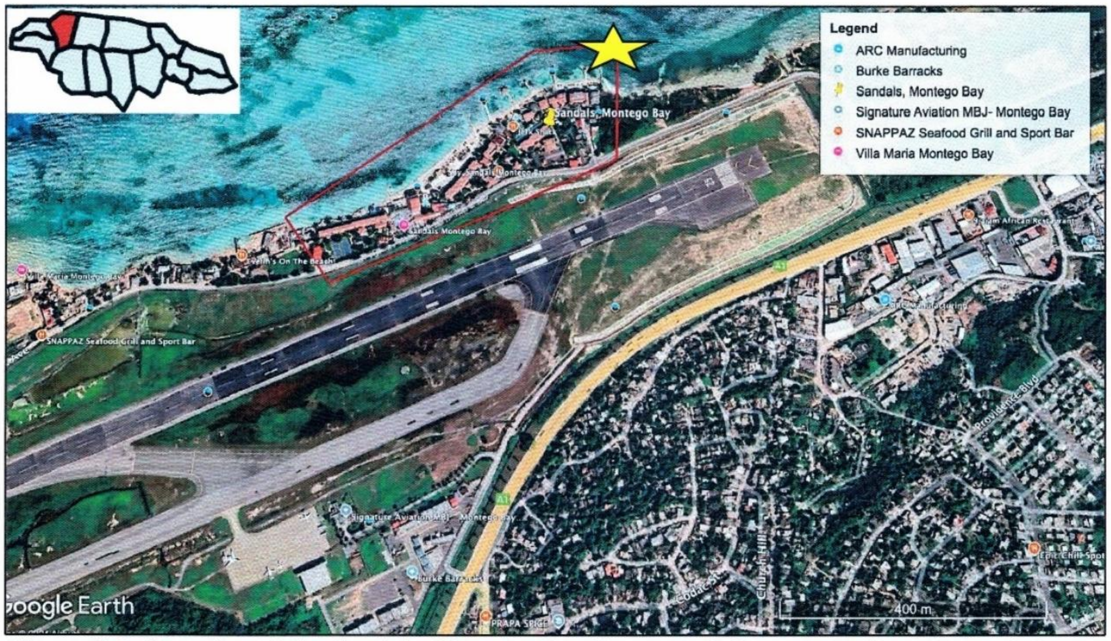


Figure 2-1: Location of the Sandals, Montego Bay Resort and the surrounding area and the area of investigation as indicated by the yellow star

2.2 Proposed Development of the Site

The site is designated for the construction of 18 overwater suites, each supported by piles driven into the seabed. These suites will be connected by a supporting boardwalk designed to carry utility pipes. While detailed specifications of the structures have not been provided, it is assumed that the suites will be of light construction material, suitable for overwater construction, with appropriate amenities and infrastructure to support the development.

2.3 Site Geology

2.3.1 Lithology and Soil

A review of the 1:50,000 Provisional Geology Map (Sheet 2 – Montego Bay) indicates that the Sandals, Montego Bay site is underlain by Raised Reefs (Ql). These occur along the coastline and are generally composed of poorly bedded to massive rubbly limestone, which is often vuggy and contains coral and mollusc debris as the primary constituents of the rock.

The limestone contains significant coral and mollusc debris, which serve as the primary constituents of the rock. The presence of coral fragments, mollusc shells and other marine organisms suggests that these raised reefs are primarily derived from a marine source. These develop as a result of marine processes, with wave action playing a significant role in dislodging and depositing reef material along the coastline.

2.3.2 Geological Structure

The geological structure surrounding Sandals, Montego Bay is characterized by a few fault systems, though no direct impact on the site has been identified. The closest faults to the site are a Northeast to Southwest (NE-SW) and North to South (N-S) trending faults approximately 1km to the south.

2.4 Seismic Risk

Historical information on earthquake indicate that earthquake epicentres have been recorded within a 7km radius of the project site. Historical seismic activity between 2010 and 2014 shows magnitudes ranging from 2.4 to 3.0. These are classified as low-magnitude earthquakes, typically associated with unfelt to light seismic events, posing minimal structural risk to buildings in the area.

Information obtained from the International Building Code (IBC) Peak Spectral Site Response maps for Jamaica is shown in **Figure 2-2.** The map indicates that the spectral acceleration for short and long periods (0.2 and 1 second) for the maximum considered earthquake with a 5% probability of exceedance in 50 years, is 0.50g and 0.20g respectively.

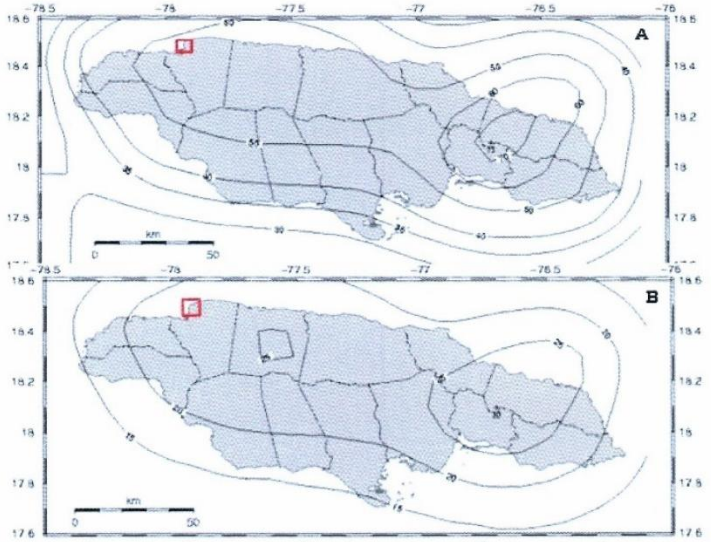


Figure 2-2: IBC based Site Spectral Response map for 0.2s short period (top) and 1.0s long period (bottom) waves at the site location, indicated by a red box, at the Sandals project site (Source: Earthquake Unit, UWI)

2.5 Other Geo-Hazard Risks

The desk review indicates that the Sandals, Montego Bay offshore construction site is vulnerable to coastal hazards, particularly storm surges and wave action. Historical records show that Montego Bay, located on Jamaica's north coast, is susceptible to these hazards during tropical storms and hurricanes. The site's proximity to the shoreline and the shallow seabed makes it exposed to storm surges, which can lead to inundation and potential structural damage. Reports from the National Hurricane Center (NHC) highlight past storm surges in Montego Bay, with significant wave heights impacting coastal infrastructure, especially during hurricanes.[i] This places the site at a medium risk of coastal flooding and erosion, particularly during extreme weather events.

3 FIELD INVESTIGATION

3.1 Borehole Location and Drilling Method

During the fieldwork phase of the investigation, nine boreholes (BH-1 to BH-9) were drilled on-site from September 19 to 27, 2024. The client provided the general location of the boreholes for the proposed buildings, and a corresponding map is included in **Appendix 1**. The borehole locations offshore were determined by a qualified land surveyor based on grid references provided by the client. All boreholes were drilled by a barge-mounted drill rig using the rotary drilling method, achieving refusal at varying depths due to the presence of limestone bedrock below the calcareous sediments. Borehole depths **Below Mean Sea Level (bmsl)** were as follows: BH-1 to 12.5m (41 ft), BH-2 to 12.3m (40.5 ft), BH-3 to BH-8 to 13.1m (43 ft), and BH-9 to 14m (46 ft).

The boreholes were advanced with a rotary drill, equipped with a split-spoon sampler and auger stem attachment **(Plate 3-1).** Disturbed samples were collected at varying intervals of 0.3m (1 ft), 0.5m (1.5 ft), 0.6m (2 ft), 0.8m (2.5) ft, or 0.9m (3 ft) up to a depth of 3m (10 ft). Beyond this depth, samples were taken at 1.5m (5 ft) intervals to the borehole's termination depth.

Detailed borehole logs are provided in **Appendix 2.**

---

[i] Taken from National Hurricane Centre Storm Surge Risk Maps

Plate 3-1: Offshore borehole drilling at Sandals, Montego Bay using a Barge mounted Drill Rig

3.2 Standard Penetration Test (SPT)

SPTs were performed in the borehole for collection of geotechnical data. The SPT is a field test conducted in the boreholes which gives an indication of the penetration resistance of the soil. The tests are generally more accurate in non-cohesive soils such as sand and gravel which are normally present under drained conditions, relative to cohesive soils (silt and clay) where the penetration resistance is recorded under undrained conditions. The SPT is done by driving a 5.1cm (2 inches) outer diameter split spoon sampler 30.5cm (12 inches) into the ground by means of a 64kg (140 lbs) hammer falling freely over a vertical distance of 76.2cm (30 inches). The procedure involves driving the sample tube 15.2 cm (6 inches) into the ground, then recording the number of blows required to advance the sample tube a further 30.5 cm (12 inches) into the soil. The number of blows recorded is referred to as N-value which is related to the relative density and angle of shear resistance for non-cohesive (coarse grain) soils. The samples were then collected, recorded and carefully placed into labelled plastic bags and taken to the soil's laboratory for testing.

4 RESULTS FROM FIELD INVESTIGATION

4.1 Summary of Soil Description

Drilling was conducted in the shallow waters, northwest of the Sandals, Montego Bay property. The subsurface geology varied across the nine boreholes, with differences observed in both depth and material composition. The boreholes predominantly contain coarse-grain soils, except for BH-4. The soil depths presented below is based on depth, bmsl. Detailed subsurface descriptions are provided in the borehole logs in **Appendix 2.** The soils encountered in the nine (9) boreholes are summarized as follows.

a) **Loose to medium dense cream calcareous SAND with traces of gravel:** In BH-3, this is found at 3.4m (11 ft), followed by silty SAND with some gravel at 4m (13 ft), then returning to calcareous SAND with traces of gravel from 4.7m (15.5 ft) to 10.1m (33 ft). Additionally, this is observed in BH-5 at 2.9m (9.5 ft), BH-8 at 8.5m (28 ft), and BH-9 at 3.8m (12.5 ft).

b) **Soft to very stiff cream calcareous sandy gravelly SILT:** This was observed in BH-4 from 3.4m (11 ft) to 7m (23 ft), followed by calcareous SAND with some silt at 8.5m(28 ft). It was also found in BH-6 at 2.9 metres (9.5 ft).

c) **Very loose to medium dense cream calcareous silty sandy GRAVEL:** This was observed in BH-6 from 3.8m (12.5 ft) to 10.1m (33 ft), followed by cream calcareous GRAVEL with some sand at 11.6m (38 ft). In BH-7 this type of soil was encountered between 4m (13 ft) and 8.5m (28 ft). A layer of calcareous GRAVEL with traces of sand was found above at 3.5m (11.5 ft). The soil layer was also present in BH-8 at 7m (23 ft).

d) **Loose to medium dense cream calcareous GRAVEL and SAND with some silt:** This is present in BH-8 at 4.7m (15.5 ft) and BH-9 between 9.4m (31 ft) and 12.5m (41 ft). This soil type is also seen in BH- 7 at 10.1m (33 ft) and continues to end of the borehole where moderately weak limestone is encountered.

4.2 Relative Density

The relative densities of the coarse grain soil taken from BH-1 to BH-9 vary from very loose to very dense.

4.3 Consistency

The consistency of the fine grain soil taken from BH-1 to BH-9 vary from very soft to very stiff.

4.4 Presumptive Profile

The presumptive profiles were prepared using information obtained from subsurface drilling, laboratory analyses and classification of soils. They provide a graphic representation of the subsurface soil on the site. The presumptive profiles are as follows:

- Presumptive profile taken from BH -2 to BH-5 (Western Section of project site, see **Figure 4.1**)
- Presumptive profile taken from BH-1 and BH 7 to BH-9 (Eastern Section of project site, see **Figure 4.2**
- Presumptive profile taken from BH-5 to BH-7 (Northern Section, see **Figure 4.3**).

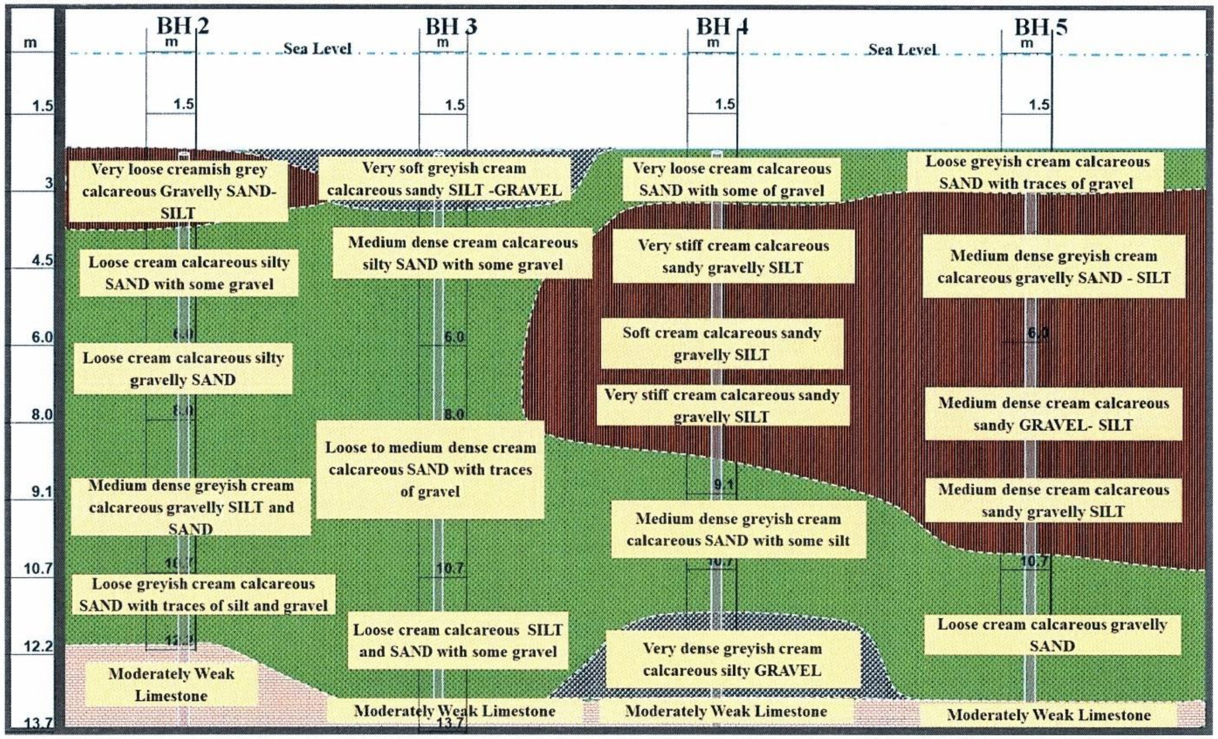


Figure 4-1: Presumptive profile of subsurface strata offshore (Western Section) at Sandals Montego Bay based on BH-2 to BH-5 (NB: Not drawn to Scale)

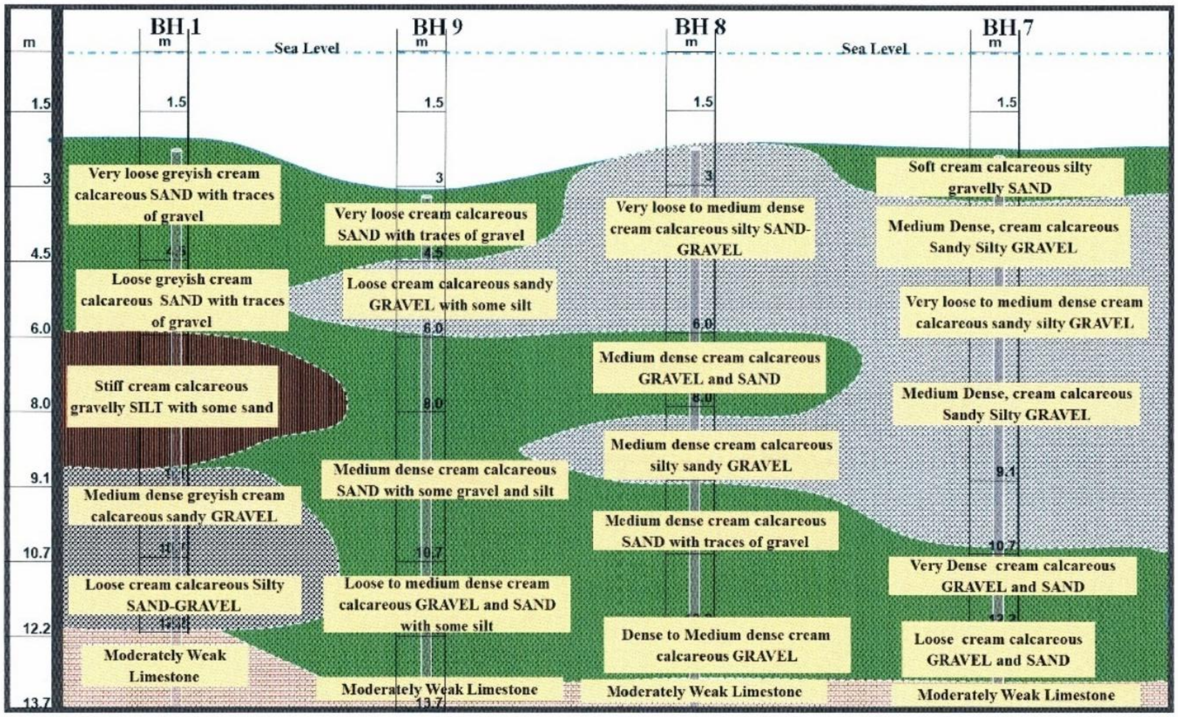


Figure 4-2: Presumptive profile of subsurface strata offshore (Eastern Section) at Sandals Montego Bay: BH-1 and B7 to BH-9 (NB: Not drawn to Scale)

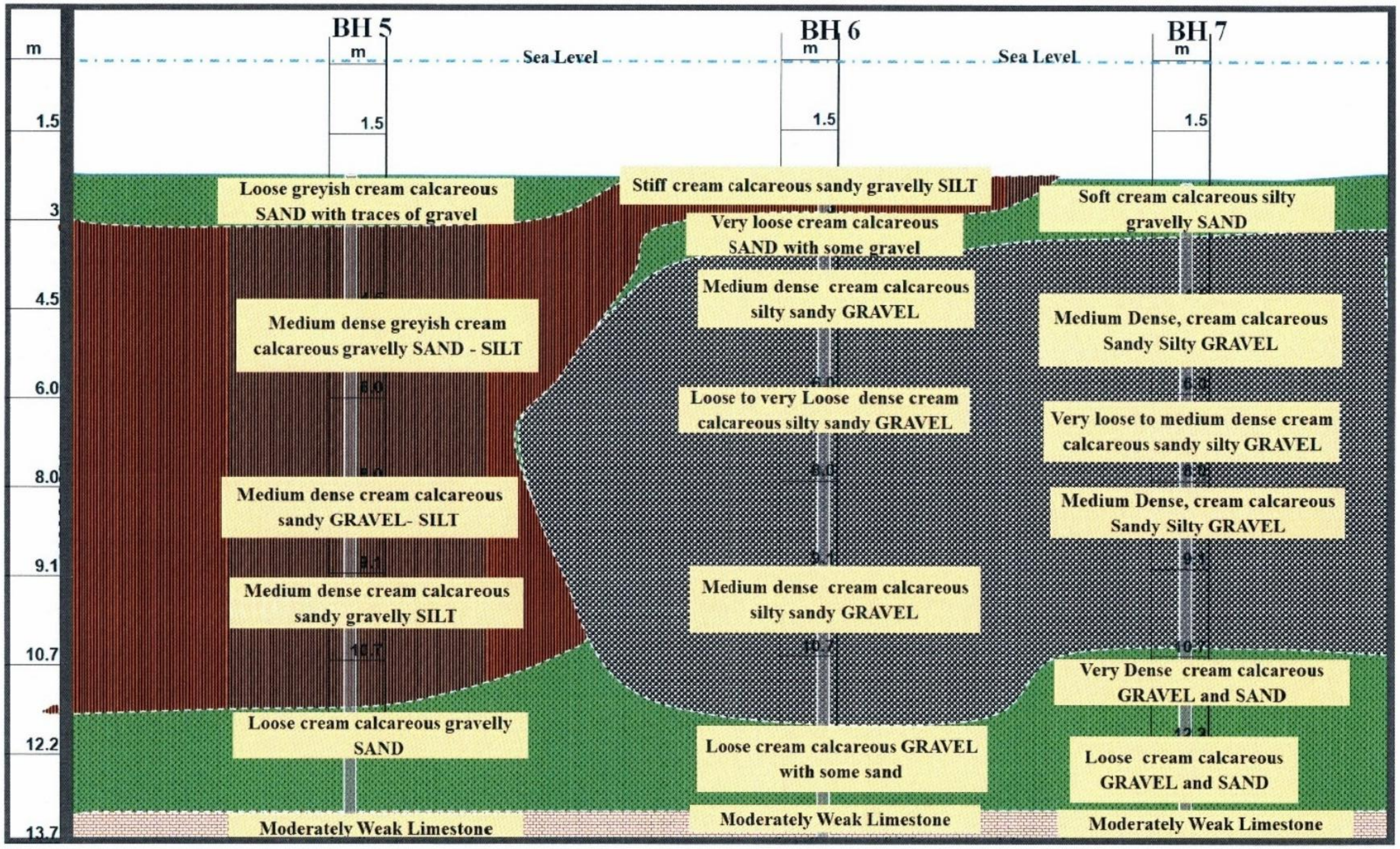


Figure 4-3: Presumptive profile of subsurface strata offshore (northern section) at Sandals Montego Bay based on BH-5 to BH-7 (NB: Not drawn to Scale)

5 LABORATORY ANALYSES

Only soil samples were recovered from the boreholes. Laboratory tests were conducted on select samples obtained from the boreholes via split spoon sampling and are presented below.

5.1 Classification of Coarse Grain Soil

Twenty-seven (27) soil samples were tested from the nine (9) boreholes drilled to determine the grain size distribution of the coarse grain soil based on their grading curve. The result of the analysis is tabulated in **Table 5-1** and detailed laboratory results are presented in **Appendix 3.**

Table 5-1: Classification of Coarse Grain Soils based on Grain Size Distribution Analysis (ASTM Soil Classification) taken from all boreholes on site. Soil depths are bmsl.

BOREHOLE #	DEPTH		SOIL CLASSIFICATION
	m	ft	
1	3	10	Cream calcareous gravelly SILT with some sand
1	9.1	30	Well graded calcareous Silty SAND and GRAVEL
2	0.5	1.5	Well graded cream calcareous Gravelly SAND and SILT
2	1.4	4.5	Well graded cream calcareous silty SAND with some gravel
2	3	10	Well graded calcareous silty Gravelly SAND
2	6.1	20	Well graded calcareous Gravelly SAND and SILT
3	0.5	1.5	Well graded calcareous sandy SILT and GRAVEL
3	1.5	5	Well graded calcareous silty SAND with some gravel
3	9.1	30	Well graded calcareous SILT and SAND with some gravel
4	1.4	4.5	Cream calcareous sandy gravelly SILT
4	9.1	30	Well graded calcareous silty GRAVEL with some sand
5	1.5	5	Well graded calcareous silty SAND with some gravel
5	3	10	Well graded calcareous Silty, SAND and GRAVEL
5	6.1	20	Well graded calcareous Sandy SILT and GRAVEL
6	0.5	1.5	Cream calcareous sandy gravelly SILT
6	1.5	5	Well graded calcareous silty Sandy GRAVEL
6	7.6	25	Well graded calcareous silty Sandy GRAVEL
7	0.5	1.5	Well graded calcareous silty gravelly SAND
7	1.5	5	Well graded calcareous Silty Sandy GRAVEL
7	4.6	15	Well graded calcareous Silty, sandy GRAVEL
7	9.1	30	Cream calcareous GRAVEL and SAND with some silt
8	0.5	1.5	Cream calcareous Silty gravelly SAND
8	2.3	7.5	Cream calcareous sandy GRAVEL with some Silt
8	4.6	15	Cream calcareous silty Sandy GRAVEL
9	1.5	5	Cream calcareous Silty sandy GRAVEL
9	3	10	Cream calcareous Gravelly SAND with some silt
9	9.1	30	Cream calcareous sandy GRAVEL with some silt

5.2 Classification of Cohesive Soil (Atterberg Limits Test Results)

A total of three (3) Atterberg Limits Tests were conducted on soil samples to determine the plasticity of the fine soils fractions taken from all the boreholes. The purpose of the test is to classify the fractions, determine their plasticity and predict its behaviour under loading conditions. The results indicate that the fine grain fractions in the soil samples are primarily classified as SILT soil of Intermediate Compressibility (MI). A summary of the Atterberg Limits test results is provided in **Table 5-2**, detailed laboratory results are shown in **Appendix 4** and plasticity Chart in **Appendix 5.**

Table 5-2: Classification of Fine Grain Soil at Sandals, Montego Bay based on Atterberg Limits Test Results. Soil depths bmsl.

BOREHOLE #	DEPTH		ATTERBERG LIMITS TEST			SOIL CLASSIFICATION (COHESIVE SOILS)
	m	ft	LL%	PL%	PI%	
1	1	3.5	47.9	33.97	13.93	SILT fraction of Intermediate Compressibility (MI)
3	0.5	1.5	38.25	29.67	8.58	SILT fraction of Intermediate Compressibility (MI)
3	9.1	30	43.2	30.85	12.35	SILT fraction of Intermediate Compressibility (MI)

6 DISCUSSION OF RESULTS

6.1 Summary

The proposal is to construct 18 bungalows in the shallow waters at Sandals, Montego Bay - St James. The bungalows are to be supported on piles, bored or driven into the seabed. Architectural drawings for the site have not been provided by the client but it can be assumed that the bungalows will be lightly loaded structures.

Borehole data for the subsurface soil in seabed and laboratory analysis of the soils were conducted to determine the type of soils and to classify the soils for engineering purposes. The seawater depth for BH-1 to BH-8 ranges from 2.4m (8 ft) to 2.6m (8.5 ft) and the water depth in the vicinity of BH 9 is approximately 3.3m (11 ft).

Visual inspection and laboratory results indicate that the geological material in the seabed/subsurface consists predominantly of calcareous Sand and Gravel with varying proportions of Silt. There is a gradual increase in grain size of the calcareous sediments from south to north, especially on the eastern section of the project site. Bedrock was encountered beneath the soil sediments consisting of moderately weak reef limestone at depths from 12.1m (40 ft) to 13.9m (46 ft).

6.2 Foundation Soil/Rock

The thickness of the foundation soil ranges from 9.7m (32 ft) to 10.6m (35 ft) and is comprised of very loose to very dense calcareous Sand and Gravel with various proportions of silt in the subsurface soil. Silty soil (BH-1, BH-4 and BH 5) was also encountered in the subsurface, particularly on the western section of the project site. However, the soil described as 'silty' consists of coarse grain fraction (sand and gravel) exceeding 50 percent. Loose to very loose coarse grain soils are more prevalent in BH-1, BH-2 BH-6 BH-7, and BH 9. However, a large percent of the coarse grain soil also falls in the range of medium dense.

The base of the foundation of the structure will be embedded in the moderately weak limestone which will provide good end bearing strength, given that pile foundation is used to support the bungalows.

7 GEOTECHNICAL ANALYSIS

7.1 Determination of Bearing Capacity

To determine the strength of the soil for pile foundation, the Ultimate Carrying Capacity of the pile will be estimated to support the bungalows on the eastern and western sides of the project site. Given a worst-case condition, the Ultimate Carrying Capacity will be based on the boreholes with the lowest average N-Values in the calcareous sediments on both sides of the project site.

7.2 Bearing Capacity for Pile Foundation

The recommended option for foundation for the overwater bungalows is the use of cast-in-place or driven piles which are required to be taken below the calcareous sediments and into the underlying bedrock consisting of reef limestone. The computations for determining Ultimate Carrying Capacity of the pile will be on the assumption that the calcareous sediments on top of the bedrock are primarily coarse-grain soil.

The estimation of carrying capacity will be determined using pile diameters of 300mm and 350mm (12 inches and 14 inches) and pile lengths of 10.6m (35ft) to support the bungalow structure.

7.2.1 Ultimate Pile Carrying Capacity in Coarse Grain (Non- Cohesive) Soil

The Ultimate Carrying Capacity of the pile (Q_u) was estimated based on computation of Ultimate Pile Base Resistance (Q_b) and Ultimate Pile Skin Friction (Q_s) where:

$$Q_u = Q_b + Q_s$$

The method used for determination of Ultimate Base Resistance was adopted from Terzaghi's equation for square footing for coarse grain soils and modified for pile foundations where:

$$Q_b = p' N_q A_b$$

p' = the average effective overburden pressure over the depth of the pile
N_q = Bearing Capacity Factor (a function of shearing resistance of the soil)
A_b = the area of the base of the pile

The pile shaft skin resistance is determined from Meyerhof's formulae:

$$Q_s = K_s P'_m A_s \tan \Phi.$$

K_s = Coefficient of lateral earth pressure acting horizontally on the side of the pile. K_s is assigned a value of 1.5 based on the relative density of the soil (Broms 1966).

P'_m = Average overburden pressure on the side of the pile.

A_s = Surface Area of Pile in the ground (soil)

Φ = Angle of friction between soil and the pile shaft. Φ is assigned a value of 0.49 and 0.51 in the equation (Broms 1966) based on the internal angle of friction.

The Ultimate Pile Carrying Capacity was determined for cast-in place concrete piles or driven piles with diameters of 300mm and 350mm (12 inches and 14 inches). Under worst case condition, the average phi (Ø') value used for the coarse grain soil with end bearing below the pile base in the moderately weak rock is 33 on the western section of the project site. The (Ø') value used for the coarse-grain soil with end bearing below pile base in the moderately weak limestone on the eastern side of the project site is 34.

The Bearing Capacity Factor Nq, determined from the Ø' value is 32 and 37 for the western and eastern sections of the project site respectively (Tomlinson MJ. 1986).

The results are tabulated in **Table 7.1** below:

Table 7-1: Estimated Ultimate Pile Carrying Capacity for a single pile in non-cohesive soils for Sandals Overwater Bungalows on the Eastern and Western sections of the site, Montego Bay, St James.

Pile Diameter	Location	Pile Length in the soil (m)	Ultimate Pile Base Resistance Qb (kN)	Ultimate Skin Friction Qs (kN)	Ultimate Pile Carrying Capacity Qu=Qb+Qs (kN)
300mm (12 inches)	**West BH's-2 to BH-5**	**10.6**	**287**	**743**	**1,030**
350mm (14 inches)	**West BH's-2 to BH-5**	**10.6**	**391**	**867**	**1,258**
300mm (12 inches)	**East BH's 7 to BH-9 & BH-1**	**10.6**	**332**	**776**	**1,108**
350mm (14 inches)	**East BH's 7 to BH-9 & BH-1**	**10.6**	**452**	**905**	**1,357**

A **Safety Factor of 2.5** can be used in determining the 'working load' for the piles.

The estimation of Ultimate Pile Carrying Capacity in **Table 7-1** is based on a single pile.

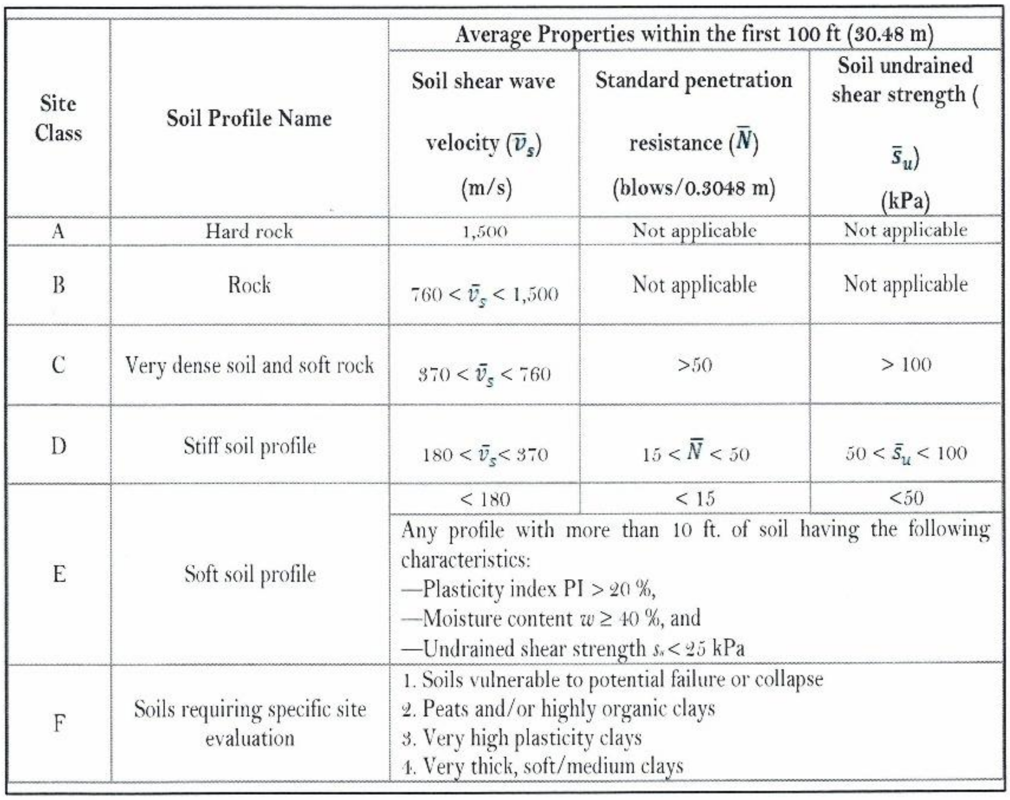
7.3 Foundation Settlement

The pile will largely be end-bearing and that foundation settlement is expected to be small, given that care is taken during the drilling process for the construction of the piles to minimize disturbance in the limestone in the zone of the embedment of the pile.

7.4 Seismic Site Class

The seismic site classification follows the procedure outlined in the ***ASCE 7: Minimum Design Loads for Buildings and Other Structures***. The site classification for seismic design of proposed structures were evaluated using the Standard Penetration Resistance method. The definitions of the different site classes under this code are summarized in Table 7.2. Based on the definitions, the site is underlain by predominantly medium dense to dense coarse grain soil and weak/moderately weak ('soft') limestone. It places the soil in Classes E and C.

Table 7-2: Seismic Site Class Definitions (ASCE -7-2005)



Site Class	Soil Profile Name	Average Properties within the first 100 ft (30.48 m)		
		Soil shear wave velocity ($\overline{v}_s$) (m/s)	**Standard penetration resistance ($\overline{N}$) (blows/0.3048 m)**	**Soil undrained shear strength ($\overline{s}_u$) (kPa)**
A	Hard rock	1,500	Not applicable	Not applicable
B	Rock	$760 < \bar{v}_s < 1,500$	Not applicable	Not applicable
C	Very dense soil and soft rock	$370 < \bar{v}_s < 760$	>50	> 100
D	Stiff soil profile	$180 < \bar{v}_s < 370$	$15 < \overline{N} < 50$	$50 < \bar{s}_u < 100$
E	Soft soil profile	< 180	< 15	<50
		Any profile with more than 10 ft. of soil having the following characteristics: —Plasticity index PI > 20 %, —Moisture content $w \geq 40$ %, and —Undrained shear strength $s_u < 25$ kPa		
F	Soils requiring specific site evaluation	1. Soils vulnerable to potential failure or collapse 2. Peats and/or highly organic clays 3. Very high plasticity clays 4. Very thick, soft/medium clays		

8 RECOMMENDATIONS

8.1 Pile Foundation Consideration

Pile foundation can be either driven piles or cast-in-place piles. In founding the tip of the pile in moderately weak rock, it is possible that pile driving will shatter the rock around the pile thereby reducing the shearing resistance of the pile. The drilling process to construct the tip of the bored or cast-in-place piles into the rock will cause some disturbance around the wall in the rock depending on the type of rock material. However, in moderately weak rock, it is expected that the rock will be less disturbed when compared to driven piles. While both types of deep foundation can be used, bored pile is the preferred option.

8.2 Bearing Capacity

The ultimate carrying capacity of the pile is presented in **Table 7-1** based on a 10.6m pile length in the soil and rock and variable pile diameters. Given that the structural loads for the bungalows are expected to be low, the allowable pile capacity, given worst case condition, should be adequate to support the structures. The structural engineer will use the information in Table 7-1 as a guide to determine the pile diameter to be used and the number of piles in each pile group for design purposes.

8.3 Settlement Considerations

Given that the base of the pile will be in moderately weak limestone and that loads will be light, settlement is expected to be within tolerable limits of 25mm, given that the drilling process does not create excessive disturbance of around the walls of the drill holes.

8.4 Pile Length Design

The project site is offshore and in relatively shallow waters of approximately 2.4m (8 ft) in all boreholes except BH-9 (3.3m/11 ft) at Sandals Montego Bay. Additionally, the recommended length of the pile in the soil/rock is 10.6m, which implies that the actual design length of piles will be in the range of 13m to 13.5m. This will ensure that the pile cap and structure will be raised above sea level.

8.5 Seismic Design Considerations

The site classification for seismic design for buildings and other structures place the overwater bungalow site as Classes C and E.

9 CONCLUSION

The geotechnical investigation conducted at Sandals Overwater Bungalows, Montego Bay, St James includes a geological evaluation, subsurface soil description and classification, Standard Penetration Tests (SPT), soils laboratory and geotechnical analyses of the soils. The bungalows are to be erected in shallow water of the Caribbean Sea with depths ranging from 2.4m (8 ft) to 3.3m (11 ft). The geotechnical information gathered from the investigation indicates the soil in the seabed consists predominantly of 9.7m (32 ft) to 10.6m (35 ft) very loose/loose, to medium dense coarse grain soil which is comprised of calcareous sand and gravel with varying proportions of silt. Where the soil is described as silty, the soil will behave as a coarse grain soil, given that the combined proportion of sand and gravel in the soil is high. Below the calcareous sediment, is moderately weak reef limestone.

The type of foundation recommended is pile foundation with the pile tip embedded in the limestone bedrock. Driven or cast-in-place piles can be considered, however, the preferred option is for **cast-in-place piles**, given that there is likely to be weakening of the rock wall around the pile during the driving process which would reduce frictional resistance in the rock. It is important the drilling process for the construction of the piles will create minimal disturbance of the rock around the tip of the pile.

Table 7-1 provides Ultimate Carrying Capacity of a single pile based on pile length of 10.6m in the soil and pile diameters of 300mm and 350mm (12 inches and 14 inches). The structural engineer will use the data in **Table 7-1** as a guide for design of the piles for the bungalows. However, actual pile length design will be based on the depth of pile in the soil and depth of water above the seabed which gives a pile length of approximately13m-13.5m.

Given that the pile will largely depend on end bearing resistance into the bedrock and that the bungalows are designed to be lightly loaded structures, it is expected that settlement will be kept within tolerable limit of 25mm, based on the working load to be determined by the structural engineer.

It is our opinion that the site can be used for the construction of overwater bungalows at the Sandals site in Montego Bay, St James.

NHarris

Norman Harris
Engineering Geologist BSc; MSc, PE

10 APPENDICES

Appendix 1: Site Layout Map and proposed borehole locations determined by the Client

Figure A 1: An aerial view of the Sandals, Montego Bay property, highlighting the general site for the geotechnical investigation (indicated by the orange arrow) for the proposed new building development.

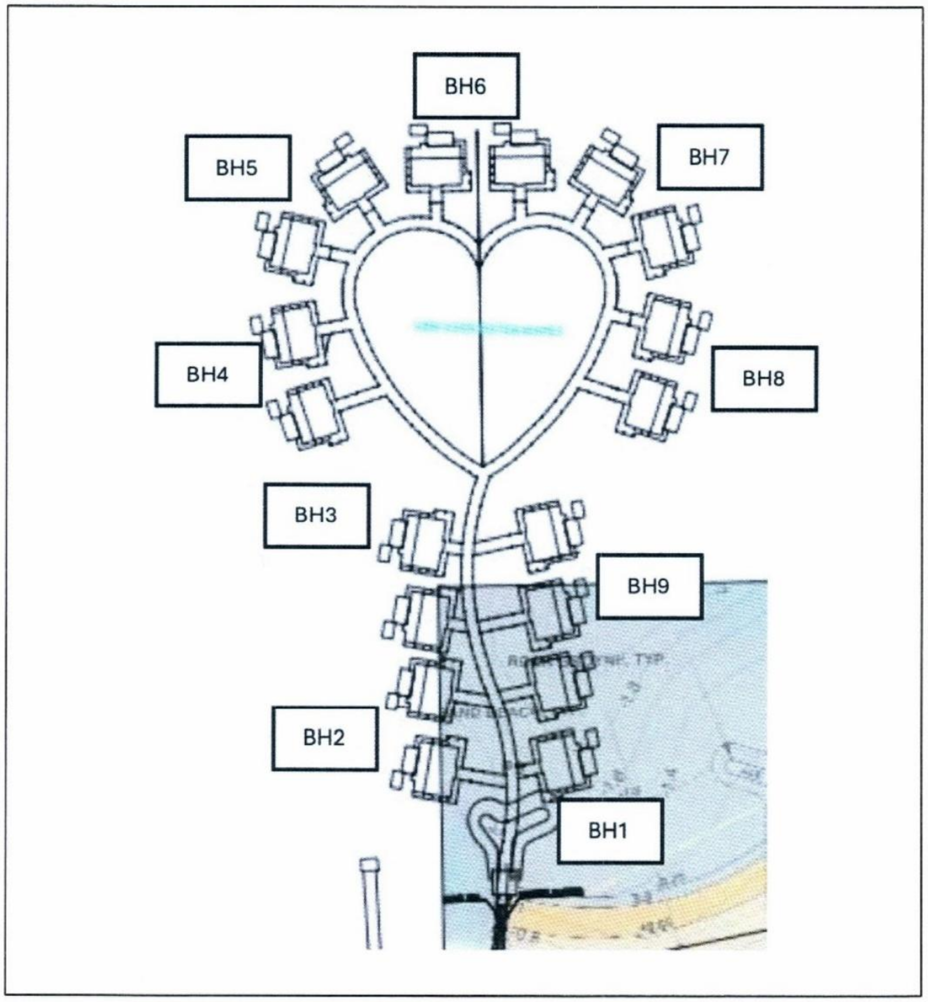
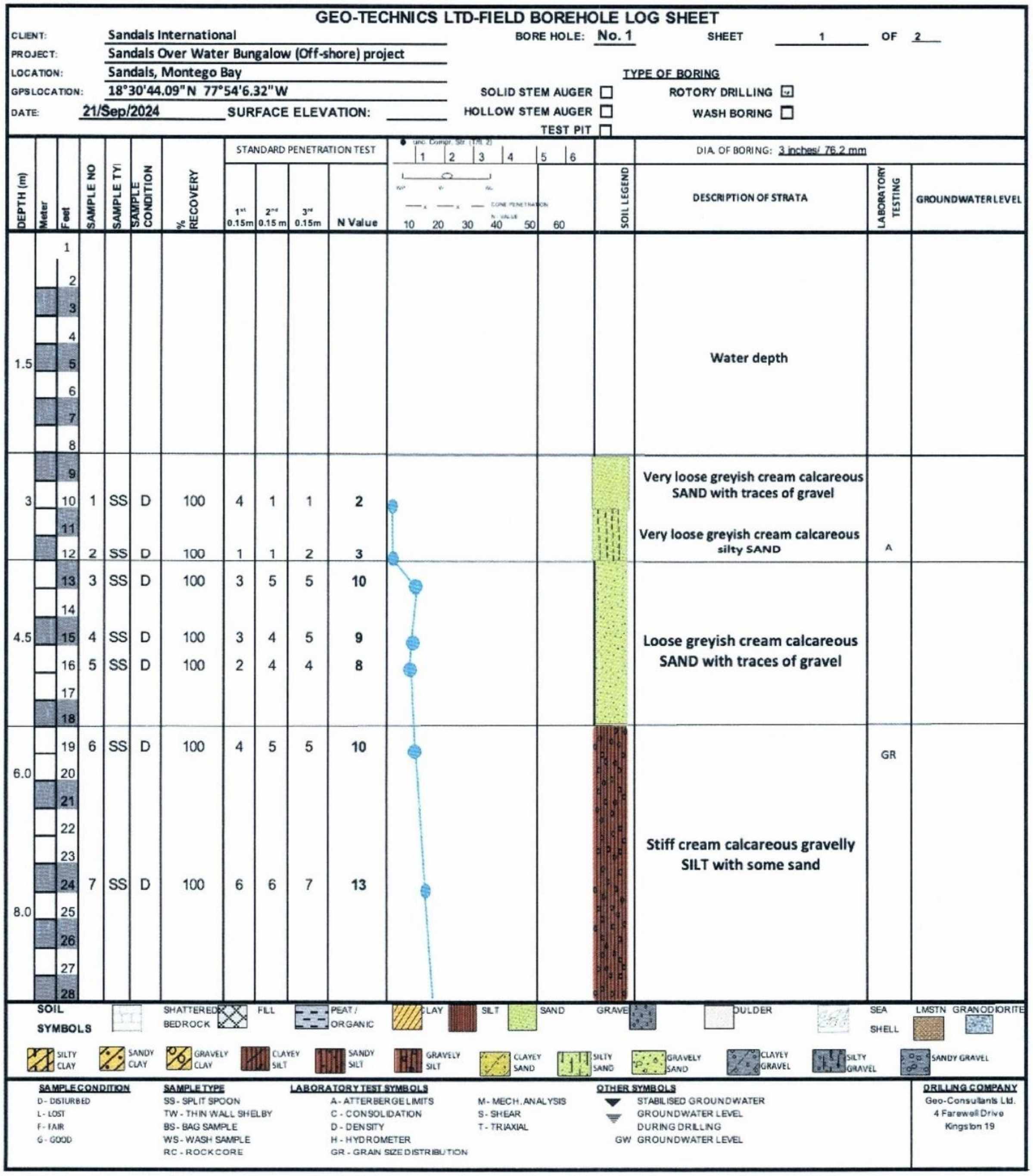


Figure A 2: Proposed borehole locations at Sandals, Montego Bay

Appendix 2: Borehole Logs Boreholes 1 – 9



GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPSLOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 21/Sep/2024 SURFACE ELEVATION:

BORE HOLE: No. 1 SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Meter	Feet	SAMPLE NO	SAMPLE TYI	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		1										Water depth		
		2												
		3												
		4												
1.5		5												
		6												
		7												
		8												
		9										Very loose greyish cream calcareous SAND with traces of gravel		
3		10	1	SS	D	100	4	1	1	2				
		11										Very loose greyish cream calcareous silty SAND		
		12	2	SS	D	100	1	1	2	3			A	
		13	3	SS	D	100	3	5	5	10		Loose greyish cream calcareous SAND with traces of gravel		
		14												
4.5		15	4	SS	D	100	3	4	5	9				
		16	5	SS	D	100	2	4	4	8				
		17												
		18												
		19	6	SS	D	100	4	5	5	10		Stiff cream calcareous gravelly SILT with some sand	GR	
6.0		20												
		21												
		22												
		23												
		24	7	SS	D	100	6	6	7	13				
8.0		25												
		26												
		27												
		28												

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT / ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCKCORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
≡ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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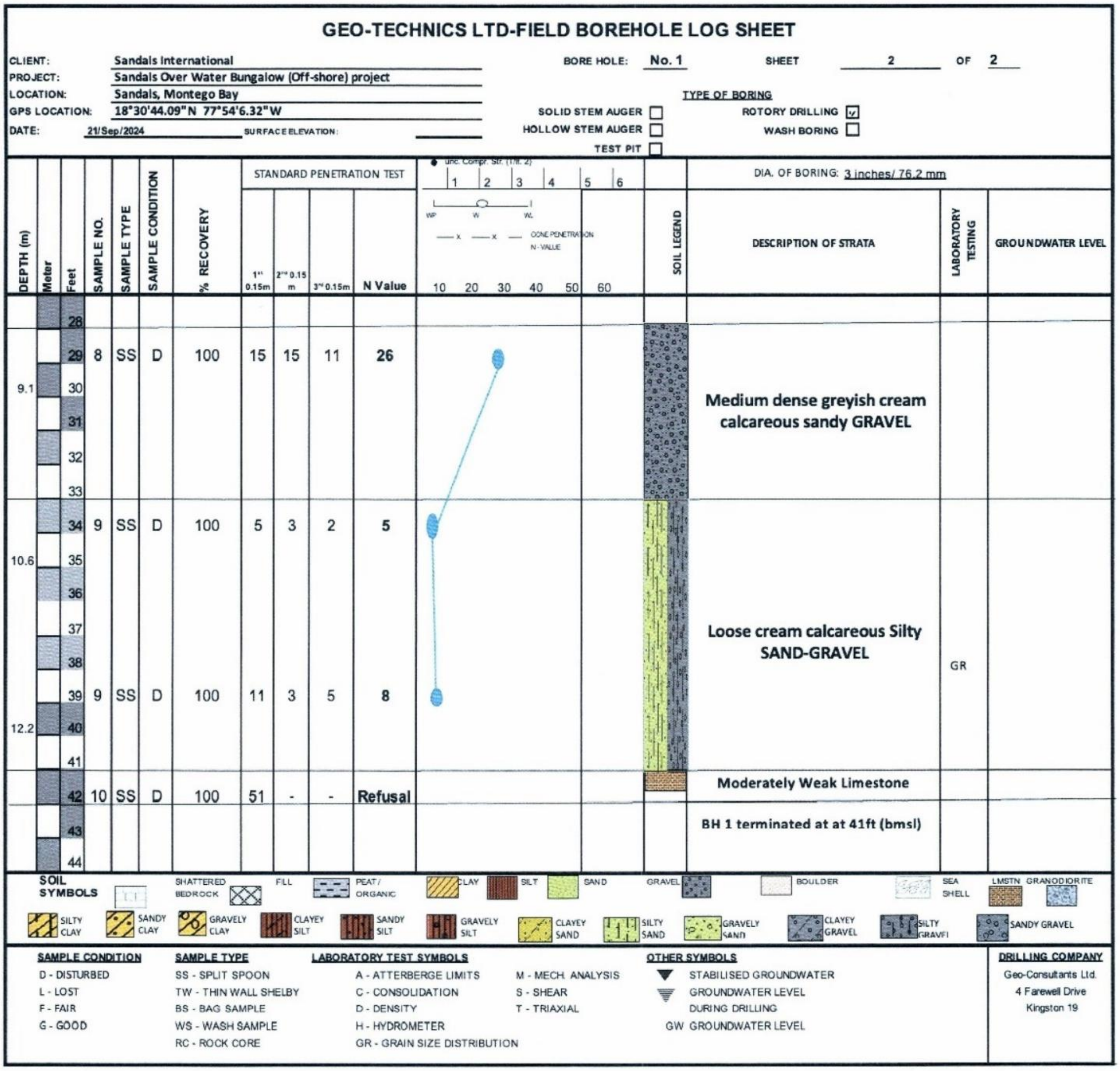

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 21/Sep/2024
SURFACE ELEVATION:

BORE HOLE: No. 1
SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	28											
	29	8	SS	D	100	15	15	11	**26**	**Medium dense greyish cream calcareous sandy GRAVEL**		
9.1	30											
	31											
	32											
	33											
	34	9	SS	D	100	5	3	2	**5**	**Loose cream calcareous Silty SAND-GRAVEL**		
10.6	35											
	36											
	37											
	38										GR	
	39	9	SS	D	100	11	3	5	**8**			
12.2	40											
	41									**Moderately Weak Limestone**		
	42	10	SS	D	100	51	-	-	**Refusal**			
	43									**BH 1 terminated at at 41ft (bmsl)**		
	44											

SOIL SYMBOLS
SHATTERED BEDROCK
FILL
PEAT/ ORGANIC
CLAY
SILT
SAND
GRAVEL
BOULDER
SEA SHELL
LMSTN
GRANODIORITE
SILTY CLAY
SANDY CLAY
GRAVELY CLAY
CLAYEY SILT
SANDY SILT
GRAVELY SILT
CLAYEY SAND
SILTY SAND
GRAVELY SAND
CLAYEY GRAVEL
SILTY GRAVEL
SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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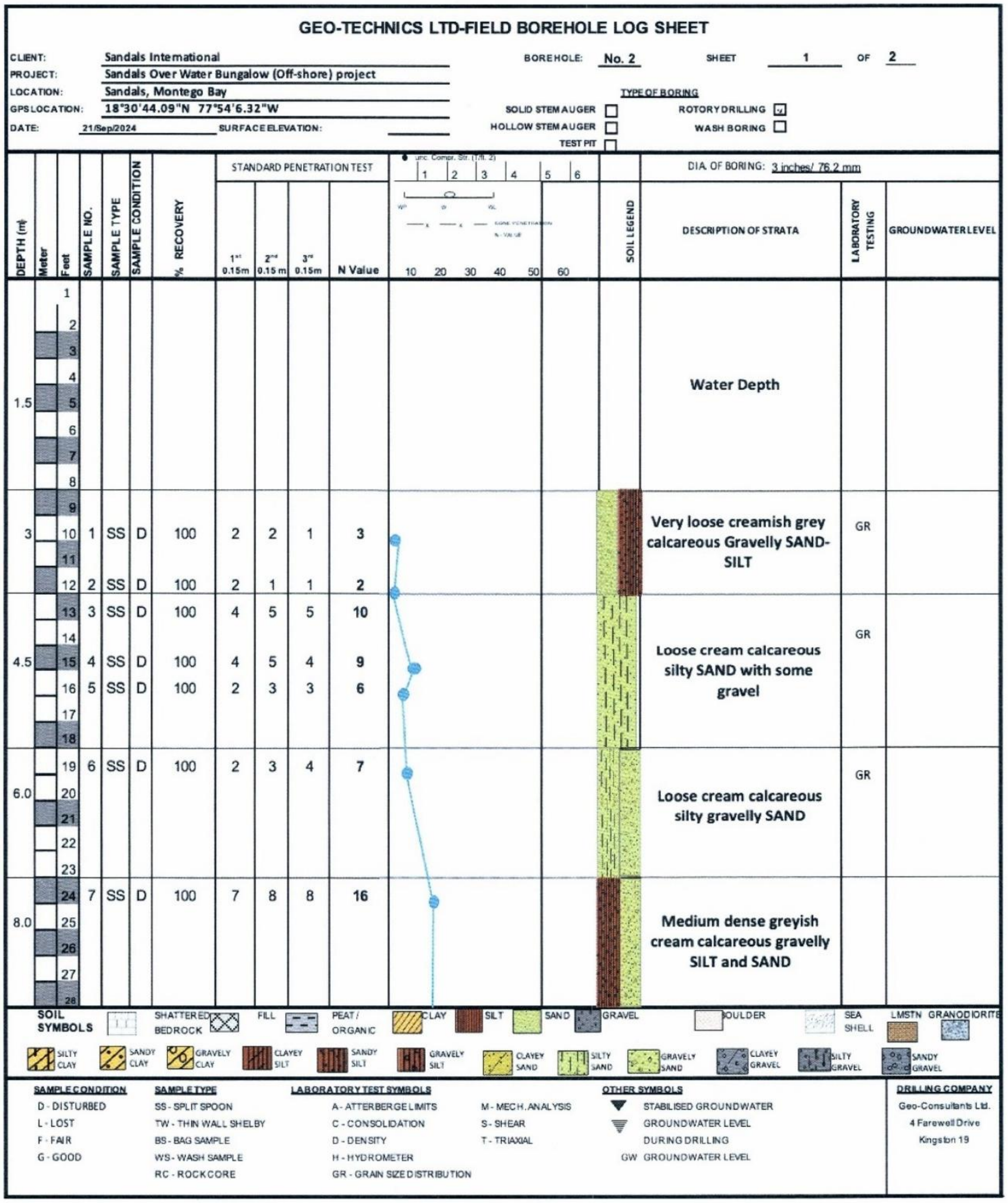

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 21/Sep/2024
SURFACE ELEVATION:

BOREHOLE: No. 2
SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	1									Water Depth		
	2											
	3											
	4											
1.5	5											
	6											
	7											
	8											
	9									Very loose creamish grey calcareous Gravelly SAND-SILT	GR	
3	10	1	SS	D	100	2	2	1	3			
	11											
	12	2	SS	D	100	2	1	1	2			
	13	3	SS	D	100	4	5	5	10	Loose cream calcareous silty SAND with some gravel	GR	
	14											
4.5	15	4	SS	D	100	4	5	4	9			
	16	5	SS	D	100	2	3	3	6			
	17											
	18											
	19	6	SS	D	100	2	3	4	7	Loose cream calcareous silty gravelly SAND	GR	
6.0	20											
	21											
	22											
	23											
	24	7	SS	D	100	7	8	8	16	Medium dense greyish cream calcareous gravelly SILT and SAND		
8.0	25											
	26											
	27											
	28											

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
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≡ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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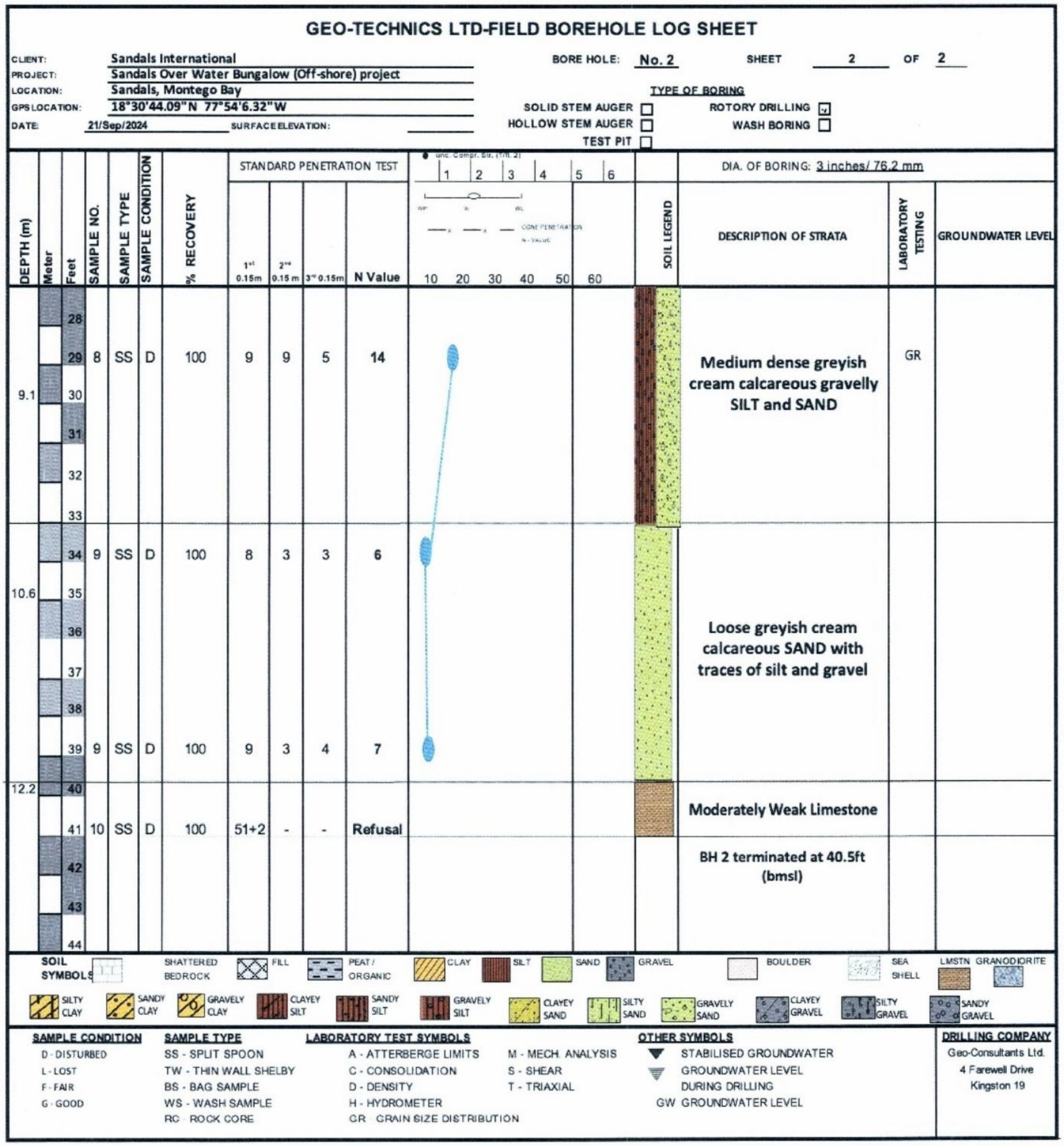

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 21/Sep/2024 SURFACE ELEVATION:

BORE HOLE: No. 2 SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	28											
	29	8	SS	D	100	9	9	5	14	Medium dense greyish cream calcareous gravelly SILT and SAND	GR	
9.1	30											
	31											
	32											
	33											
	34	9	SS	D	100	8	3	3	6	Loose greyish cream calcareous SAND with traces of silt and gravel		
10.6	35											
	36											
	37											
	38											
	39	9	SS	D	100	9	3	4	7			
12.2	40									Moderately Weak Limestone		
	41	10	SS	D	100	51+2	-	-	Refusal			
	42									BH 2 terminated at 40.5ft (bmsl)		
	43											
	44											

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT / ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
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▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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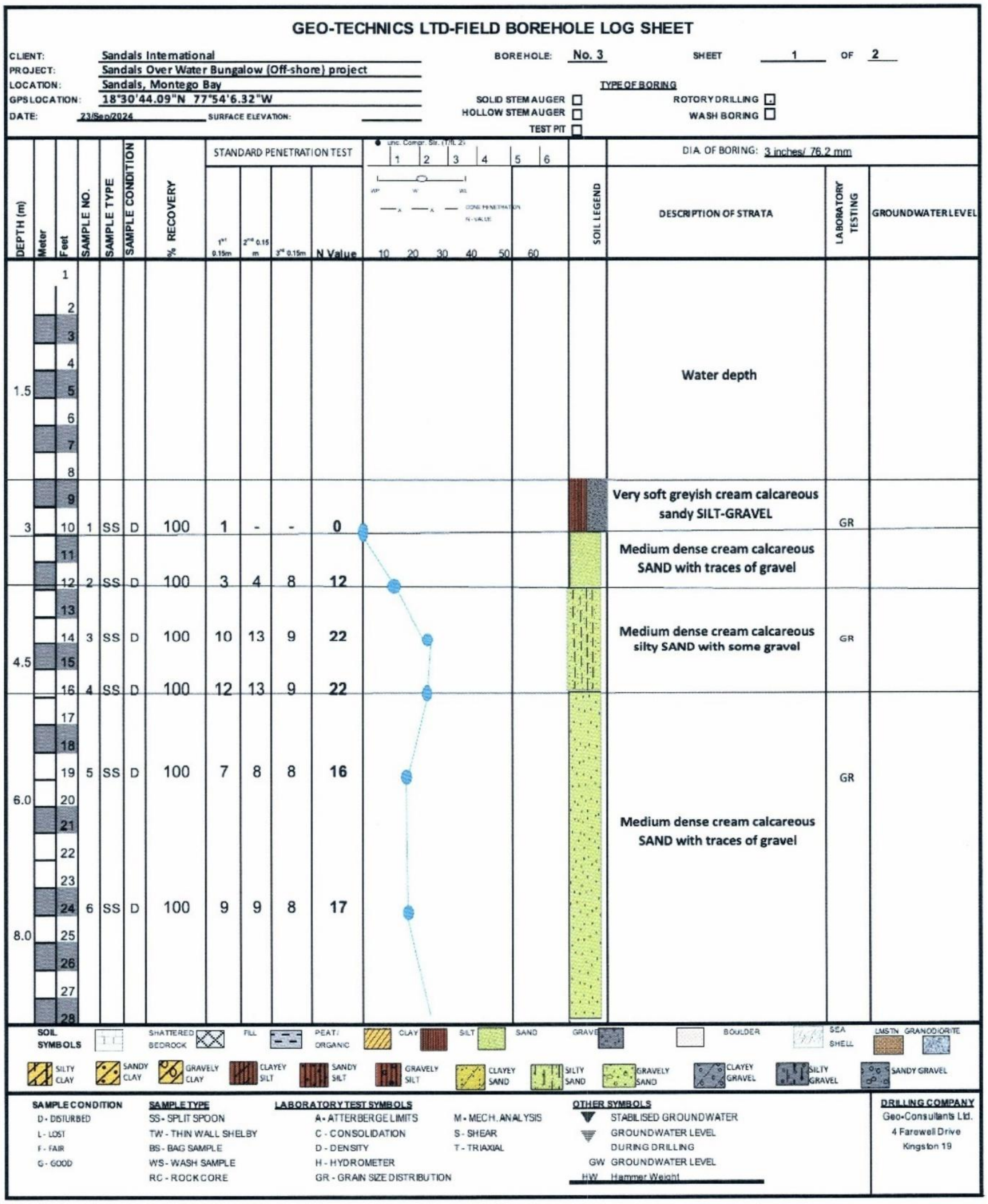

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 23/Sep/2024 SURFACE ELEVATION:

BOREHOLE: No. 3 SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐ ROTORY DRILLING ☐
HOLLOW STEM AUGER ☐ WASH BORING ☐
TEST PIT ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m) Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	1									Water depth		
	2											
	3											
	4											
1.5	5											
	6											
	7											
	8											
	9									Very soft greyish cream calcareous sandy SILT-GRAVEL		
3	10	1	SS	D	100	1	-	-	0		GR	
	11									Medium dense cream calcareous SAND with traces of gravel		
	12	2	SS	D	100	3	4	8	12			
	13									Medium dense cream calcareous silty SAND with some gravel		
	14	3	SS	D	100	10	13	9	22		GR	
4.5	15											
	16	4	SS	D	100	12	13	9	22			
	17									Medium dense cream calcareous SAND with traces of gravel		
	18											
	19	5	SS	D	100	7	8	8	16		GR	
6.0	20											
	21											
	22											
	23											
	24	6	SS	D	100	9	9	8	17			
8.0	25											
	26											
	27											
	28											

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL
HW Hammer Weight

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4 Farewell Drive
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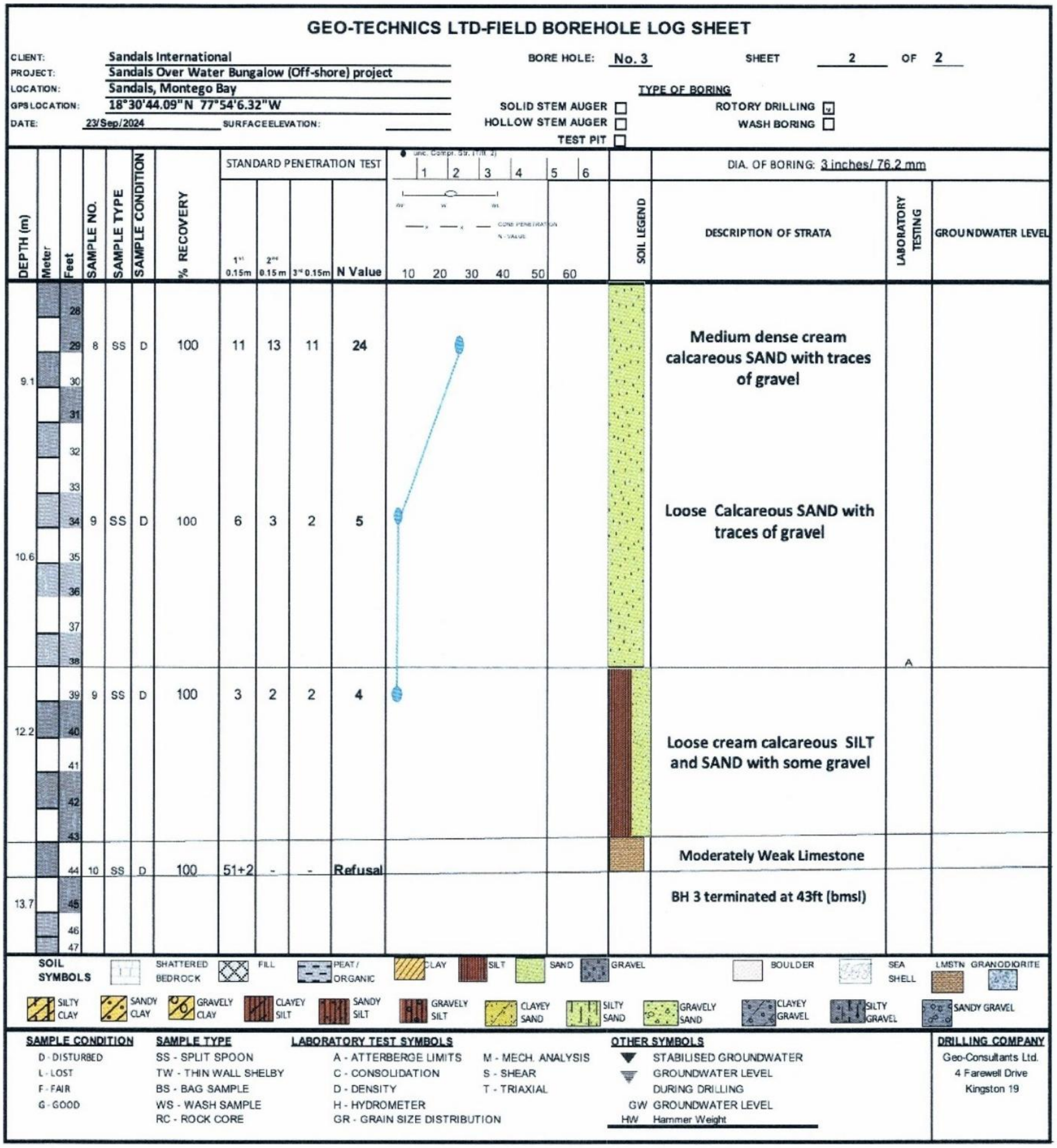


GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 23/Sep/2024 SURFACE ELEVATION:

BORE HOLE: No. 3 SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	28									Medium dense cream calcareous SAND with traces of gravel		
	29	8	SS	D	100	11	13	11	24			
9.1	30											
	31											
	32											
	33									Loose Calcareous SAND with traces of gravel		
	34	9	SS	D	100	6	3	2	5			
10.6	35											
	36											
	37											
	38										A	
	39	9	SS	D	100	3	2	2	4	Loose cream calcareous SILT and SAND with some gravel		
12.2	40											
	41											
	42											
	43									Moderately Weak Limestone		
	44	10	SS	D	100	51+2	-	-	Refusal			
13.7	45									BH 3 terminated at 43ft (bmsl)		
	46											
	47											

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT / ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL
HW Hammer Weight

DRILLING COMPANY
Geo-Consultants Ltd.
4 Farewell Drive
Kingston 19

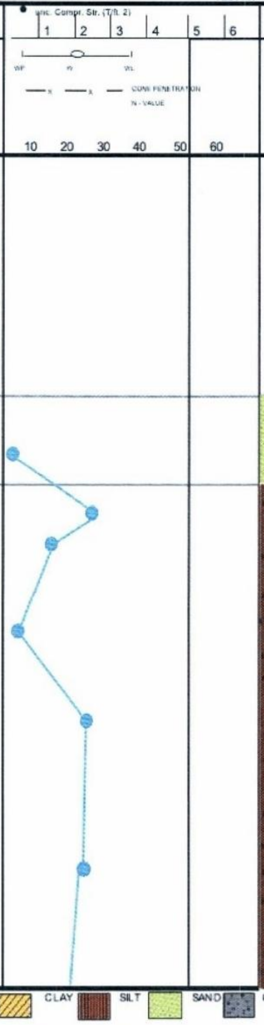
GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 23/Sep/2024 SURFACE ELEVATION: ______

BOREHOLE: No. 4 SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐ ROTORY DRILLING ☑
HOLLOW STEM AUGER ☐ WASH BORING ☐
TEST PIT ☐

DIA. OF BORING: 3 inches/ 76.2 mm



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		1									**Water depth**		
		2											
		3											
		4											
1.5		5											
		6											
		7											
		8											
		9									**Very loose cream calcareous SAND with some of gravel**	GR	
3		10	1	SS	D	100	2	1	2	3			
		11											
		12	2	SS	D	100	6	14	12	26	**Very stiff cream calcareous sandy gravelly SILT**	GR	
		13	3	SS	D	100	4	7	6	13			
		14											
4.5		15									**Soft cream calcareous sandy gravelly SILT**		
		16	4	SS	D	100	3	2	2	4			
		17											
		18											
		19	5	SS	D	100	17	11	12	23	**Very stiff cream calcareous sandy gravelly SILT**	G	
6.0		20											
		21											
		22											
		23											
		24	7	SS	D	100	15	12	10	22			
8.0		25											
		26											
		27											
		28											

SOIL SYMBOLS SHATTERED BEDROCK FILL PEAT / ORGANIC CLAY SILT SAND GRAVEL BOULDER SEA SHELL LMSTN GRANODIORITE
SILTY CLAY SANDY CLAY GRAVELY CLAY CLAYEY SILT SANDY SILT GRAVELY SILT CLAYEY SAND SILTY SAND GRAVELY SAND CLAYEY GRAVEL SILTY GRAVEL SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCKCORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▼ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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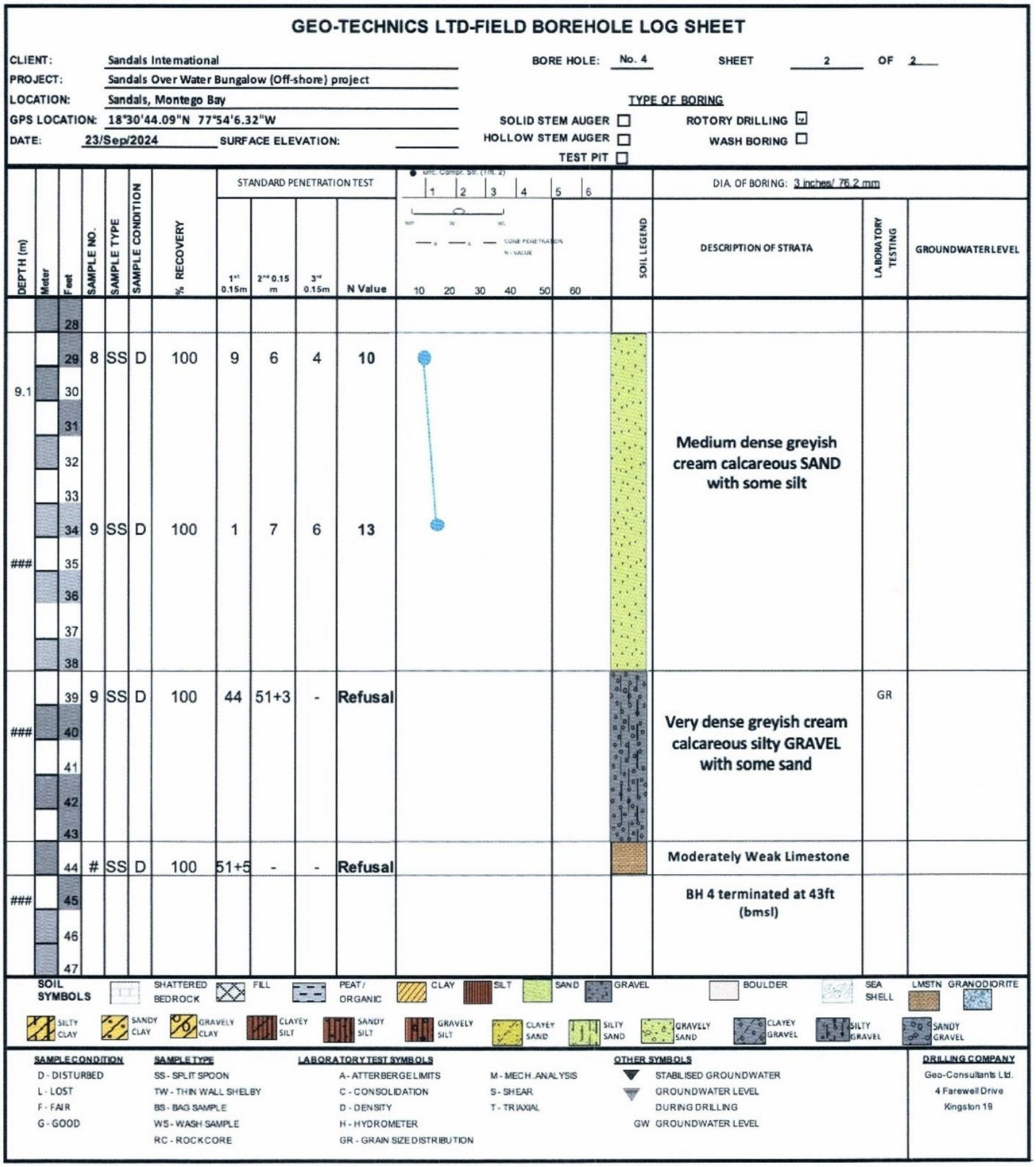
Kingston 19



GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 23/Sep/2024 **SURFACE ELEVATION:**

BORE HOLE: No. 4 **SHEET** 2 **OF** 2

TYPE OF BORING
SOLID STEM AUGER ☐ ROTORY DRILLING ☑
HOLLOW STEM AUGER ☐ WASH BORING ☐
TEST PIT ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	● Unc. Compr. Str. (T/ft. 2) 1 2 3 4 5 6 WP W WL CONE PENETRATION N - VALUE 10 20 30 40 50 60	SOIL LEGEND	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		28													
		29	8	SS	D	100	9	6	4	10			**Medium dense greyish cream calcareous SAND with some silt**		
9.1		30													
		31													
		32													
		33													
		34	9	SS	D	100	1	7	6	13					
###		35													
		36													
		37													
		38													
		39	9	SS	D	100	44	51+3	-	Refusal			**Very dense greyish cream calcareous silty GRAVEL with some sand**	GR	
###		40													
		41													
		42													
		43													
		44	#	SS	D	100	51+5	-	-	Refusal			**Moderately Weak Limestone**		
###		45											**BH 4 terminated at 43ft (bmsl)**		
		46													
		47													

SOIL SYMBOLS
SHATTERED BEDROCK
FILL
PEAT / ORGANIC
CLAY
SILT
SAND
GRAVEL
BOULDER
SEA SHELL
LMSTN
GRANODIORITE
SILTY CLAY
SANDY CLAY
GRAVELY CLAY
CLAYEY SILT
SANDY SILT
GRAVELY SILT
CLAYEY SAND
SILTY SAND
GRAVELY SAND
CLAYEY GRAVEL
SILTY GRAVEL
SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCKCORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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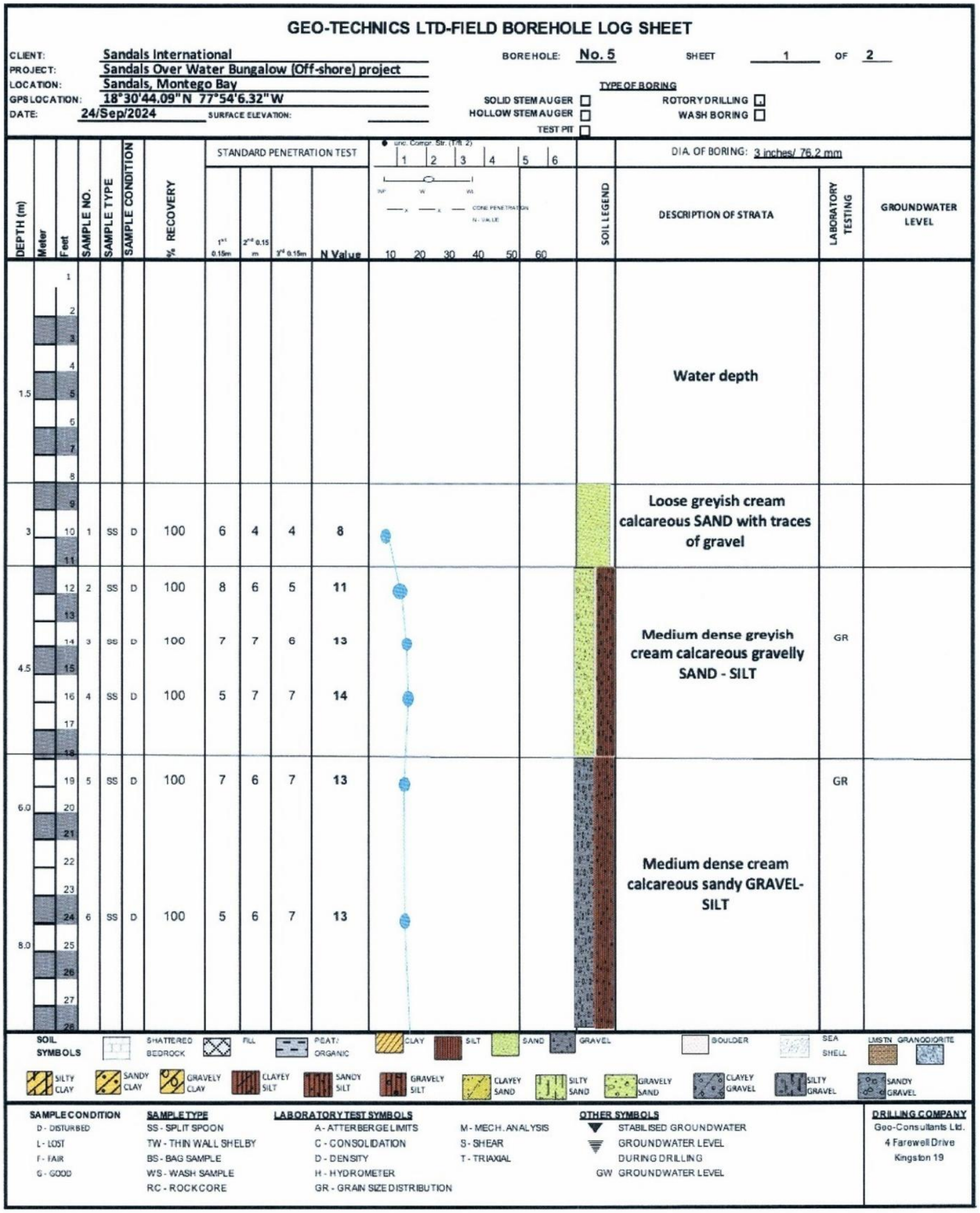

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 24/Sep/2024 SURFACE ELEVATION: ____

BOREHOLE: No. 5 SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☐
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	 2nd 0.15 m	 3rd 0.15m	 N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		1									Water depth		
		2											
		3											
		4											
1.5		5											
		6											
		7											
		8											
		9									Loose greyish cream calcareous SAND with traces of gravel		
3		10	1	SS	D	100	6	4	4	8			
		11											
		12	2	SS	D	100	8	6	5	11	Medium dense greyish cream calcareous gravelly SAND - SILT		
		13											
		14	3	SS	D	100	7	7	6	13		GR	
4.5		15											
		16	4	SS	D	100	5	7	7	14			
		17											
		18											
		19	5	SS	D	100	7	6	7	13	Medium dense cream calcareous sandy GRAVEL-SILT	GR	
6.0		20											
		21											
		22											
		23											
		24	6	SS	D	100	5	6	7	13			
8.0		25											
		26											
		27											
		28											

SOIL SYMBOLS
SHATTERED BEDROCK
FILL
PEAT/ ORGANIC
CLAY
SILT
SAND
GRAVEL
BOULDER
SEA SHELL
LMSTN
GRANODIORITE
SILTY CLAY
SANDY CLAY
GRAVELY CLAY
CLAYEY SILT
SANDY SILT
GRAVELY SILT
CLAYEY SAND
SILTY SAND
GRAVELY SAND
CLAYEY GRAVEL
SILTY GRAVEL
SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCKCORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
≡ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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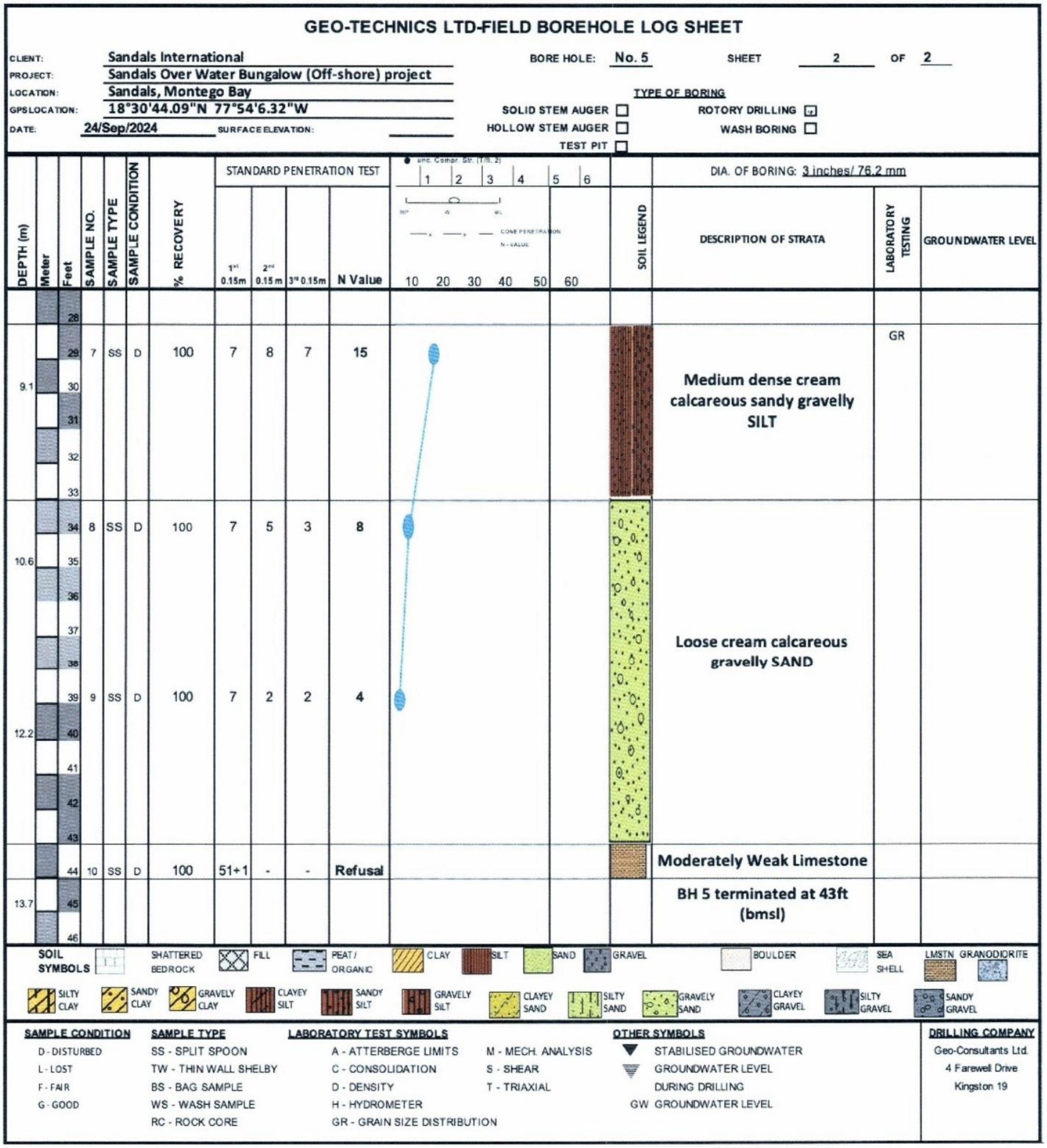

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPSLOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 24/Sep/2024 SURFACE ELEVATION:

BORE HOLE: No. 5 SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	10 20 30 40 50 60	SOIL LEGEND	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		28													
		29	7	SS	D	100	7	8	7	15			**Medium dense cream calcareous sandy gravelly SILT**	GR	
9.1		30													
		31													
		32													
		33													
		34	8	SS	D	100	7	5	3	8			**Loose cream calcareous gravelly SAND**		
10.6		35													
		36													
		37													
		38													
		39	9	SS	D	100	7	2	2	4					
12.2		40													
		41													
		42													
		43													
		44	10	SS	D	100	51+1	-	-	Refusal			**Moderately Weak Limestone**		
13.7		45											**BH 5 terminated at 43ft (bmsl)**		
		46													

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT / ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
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OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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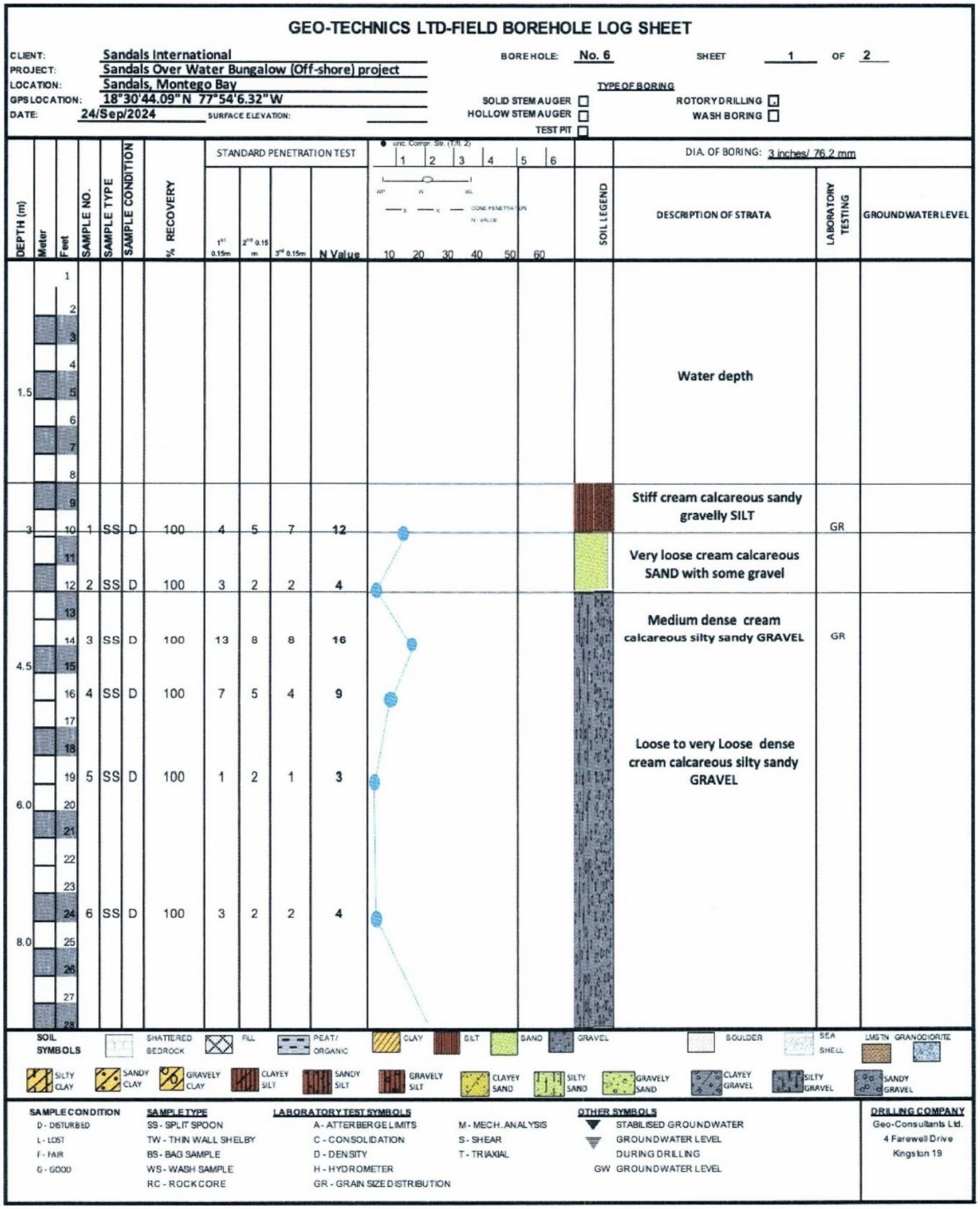

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 24/Sep/2024
SURFACE ELEVATION:

BOREHOLE: No. 6
SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☐
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m) Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
1.5	5									Water depth		
	9									Stiff cream calcareous sandy gravelly SILT		
3	10	1	SS	D	100	4	5	7	12		GR	
	11									Very loose cream calcareous SAND with some gravel		
	12	2	SS	D	100	3	2	2	4			
	13									Medium dense cream calcareous silty sandy GRAVEL		
	14	3	SS	D	100	13	8	8	16		GR	
4.5	15											
	16	4	SS	D	100	7	5	4	9			
	18									Loose to very Loose dense cream calcareous silty sandy GRAVEL		
	19	5	SS	D	100	1	2	1	3			
6.0	20											
	24	6	SS	D	100	3	2	2	4			
8.0	25											

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT/ ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
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OTHER SYMBOLS
▼ STABILISED GROUNDWATER
☰ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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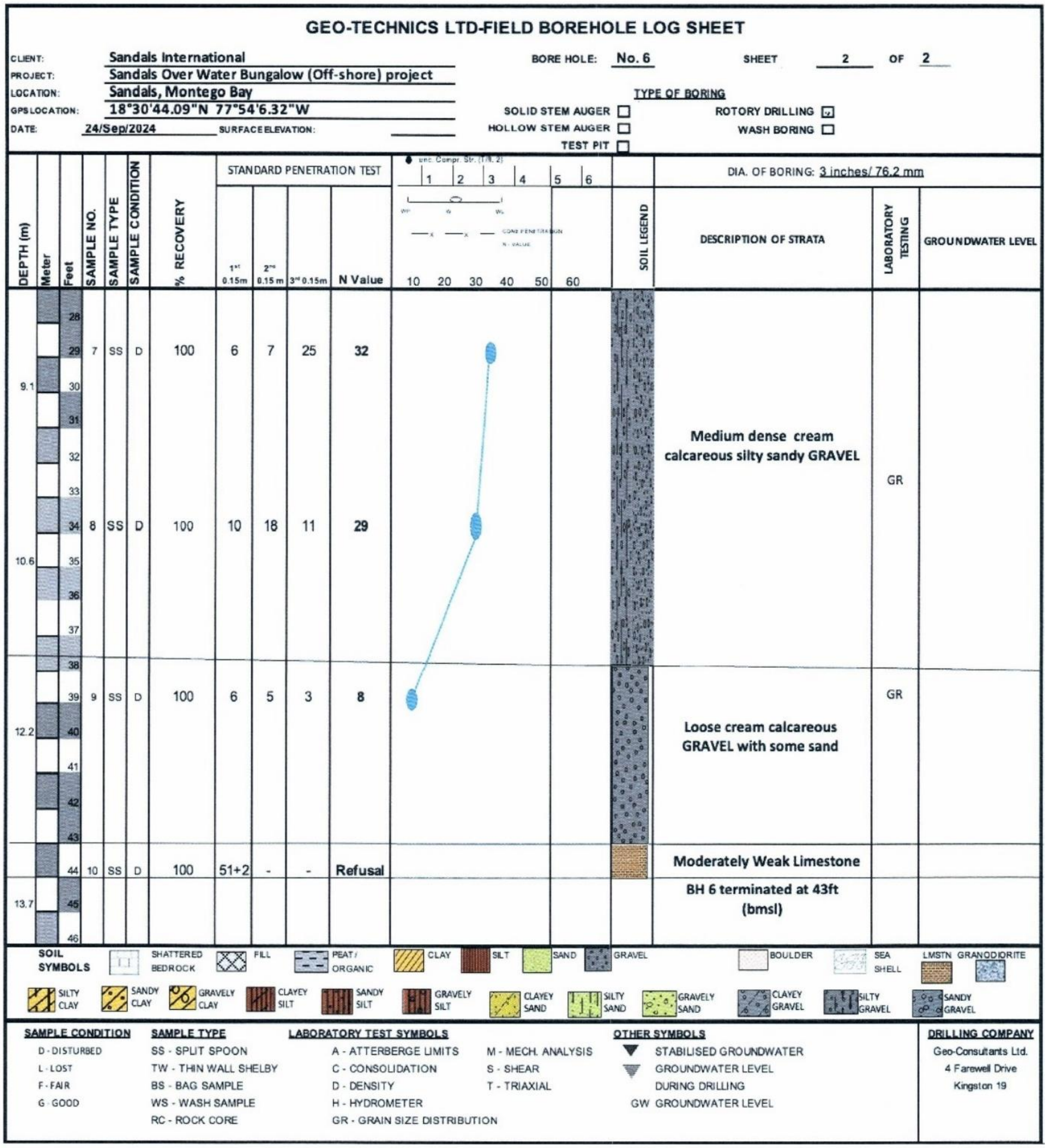

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 24/Sep/2024 SURFACE ELEVATION:

BORE HOLE: No. 6 SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		28									▨	Medium dense cream calcareous silty sandy GRAVEL	GR	
		29	7	SS	D	100	6	7	25	32				
9.1		30												
		31												
		32												
		33												
		34	8	SS	D	100	10	18	11	29				
10.6		35												
		36												
		37												
		38									▨	Loose cream calcareous GRAVEL with some sand	GR	
		39	9	SS	D	100	6	5	3	8				
12.2		40												
		41												
		42												
		43												
		44	10	SS	D	100	51+2	-	-	Refusal	▨	Moderately Weak Limestone		
13.7		45										BH 6 terminated at 43ft (bmsl)		
		46												

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT / ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▼ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

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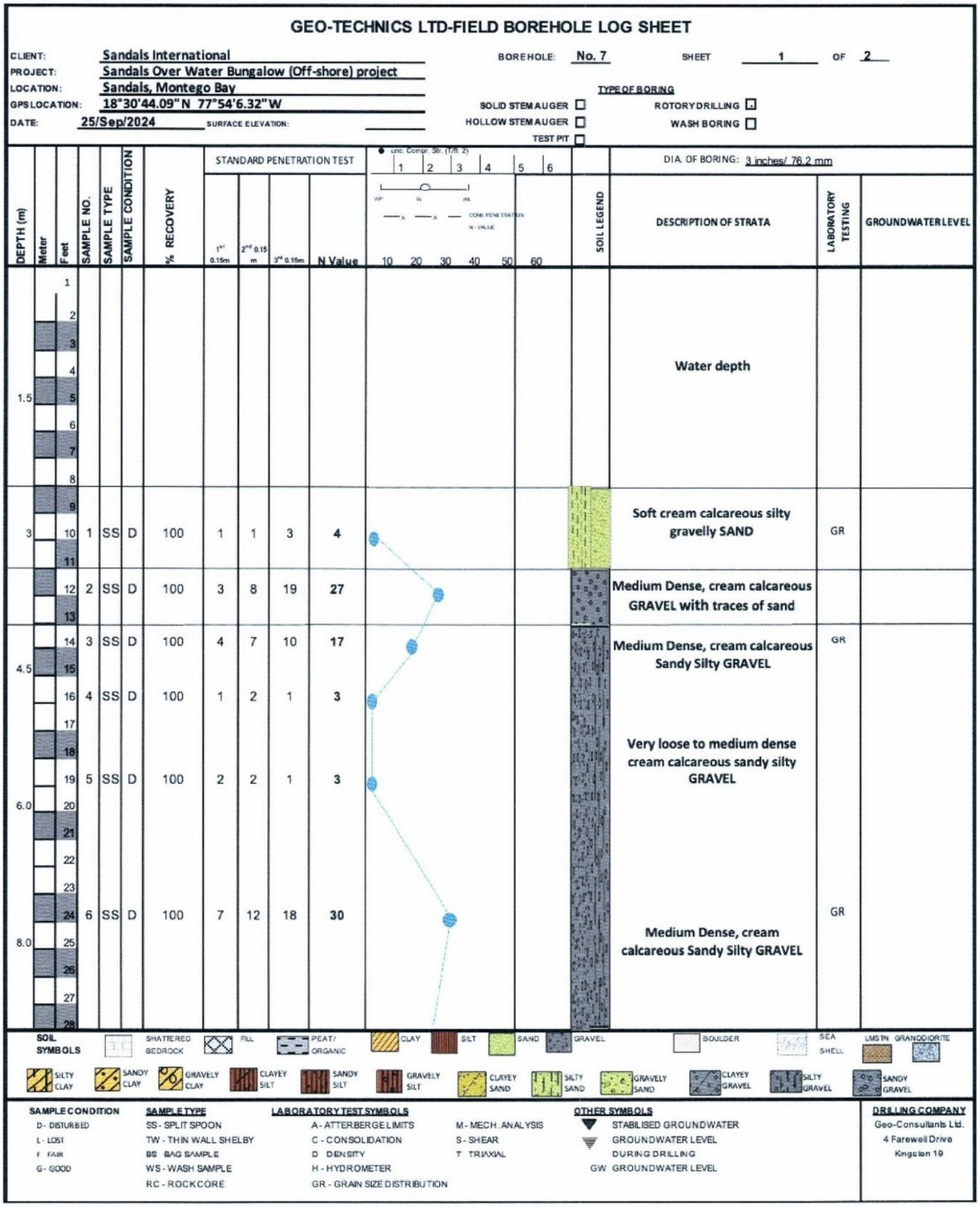


GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 25/Sep/2024 SURFACE ELEVATION:

BOREHOLE: No. 7 SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐ ROTORY DRILLING ☑
HOLLOW STEM AUGER ☐ WASH BORING ☐
TEST PIT ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	1											
	2											
	3											
	4									Water depth		
1.5	5											
	6											
	7											
	8											
	9									Soft cream calcareous silty gravelly SAND		
3	10	1	SS	D	100	1	1	3	4		GR	
	11											
	12	2	SS	D	100	3	8	19	27	Medium Dense, cream calcareous GRAVEL with traces of sand		
	13											
	14	3	SS	D	100	4	7	10	17	Medium Dense, cream calcareous Sandy Silty GRAVEL	GR	
4.5	15											
	16	4	SS	D	100	1	2	1	3			
	17											
	18									Very loose to medium dense cream calcareous sandy silty GRAVEL		
	19	5	SS	D	100	2	2	1	3			
6.0	20											
	21											
	22											
	23											
	24	6	SS	D	100	7	12	18	30		GR	
8.0	25									Medium Dense, cream calcareous Sandy Silty GRAVEL		
	26											
	27											
	28											

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT/ ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS BAG SAMPLE
WS - WASH SAMPLE
RC - ROCKCORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
Geo-Consultants Ltd.
4 Farewell Drive
Kingston 19

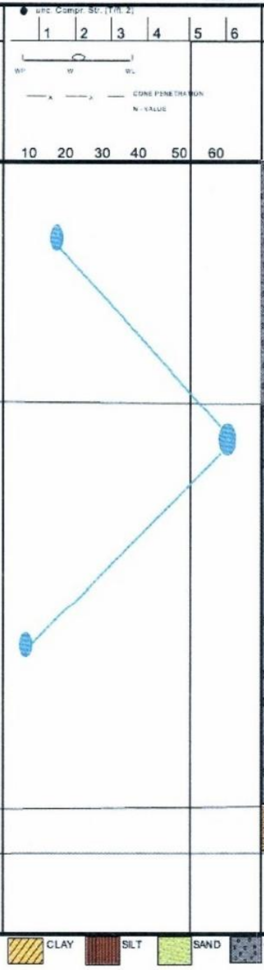
GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: **Sandals International**
PROJECT: **Sandals Over Water Bungalow (Off-shore) project**
LOCATION: **Sandals, Montego Bay**
GPS LOCATION: **18°30'44.09"N 77°54'6.32"W**
DATE: 25/Sep/2024 SURFACE ELEVATION: ______

BORE HOLE: **No. 7** SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUN
		28									▨			
		29	7	SS	D	100	7	8	8	**16**		**Medium Dense, cream calcareous Sandy Silty GRAVEL**		
9.1		30												
		31												
		32												
		33									▨			
		34	8	SS	D	100	36	42	19	**61**		**Very Dense cream calcareous GRAVEL and SAND with some silt**		
10.6		35												
		36												
		37												
		38												
		39	9	SS	D	100	12	6	2	**8**			GR	
12.2		40										**Loose cream calcareous GRAVEL and SAND with some silt**		
		41												
		42												
		43									▨	**Moderately Weak Limestone**		
		44	10	SS	D	100	51+2	-	-	**Refusal**				
13.7		45										**BH 7 terminated at 43ft (bmsl)**		
		46												

SOIL SYMBOLS
▨ SHATTERED BEDROCK
☒ FILL
▨ PEAT / ORGANIC
▨ CLAY
▨ SILT
▨ SAND
▨ GRAVEL
▨ BOULDER
▨ SEA SHELL
▨ LMSTN
G
▨ SILTY CLAY
▨ SANDY CLAY
▨ GRAVELY CLAY
▨ CLAYEY SILT
▨ SANDY SILT
▨ GRAVELY SILT
▨ CLAYEY SAND
▨ SILTY SAND
▨ GRAVELY SAND
▨ CLAYEY GRAVEL
▨ SILTY GRAVEL
▨ SAND
GRAV

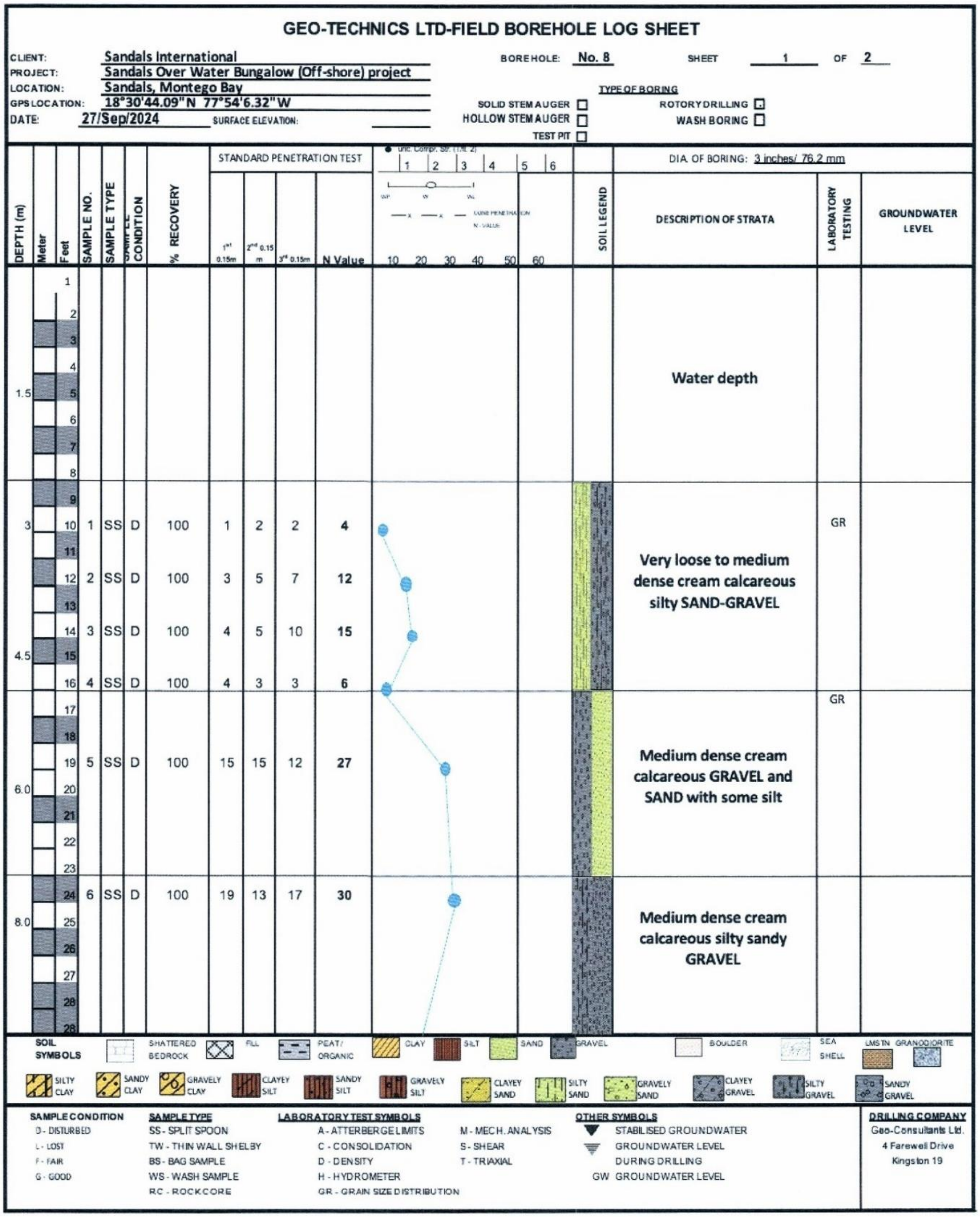
SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▼ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLIN
Geo-Co
4 Fa
Ki



GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 27/Sep/2024 SURFACE ELEVATION:

BOREHOLE: No. 8 SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☐
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m) Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	1–9									Water depth		
1.5	5											
3	10	1	SS	D	100	1	2	2	4	Very loose to medium dense cream calcareous silty SAND-GRAVEL	GR	
	12	2	SS	D	100	3	5	7	12			
	14	3	SS	D	100	4	5	10	15			
4.5	15											
	16	4	SS	D	100	4	3	3	6			
	17									Medium dense cream calcareous GRAVEL and SAND with some silt	GR	
	19	5	SS	D	100	15	15	12	27			
6.0	20											
	24	6	SS	D	100	19	13	17	30	Medium dense cream calcareous silty sandy GRAVEL		
8.0	25											
	28											

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT/ ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE, SILTY CLAY, SANDY CLAY, GRAVELY CLAY, CLAYEY SILT, SANDY SILT, GRAVELY SILT, CLAYEY SAND, SILTY SAND, GRAVELY SAND, CLAYEY GRAVEL, SILTY GRAVEL, SANDY GRAVEL

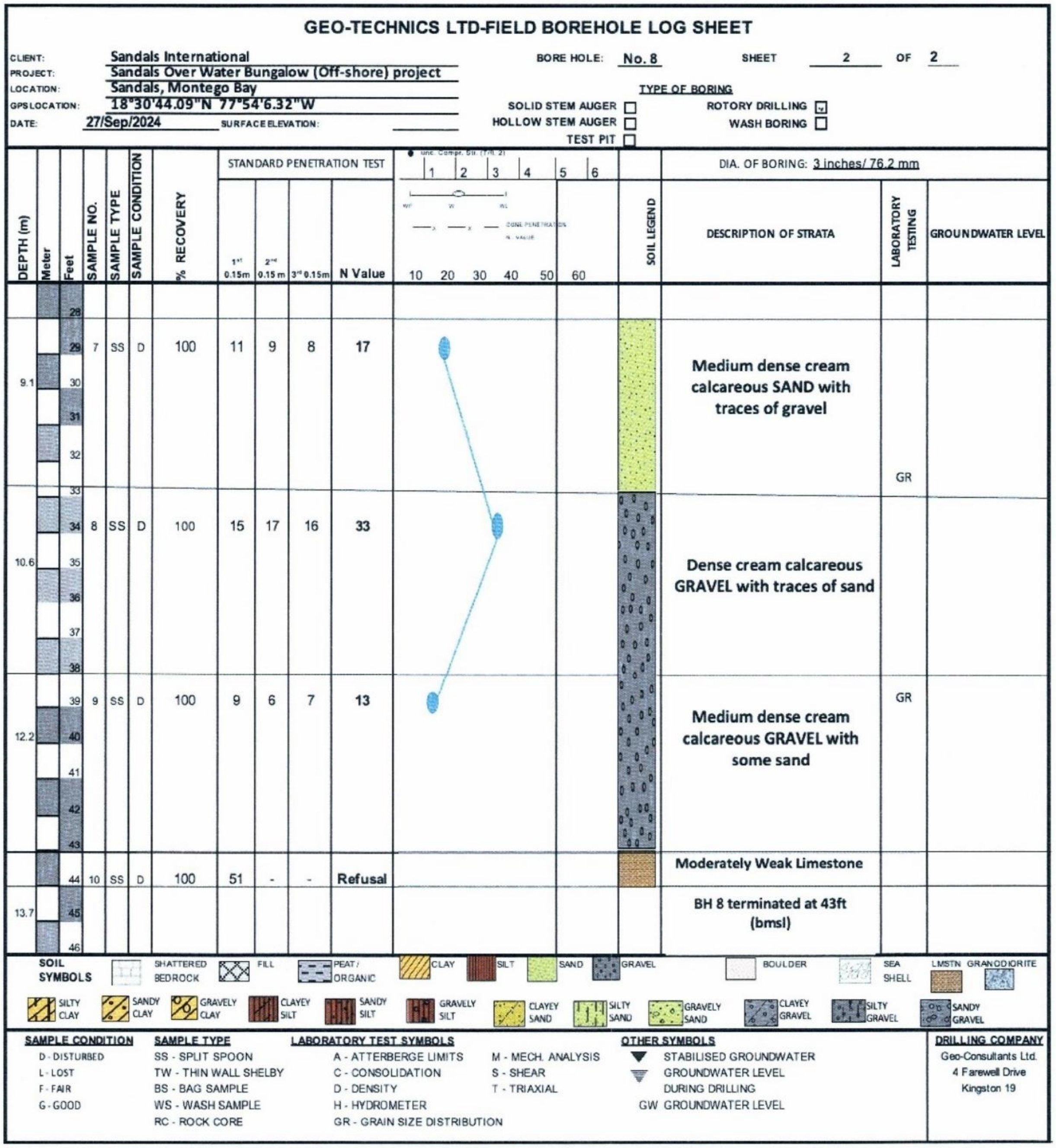
SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCKCORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
Geo-Consultants Ltd.
4 Farewell Drive
Kingston 19



GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 27/Sep/2024 SURFACE ELEVATION: ______

BORE HOLE: No. 8 SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m) Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
	28											
	29	7	SS	D	100	11	9	8	17	Medium dense cream calcareous SAND with traces of gravel		
9.1	30											
	31											
	32										GR	
	33											
	34	8	SS	D	100	15	17	16	33	Dense cream calcareous GRAVEL with traces of sand		
10.6	35											
	36											
	37											
	38											
	39	9	SS	D	100	9	6	7	13	Medium dense cream calcareous GRAVEL with some sand	GR	
12.2	40											
	41											
	42											
	43											
	44	10	SS	D	100	51	-	-	Refusal	Moderately Weak Limestone		
13.7	45									BH 8 terminated at 43ft (bmsl)		
	46											

SOIL SYMBOLS
SHATTERED BEDROCK
FILL
PEAT / ORGANIC
CLAY
SILT
SAND
GRAVEL
BOULDER
SEA SHELL
LMSTN
GRANODIORITE
SILTY CLAY
SANDY CLAY
GRAVELY CLAY
CLAYEY SILT
SANDY SILT
GRAVELY SILT
CLAYEY SAND
SILTY SAND
GRAVELY SAND
CLAYEY GRAVEL
SILTY GRAVEL
SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
Geo-Consultants Ltd.
4 Farewell Drive
Kingston 19

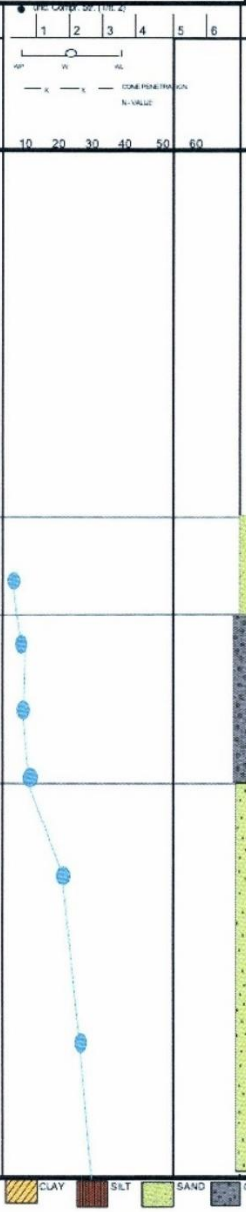
GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09" N 77°54'6.32" W
DATE: 27/Sep/2024 SURFACE ELEVATION: ____

BOREHOLE: No. 9 SHEET 1 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/76.2 mm



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		1										**Water depth**		
		2												
		3												
		4												
1.5		5												
		6												
		7												
		8												
		9												
3		10												
		11												
		12									🟩	**Very loose cream calcareous SAND with traces of gravel**		
		13	1	SS	D	100	1	1	2	3				
		14												
4.5		15	2	SS	D	100	2	3	3	6	▨	**Loose cream calcareous sandy GRAVEL with some silt**		
		16												
		17	3	SS	D	100	3	4	3	7			GR	
		18												
		19	4	SS	D	100	5	4	5	9				
6.0		20									🟩	**Medium dense cream calcareous SAND with some gravel and silt**		
		21												
		22	5	SS	D	100	8	7	12	19			GR	
		23												
		24												
8.0		25												
		26												
		27	6	SS	D	100	9	9	15	24		**Medium dense cream calcareous SAND with some gravel**		
		28												
		29												
9.1		30												
		31												

SOIL SYMBOLS

☐	SHATTERED BEDROCK
☒	FILL
▤	PEAT/ ORGANIC
▨	CLAY
▥	SILT
🟩	SAND
▩	GRAVEL
☐	BOULDER
▒	SEA SHELL
▦	LMSTN
▦	GRANODIORITE
▨	SILTY CLAY
▨	SANDY CLAY
▨	GRAVELY CLAY
▥	CLAYEY SILT
▥	SANDY SILT
▥	GRAVELY SILT
▨	CLAYEY SAND
▥	SILTY SAND
🟩	GRAVELY SAND
▩	CLAYEY GRAVEL
▩	SILTY GRAVEL
▩	SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCKCORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
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GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
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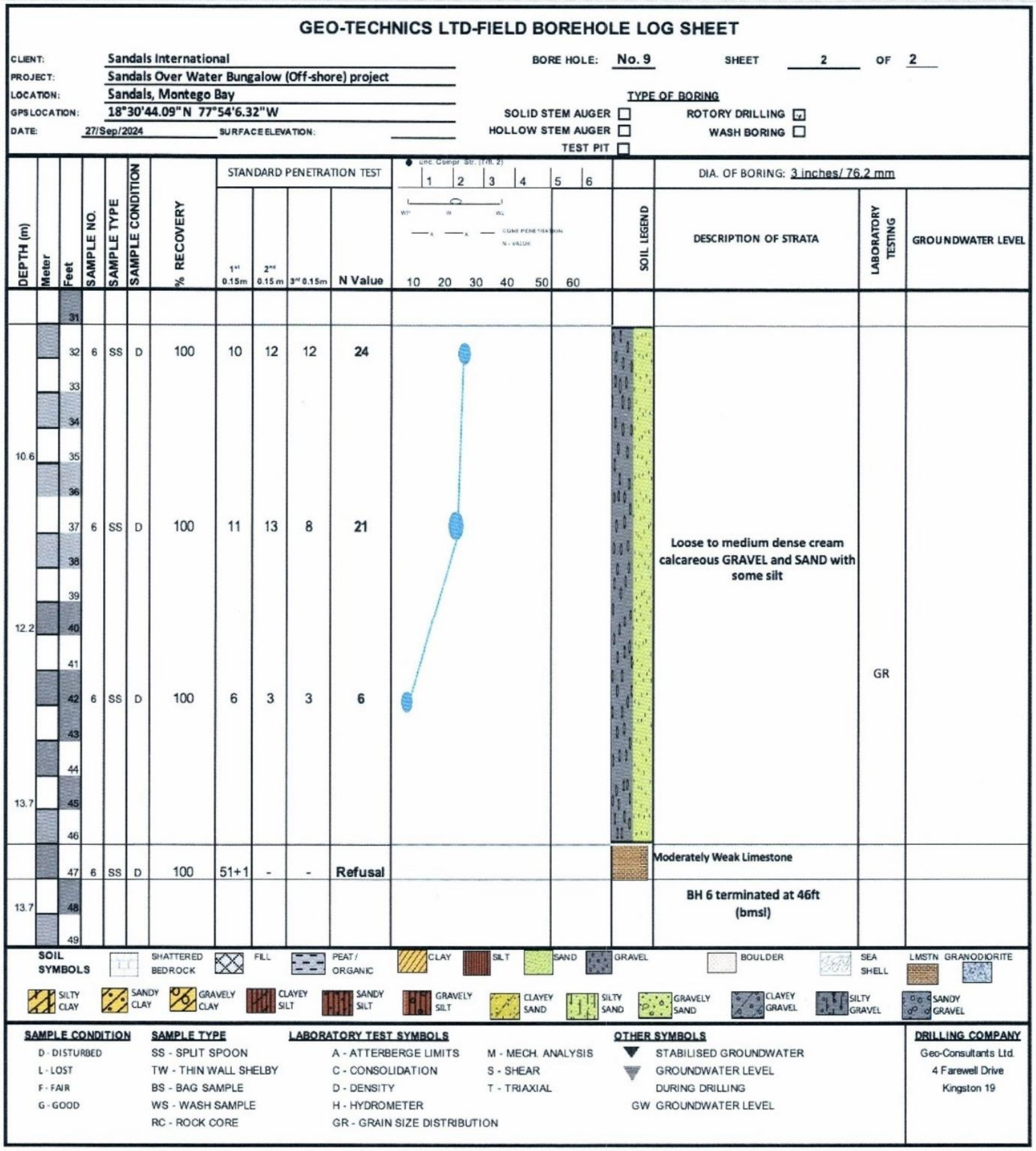
OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
Geo-Consultants Ltd.
4 Farewell Drive
Kingston 19



GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

CLIENT: Sandals International
PROJECT: Sandals Over Water Bungalow (Off-shore) project
LOCATION: Sandals, Montego Bay
GPS LOCATION: 18°30'44.09"N 77°54'6.32"W
DATE: 27/Sep/2024 SURFACE ELEVATION:
BORE HOLE: No. 9 SHEET 2 OF 2

TYPE OF BORING
SOLID STEM AUGER ☐
HOLLOW STEM AUGER ☐
TEST PIT ☐
ROTORY DRILLING ☑
WASH BORING ☐

DIA. OF BORING: 3 inches/ 76.2 mm

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYPE	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	LABORATORY TESTING	GROUNDWATER LEVEL
		31												
		32	6	SS	D	100	10	12	12	24		Loose to medium dense cream calcareous GRAVEL and SAND with some silt		
		33												
		34												
10.6		35												
		36												
		37	6	SS	D	100	11	13	8	21				
		38												
		39												
12.2		40												
		41											GR	
		42	6	SS	D	100	6	3	3	6				
		43												
		44												
13.7		45												
		46												
		47	6	SS	D	100	51+1	-	-	Refusal		Moderately Weak Limestone		
13.7		48										BH 6 terminated at 46ft (bmsl)		
		49												

SOIL SYMBOLS
▨ SHATTERED BEDROCK
▨ FILL
▨ PEAT / ORGANIC
▨ CLAY
▨ SILT
▨ SAND
▨ GRAVEL
▨ BOULDER
▨ SEA SHELL
▨ LMSTN
▨ GRANODIORITE
▨ SILTY CLAY
▨ SANDY CLAY
▨ GRAVELY CLAY
▨ CLAYEY SILT
▨ SANDY SILT
▨ GRAVELY SILT
▨ CLAYEY SAND
▨ SILTY SAND
▨ GRAVELY SAND
▨ CLAYEY GRAVEL
▨ SILTY GRAVEL
▨ SANDY GRAVEL

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

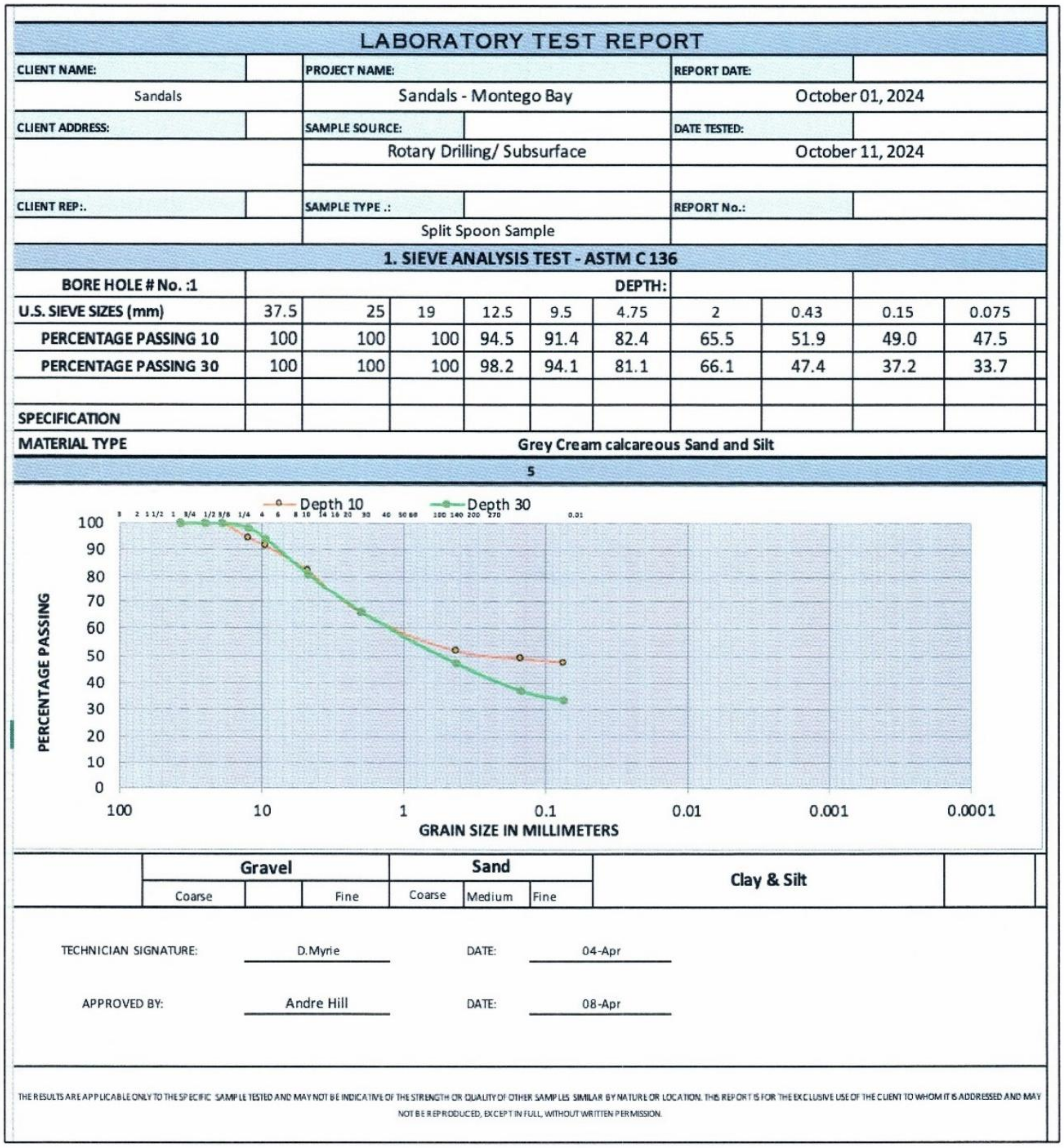
SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
GR - GRAIN SIZE DISTRIBUTION
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▼ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
Geo-Consultants Ltd.
4 Farewell Drive
Kingston 19

Appendix 3: Grain Size Distribution Analysis



LABORATORY TEST REPORT

CLIENT NAME: Sandals

PROJECT NAME: Sandals - Montego Bay

REPORT DATE: October 01, 2024

CLIENT ADDRESS:

SAMPLE SOURCE: Rotary Drilling/ Subsurface

DATE TESTED: October 11, 2024

CLIENT REP:.

SAMPLE TYPE .: Split Spoon Sample

REPORT No.:

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :1 **DEPTH:**

U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 10	100	100	100	94.5	91.4	82.4	65.5	51.9	49.0	47.5
PERCENTAGE PASSING 30	100	100	100	98.2	94.1	81.1	66.1	47.4	37.2	33.7
SPECIFICATION										

MATERIAL TYPE Grey Cream calcareous Sand and Silt

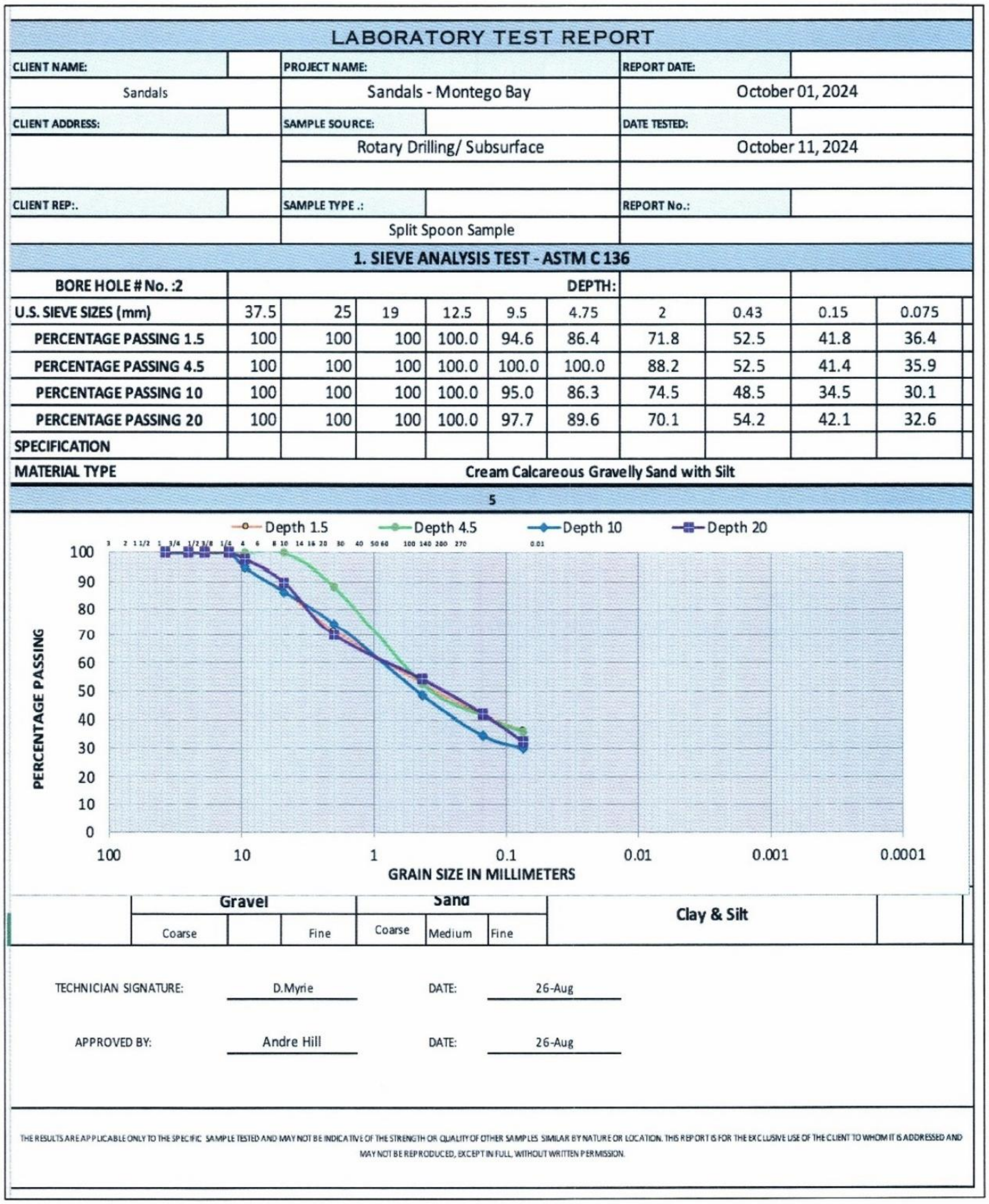
5

	Gravel			**Sand**			**Clay & Silt**
	Coarse		Fine	Coarse	Medium	Fine	

TECHNICIAN SIGNATURE: D.Myrie DATE: 04-Apr

APPROVED BY: Andre Hill DATE: 08-Apr

THE RESULTS ARE APPLICABLE ONLY TO THE SPECIFIC SAMPLE TESTED AND MAY NOT BE INDICATIVE OF THE STRENGTH OR QUALITY OF OTHER SAMPLES SIMILAR BY NATURE OR LOCATION. THIS REPORT IS FOR THE EXCLUSIVE USE OF THE CLIENT TO WHOM IT IS ADDRESSED AND MAY NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT WRITTEN PERMISSION.



LABORATORY TEST REPORT

CLIENT NAME: Sandals

PROJECT NAME: Sandals - Montego Bay

REPORT DATE: October 01, 2024

CLIENT ADDRESS:

SAMPLE SOURCE: Rotary Drilling/ Subsurface

DATE TESTED: October 11, 2024

CLIENT REP:.

SAMPLE TYPE .: Split Spoon Sample

REPORT No.:

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :2 **DEPTH:**

U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 1.5	100	100	100	100.0	94.6	86.4	71.8	52.5	41.8	36.4
PERCENTAGE PASSING 4.5	100	100	100	100.0	100.0	100.0	88.2	52.5	41.4	35.9
PERCENTAGE PASSING 10	100	100	100	100.0	95.0	86.3	74.5	48.5	34.5	30.1
PERCENTAGE PASSING 20	100	100	100	100.0	97.7	89.6	70.1	54.2	42.1	32.6
SPECIFICATION										

MATERIAL TYPE **Cream Calcareous Gravelly Sand with Silt**

5

	Gravel		Sand			Clay & Silt
	Coarse	Fine	Coarse	Medium	Fine	

TECHNICIAN SIGNATURE: D.Myrie DATE: 26-Aug

APPROVED BY: Andre Hill DATE: 26-Aug

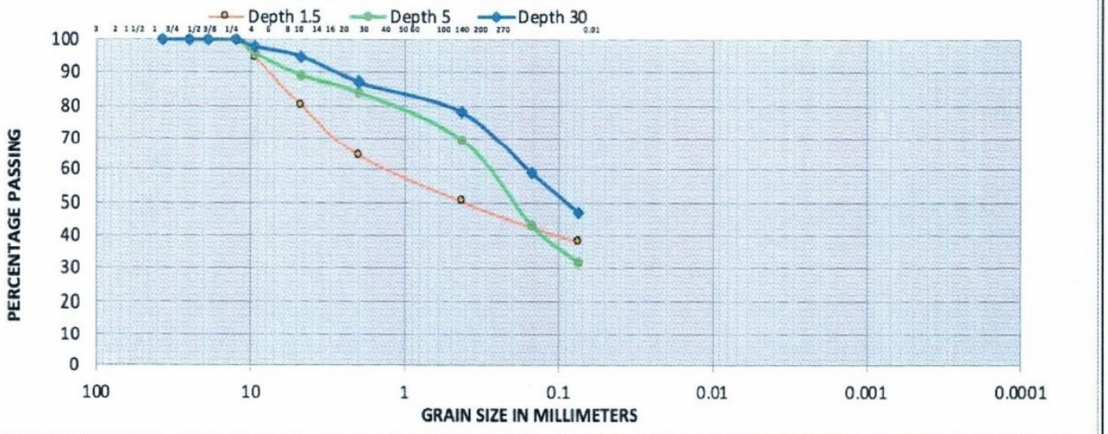
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**	
Sandals	Sandals - Montego Bay	October 01, 2024	
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**	
	Rotary Drilling/ Subsurface	October 11, 2024	
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**	
	Split Spoon Sample		

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :3					**DEPTH:**					
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 1.5	100	100	100	100.0	94.7	80.4	64.5	50.5	42.7	38.2
PERCENTAGE PASSING 5	100	100	100	100.0	95.9	89.1	84.1	69.4	43.0	31.8
PERCENTAGE PASSING 30	100	100	100	100.0	97.8	94.9	87.2	78.1	59.0	47.1
SPECIFICATION										
MATERIAL TYPE	**Cream Calcareous Sand with Silt and trace of Gravel**									

5



	Gravel			**Sand**			**Clay & Silt**
	Coarse		Fine	Coarse	Medium	Fine	

TECHNICIAN SIGNATURE: D.Myrie DATE: 26-Aug

APPROVED BY: Andre Hill DATE: 26-Aug

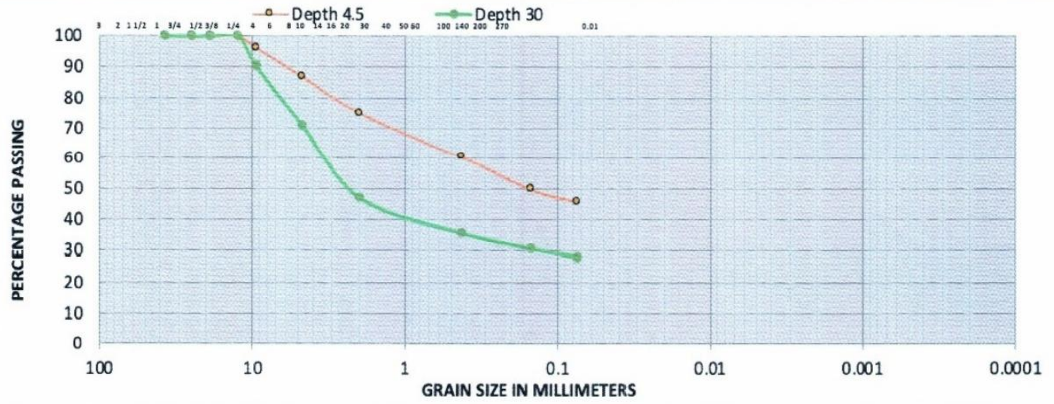
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
Sandals	Sandals - Montego Bay	October 01, 2024
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
	Rotary Drilling/ Subsurface	October 11, 2024
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :4					**DEPTH:**					
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 4.5	100	100	100	100.0	96.2	87.0	75.1	60.7	49.8	45.6
PERCENTAGE PASSING 30	100	100	100	100.0	90.4	71.2	47.0	35.7	30.8	28.1
SPECIFICATION										
MATERIAL TYPE	Grey Cream calcareous Sandy Gravel with Silt									

5



	Gravel			Sand			Clay & Silt
	Coarse		Fine	Coarse	Medium	Fine	

TECHNICIAN SIGNATURE: D.Myrie DATE: 04-Apr

APPROVED BY: Andre Hill DATE: 08-Apr

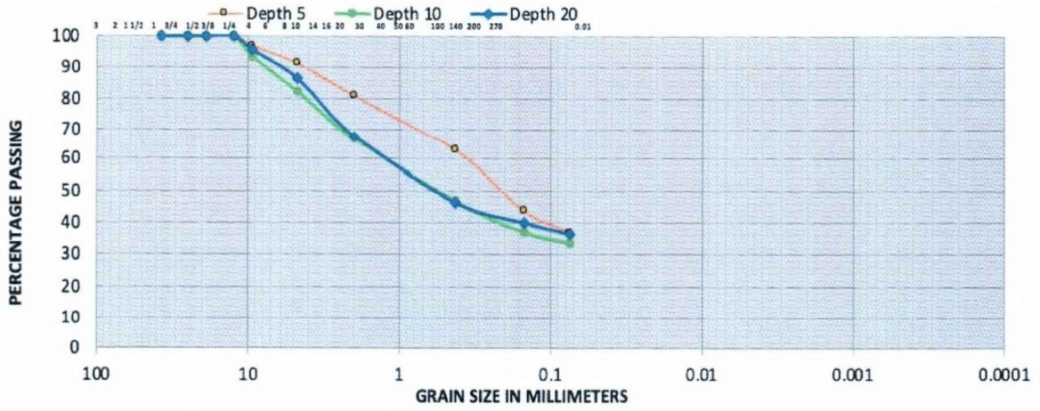
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**	
Sandals	Sandals - Montego Bay	October 01, 2024	
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**	
	Rotary Drilling/ Subsurface	October 11, 2024	
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**	
	Split Spoon Sample		

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :5						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 5	100	100	100	100.0	97.0	91.4	80.8	63.0	43.7	36.9
PERCENTAGE PASSING 10	100	100	100	100.0	93.7	82.3	66.8	46.8	37.1	33.7
PERCENTAGE PASSING 20	100	100	100	100.0	95.8	86.5	67.6	46.4	40.0	36.5
SPECIFICATION										
MATERIAL TYPE	Cream Calcareous Sand with Silt and trace of Gravel									

5



	Gravel			**Sand**			**Clay & Silt**	
	Coarse		Fine	Coarse	Medium	Fine		

TECHNICIAN SIGNATURE: D.Myrie DATE: 26-Aug

APPROVED BY: Andre Hill DATE: 26-Aug

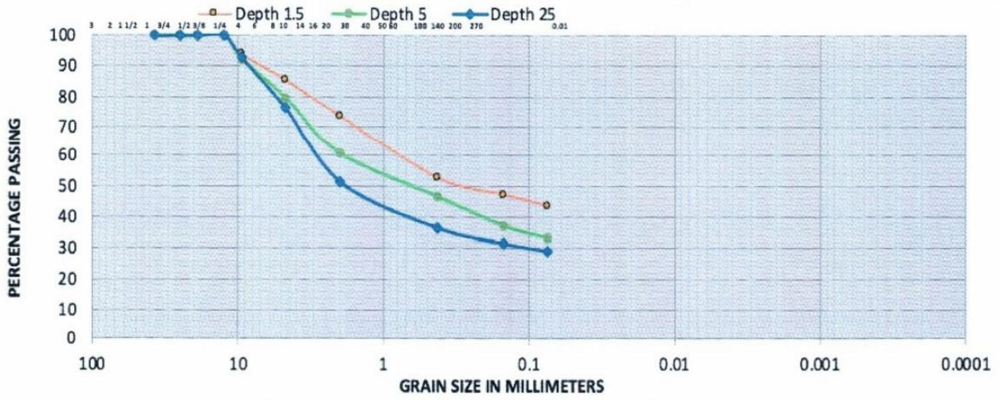
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
Sandals	Sandals - Montego Bay	October 01, 2024
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
	Rotary Drilling/ Subsurface	October 11, 2024
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :6						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 1.5	100	100	100	100.0	94.0	85.6	73.6	52.8	47.2	43.6
PERCENTAGE PASSING 5	100	100	100	100.0	92.3	79.7	60.7	46.6	37.2	33.2
PERCENTAGE PASSING 25	100	100	100	100.0	92.8	76.4	51.3	36.5	31.5	29.0
SPECIFICATION										
MATERIAL TYPE	**Cream Calcareous Sand with Silt and trace of Gravel**									

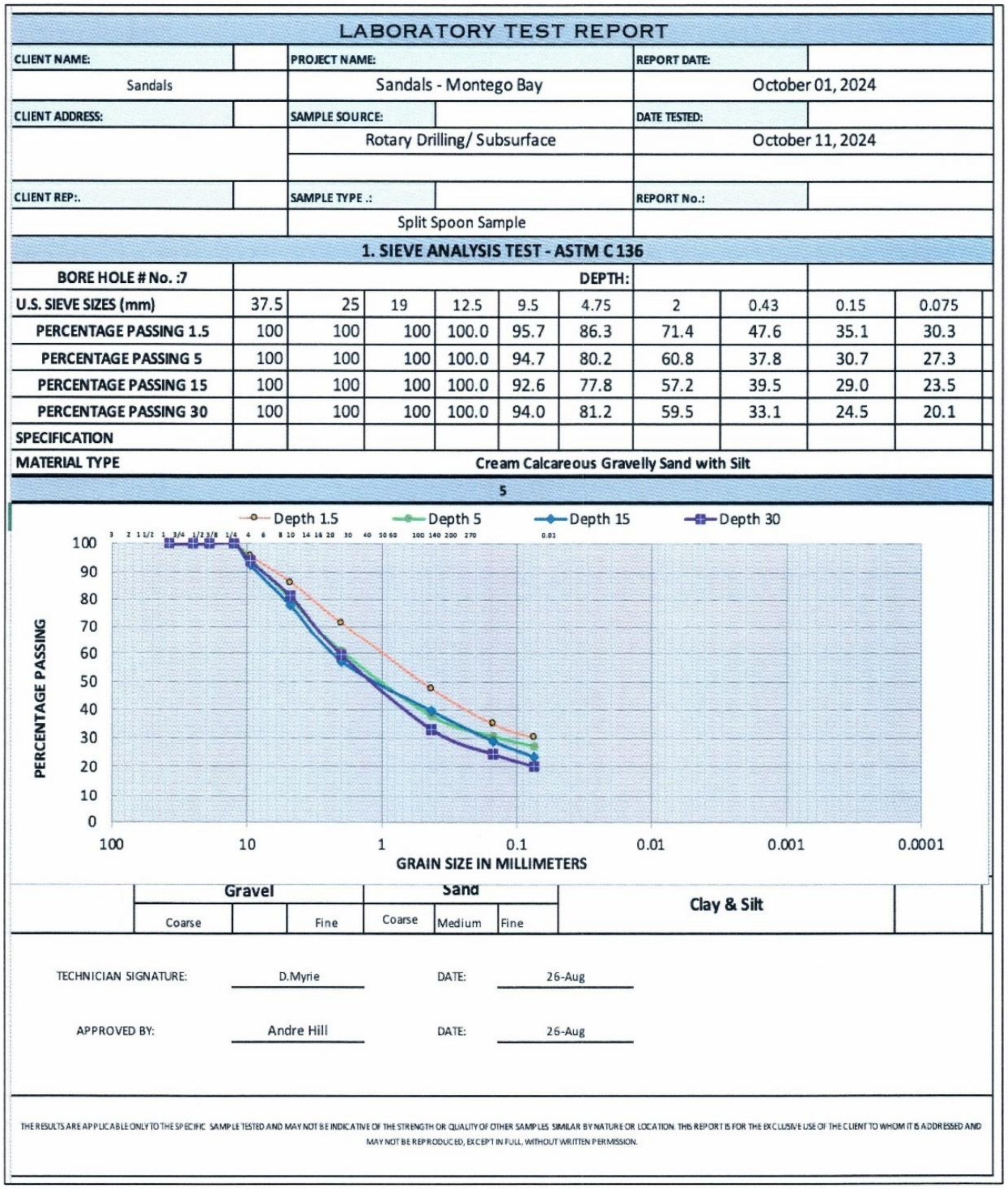
5



Gravel			Sand			Clay & Silt
Coarse		Fine	Coarse	Medium	Fine	

TECHNICIAN SIGNATURE: D.Myrie DATE: 26-Aug

APPROVED BY: Andre Hill DATE: 26-Aug



LABORATORY TEST REPORT

CLIENT NAME: Sandals

PROJECT NAME: Sandals - Montego Bay

REPORT DATE: October 01, 2024

CLIENT ADDRESS:

SAMPLE SOURCE: Rotary Drilling/ Subsurface

DATE TESTED: October 11, 2024

CLIENT REP:.

SAMPLE TYPE .: Split Spoon Sample

REPORT No.:

1. SIEVE ANALYSIS TEST - ASTM C136

BORE HOLE # No. :7						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 1.5	100	100	100	100.0	95.7	86.3	71.4	47.6	35.1	30.3
PERCENTAGE PASSING 5	100	100	100	100.0	94.7	80.2	60.8	37.8	30.7	27.3
PERCENTAGE PASSING 15	100	100	100	100.0	92.6	77.8	57.2	39.5	29.0	23.5
PERCENTAGE PASSING 30	100	100	100	100.0	94.0	81.2	59.5	33.1	24.5	20.1
SPECIFICATION										
MATERIAL TYPE					**Cream Calcareous Gravelly Sand with Silt**					

5

TECHNICIAN SIGNATURE: D.Myrie DATE: 26-Aug

APPROVED BY: Andre Hill DATE: 26-Aug

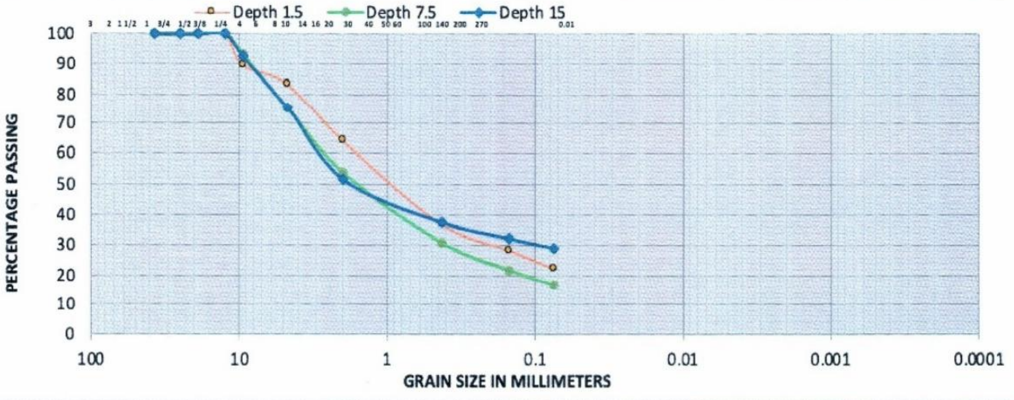
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
Sandals	Sandals - Montego Bay	October 01, 2024
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
	Rotary Drilling/ Subsurface	October 11, 2024
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :8						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 1.5	100	100	100	100.0	89.7	83.4	64.3	37.0	28.4	22.3
PERCENTAGE PASSING 7.5	100	100	100	100.0	93.3	75.1	53.7	30.8	21.7	16.6
PERCENTAGE PASSING 15	100	100	100	100.0	92.6	75.4	51.5	37.5	32.1	29.0
SPECIFICATION										
MATERIAL TYPE	**Cream Calcareous Sand with Silt and trace of Gravel**									

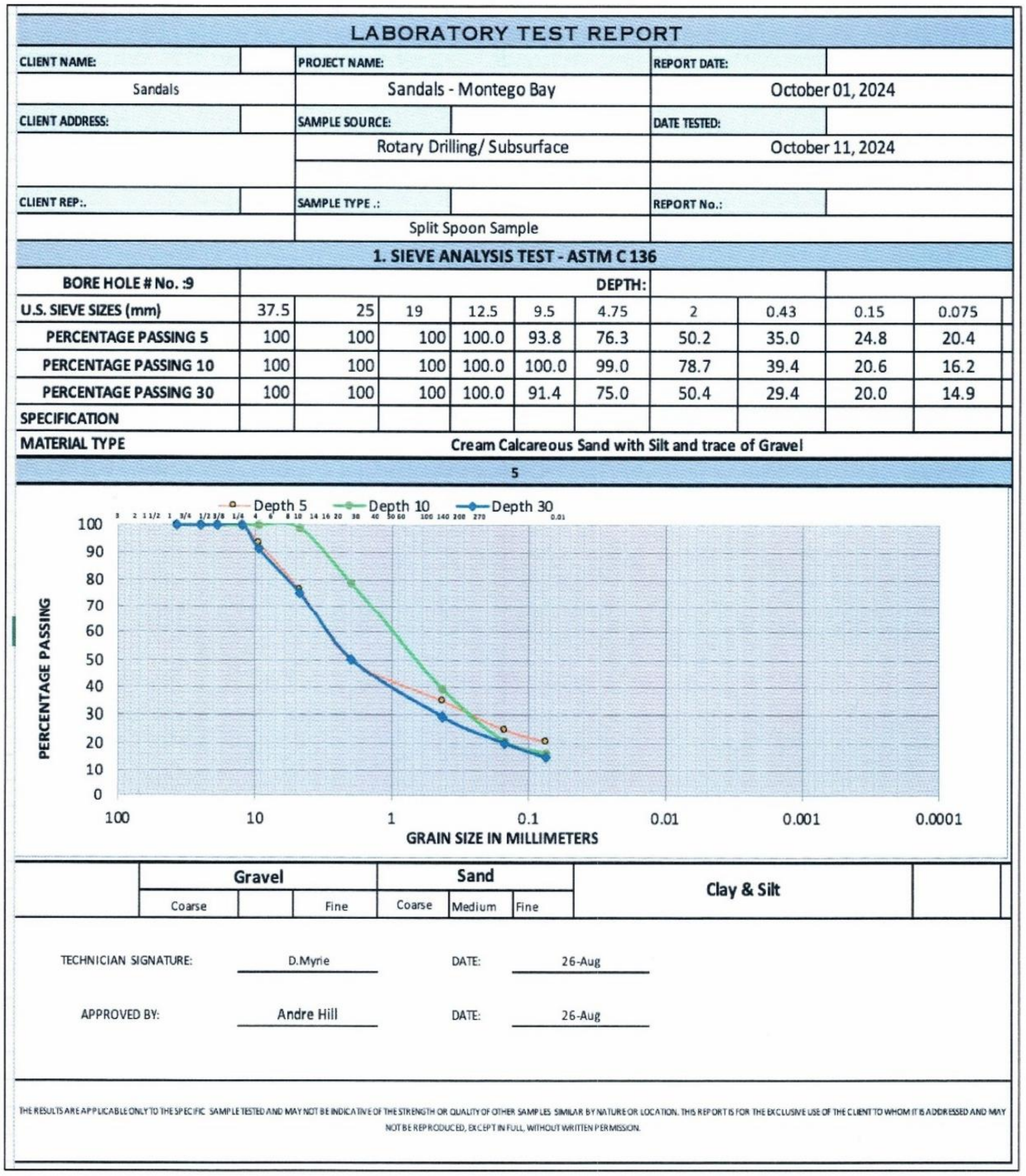
5



Gravel		**Sand**			**Clay & Silt**
Coarse	Fine	Coarse	Medium	Fine	

TECHNICIAN SIGNATURE: D.Myrie DATE: 26-Aug

APPROVED BY: Andre Hill DATE: 26-Aug



LABORATORY TEST REPORT

CLIENT NAME: Sandals

PROJECT NAME: Sandals - Montego Bay

REPORT DATE: October 01, 2024

CLIENT ADDRESS:

SAMPLE SOURCE: Rotary Drilling/ Subsurface

DATE TESTED: October 11, 2024

CLIENT REP:.

SAMPLE TYPE .: Split Spoon Sample

REPORT No.:

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :9						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 5	100	100	100	100.0	93.8	76.3	50.2	35.0	24.8	20.4
PERCENTAGE PASSING 10	100	100	100	100.0	100.0	99.0	78.7	39.4	20.6	16.2
PERCENTAGE PASSING 30	100	100	100	100.0	91.4	75.0	50.4	29.4	20.0	14.9
SPECIFICATION										
MATERIAL TYPE	Cream Calcareous Sand with Silt and trace of Gravel									

5

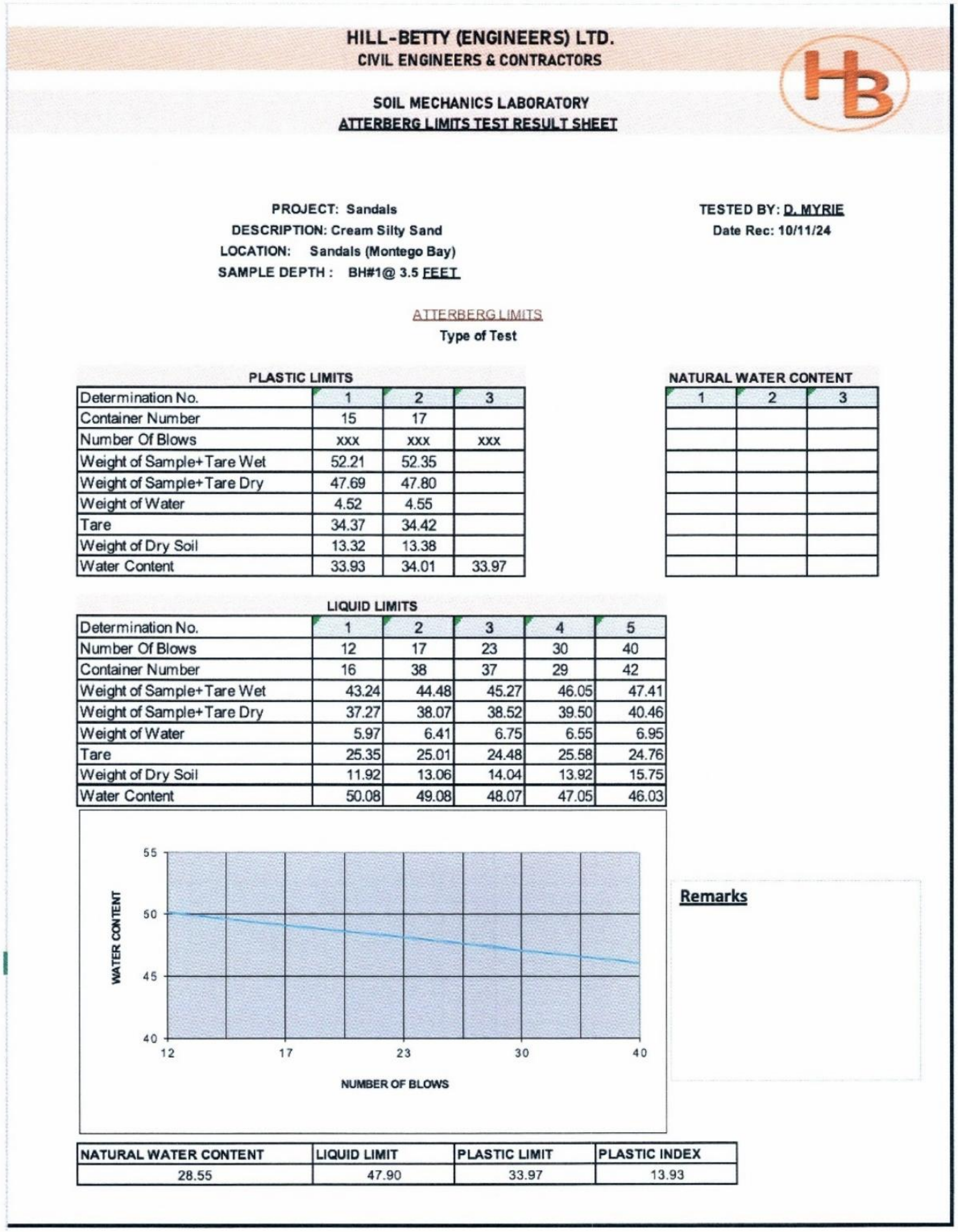
	Gravel			**Sand**			**Clay & Silt**
	Coarse		Fine	Coarse	Medium	Fine	

TECHNICIAN SIGNATURE: D.Myrie DATE: 26-Aug

APPROVED BY: Andre Hill DATE: 26-Aug

THE RESULTS ARE APPLICABLE ONLY TO THE SPECIFIC SAMPLE TESTED AND MAY NOT BE INDICATIVE OF THE STRENGTH OR QUALITY OF OTHER SAMPLES SIMILAR BY NATURE OR LOCATION. THIS REPORT IS FOR THE EXCLUSIVE USE OF THE CLIENT TO WHOM IT IS ADDRESSED AND MAY NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT WRITTEN PERMISSION.

Appendix 4: Atterberg Limits Test Results



HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Sandals
DESCRIPTION: Cream Silty Sand
LOCATION: Sandals (Montego Bay)
SAMPLE DEPTH : BH#1@ 3.5 FEET

TESTED BY: D. MYRIE
Date Rec: 10/11/24

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

Determination No.	1	2	3
Container Number	15	17	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	52.21	52.35	
Weight of Sample+Tare Dry	47.69	47.80	
Weight of Water	4.52	4.55	
Tare	34.37	34.42	
Weight of Dry Soil	13.32	13.38	
Water Content	33.93	34.01	33.97

NATURAL WATER CONTENT

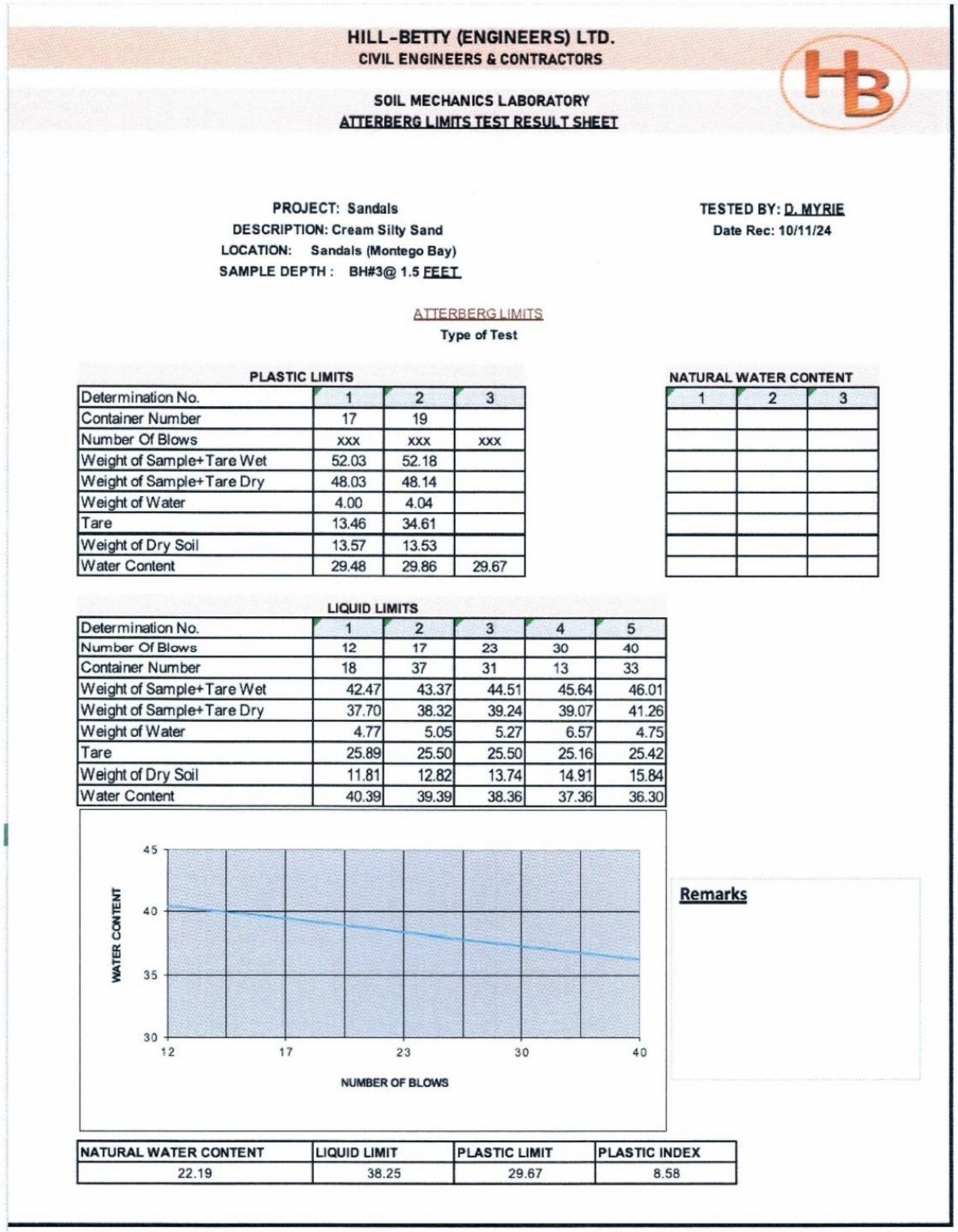
1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	16	38	37	29	42
Weight of Sample+Tare Wet	43.24	44.48	45.27	46.05	47.41
Weight of Sample+Tare Dry	37.27	38.07	38.52	39.50	40.46
Weight of Water	5.97	6.41	6.75	6.55	6.95
Tare	25.35	25.01	24.48	25.58	24.76
Weight of Dry Soil	11.92	13.06	14.04	13.92	15.75
Water Content	50.08	49.08	48.07	47.05	46.03

Remarks

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
28.55	47.90	33.97	13.93



HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Sandals
DESCRIPTION: Cream Silty Sand
LOCATION: Sandals (Montego Bay)
SAMPLE DEPTH : BH#3@ 1.5 FEET

TESTED BY: D. MYRIE
Date Rec: 10/11/24

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

Determination No.	1	2	3
Container Number	17	19	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	52.03	52.18	
Weight of Sample+Tare Dry	48.03	48.14	
Weight of Water	4.00	4.04	
Tare	13.46	34.61	
Weight of Dry Soil	13.57	13.53	
Water Content	29.48	29.86	29.67

NATURAL WATER CONTENT

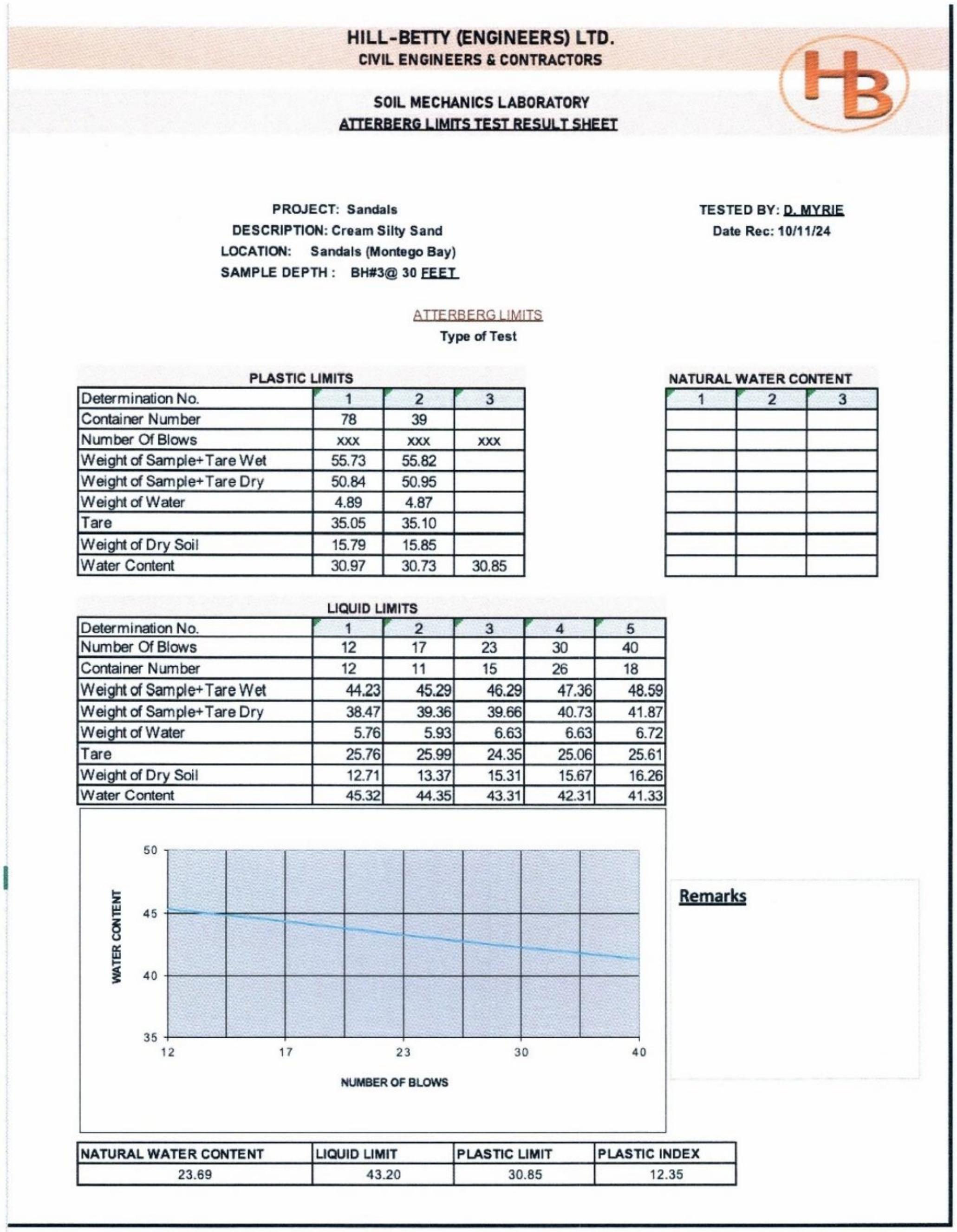
1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	18	37	31	13	33
Weight of Sample+Tare Wet	42.47	43.37	44.51	45.64	46.01
Weight of Sample+Tare Dry	37.70	38.32	39.24	39.07	41.26
Weight of Water	4.77	5.05	5.27	6.57	4.75
Tare	25.89	25.50	25.50	25.16	25.42
Weight of Dry Soil	11.81	12.82	13.74	14.91	15.84
Water Content	40.39	39.39	38.36	37.36	36.30

Remarks

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
22.19	38.25	29.67	8.58



HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Sandals
DESCRIPTION: Cream Silty Sand
LOCATION: Sandals (Montego Bay)
SAMPLE DEPTH : BH#3@ 30 FEET

TESTED BY: D. MYRIE
Date Rec: 10/11/24

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

Determination No.	1	2	3
Container Number	78	39	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	55.73	55.82	
Weight of Sample+Tare Dry	50.84	50.95	
Weight of Water	4.89	4.87	
Tare	35.05	35.10	
Weight of Dry Soil	15.79	15.85	
Water Content	30.97	30.73	30.85

NATURAL WATER CONTENT

1	2	3

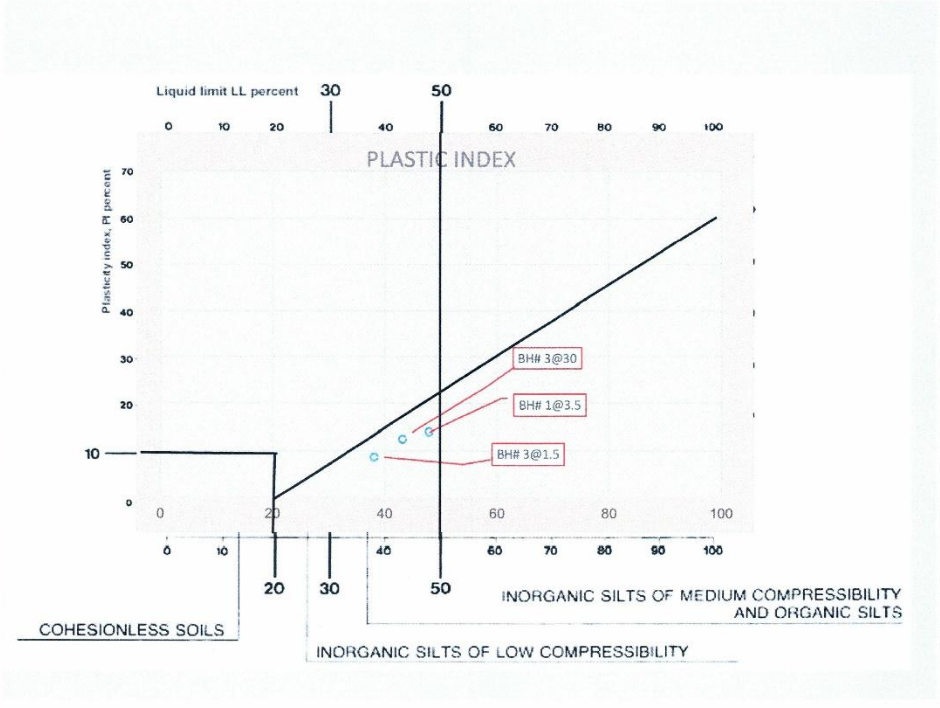
LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	12	11	15	26	18
Weight of Sample+Tare Wet	44.23	45.29	46.29	47.36	48.59
Weight of Sample+Tare Dry	38.47	39.36	39.66	40.73	41.87
Weight of Water	5.76	5.93	6.63	6.63	6.72
Tare	25.76	25.99	24.35	25.06	25.61
Weight of Dry Soil	12.71	13.37	15.31	15.67	16.26
Water Content	45.32	44.35	43.31	42.31	41.33

Remarks

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
23.69	43.20	30.85	12.35

Appendix 5: Cassagrande Plasticity Chart



13.4 Appendix 4 – Natural Resource Valuation

REPORT

Ecosystem Service Valuation of Nearshore Coastal Environment of Sandals Montego Bay Hotel Expansion

Prepared by
Peter E.T. Edwards, PhD
Natural Resource Economist
for
Environmental Solutions Limited

UPDATED August 16, 2024

Table of Contents

1 Introduction

Coastal ecosystems throughout Jamaica are threatened by expanding development associated with a growing population. Human impacts can lead to decreased quality and quantity of coastal ecosystems thereby resulting in a reduction in their ability to provide valuable ecosystem services such as climate regulation, water purification, flood control, and recreational opportunities. Coastal ecosystems including seagrass beds and mangrove forests provide essential ecosystem services like water filtration, carbon storage, wildlife habitat, recreational opportunities and scenic beauty.

The benefits of ecosystem services are similar to the economic benefits typically valued in the economy, such as the services of skilled workers, buildings and infrastructure. When ecosystem services are lost, economic impacts can be measured in terms of job loss, infrastructure cost, restoration cost and loss of property due to storm events (such as flooding). Healthy, functioning natural capital is critical to the production of ecosystem services.

Ecosystem services are those things that nature provides that are of direct benefit to humans. However, because no market exists in which to trade many of these services, it is difficult to quantify the benefits they provide. When ecosystems are valued as assets and brought into the light of economic decision-making, these cost-effective services are more likely to be retained and save citizens, private companies and other interests. In the context of this proposed development an ecosystem services framework can improve the decision-making context for the ecological and economic trade-offs being considered.

Recognizing that human pressures on ecosystems such as mangrove forests and wetlands reduce their effectiveness in providing important social and economic benefits. This may result in impacts such as the reduction of natural water filters, biodiversity loss, and loss of the ability to sequester atmospheric carbon. Given these facts, wherever possible the developer should aim to ensure that there is no net loss in ecosystem service values because of construction and other operational impacts. However, the level of these mitigation measures must be based on accurate assessments of value that are tied to the impacted area, previous level of habitat quality and ecological functionality. Establishing the appropriate monetary value of ecosystem services should be linked to that actual ecological quality and functions provided by these habitats. In this case the impacted mangrove/wetland area.

2 Categorizing Ecosystem Services

Ecosystem services can be categorized in different ways. The Millennium Ecosystem Assessment (MEA 2005) describes 23 categories of ecosystem services. For the purpose of this report we will discuss some of the services typically found in the Jamaican coastline in four functional groups: Regulating Services, Habitat Services, Provisioning Services and Information/Cultural Services. This approach is consistent with the MEA, as well as much of the scientific and economic literature. The four categories of ecosystem services are described below.

- Provisioning services - provide basic goods including food, water and materials. Forests grow trees that can be used for lumber, harvesting forest products such as honey and medicinal plants. Coral reefs are a source of fish and shellfish and other products.
- Regulating services are benefits obtained from the natural control of ecosystem processes. Intact ecosystems provide regulation of climate, water, soil, floods and storms.
- Habitat services - provide refuge and reproduction (nursery) habitat to wild plants and animals and thereby contribute to the (*in situ*) conservation of biological and genetic diversity.
- Information/Cultural services - provide humans with meaningful interaction with nature. These services include aesthetic, spiritual, recreational, educational and cultural values derived from important species, natural areas, places and experiences. Coastal tourism is a by-product of this type of ecosystem service.

Some of these services can be described in the context of economic value. It is not always easy but this report will discuss ways to describe ecosystem service benefit streams sometimes in terms of monetary values. By describing ecosystem service benefits in this manner it is hoped that this can contribute to improved natural resource policy and decision making.

3 Comparison of proposed development site from 2018 and 2022

Taking into consideration the status quo of the impacted area, relative habitat quality and related level of ecosystem services, the estimates of value are recalculated using standardized approaches and relevant ecological weighting that accurately reflects the economic value of the impacted area. These are discussed in later sections of this report.

Figure 1: Proposed Project Area in 2018, showing project area footprint (blue polygon)

Figure 2 Proposed development site in 2022, showing project area footprint (blue polygon)

4 Coastal Ecosystem Services

Coastal ecosystems have particular ecosystem services of interest. Of course the level at which these ecosystems are able to perform their roles depends on the type, condition, extent and threats to same. Some of the ecosystem services of mangroves seagrasses and coral reefs include;

- Surface water detention; (mangroves)
- Nutrient transformation; (mangroves, seagrass)
- Sediment and other particulate retention; (mangroves, seagrass, coral reefs)
- Coastal storm surge detention; (mangroves, seagrass, coral reefs)
- Shoreline stabilization; (mangroves, seagrass, coral reefs)
- Provision of fish and other shellfish habitat; (mangroves, seagrass, coral reefs)
- Provision of waterfowl and other water-bird habitat; (mangroves, seagrass)
- Provision of other wildlife habitat; (mangroves, seagrass, coral reefs)
- Conservation of biodiversity; (mangroves, seagrass, coral reefs)

- Carbon sequestration (mangroves, seagrass)

For the purposes of economic value, we typically correlate these functions with coastal ecosystem services, which can be measured in terms that are more meaningful to people. For example, water purification services defined in terms of drinking water quality, however, may be more readily understood, and valued in terms of treatment costs. In addition to these services that are more directly linked to coastal ecosystem functions, they may also provide cultural and aesthetic values for humans. The adapted table below also illustrates this concept.

Table 1 Typical Coastal Ecosystem Services

Coastal Ecosystem Function	Associated Ecosystem Services
Surface water detention	Flood control
Nutrient transformation	Water quality improvements
Sediment and other particulate retention	Water quality improvements
Coastal storm surge detention	Storm protection
Shoreline stabilization	Storm protection
Fish/shellfish habitat	Commercial & recreational fishing and shellfish harvesting (Provisioning & Cultural services)
Waterfowl/waterbird habitat	Hunting, Wildlife viewing (Provisioning & Cultural)
Wildlife habitat	Wildlife viewing (Cultural services)
Conservation of biodiversity	Cultural services/existence value of biodiversity
Carbon storage and sequestration	Regulatory Services/ Climate stability

Table adapted using the Millennium Ecosystem Assessment framework. MEA (2005)

We can explore in more detail some of the functions and associated benefits provided by the three key coastal ecosystems at the site. These benefits include:

- Water quality improvement: mangroves and seagrasses can change water chemistry, removing pollutants such as nitrogen and phosphorus, and increasing water clarity. Multiple benefits of water quality improvements to humans include drinking water supply, improved conditions for fishing and other water-based recreation, and aesthetic values.
- Flood mitigation: intact mangrove forests act as sponges, capturing overflow from flooded rivers and streams. As with coastal protection, the costs of flooding may be valued in terms of increased damages, or associated decreased property values.
- Coastal protection: Recent studies on tsunami and hurricane events have demonstrated the importance of coral reefs and mangrove forests in attenuating coastal storm surges. By detaining storm related surges along the coast, this may decrease the extent of damage associated with flooding to infrastructure or other land uses.
- Wildlife protection: coastal ecosystems are important for wildlife in directly providing habitat for species (for example, for breeding, nesting, or feeding), and by supporting food chains through the provision of habitat for prey species. Maintaining the biodiversity of species (terrestrial and aquatic) has incidental benefits. These include contributions to human well-being such as: food, recreational opportunities (wildlife-viewing, hunting, fishing), and cultural importance. These values may be associated with individual species or with the biodiversity protected by these habitats, in general.
- Climate stability: Mangrove forests and seagrass beds are particularly important ecosystems with respect to storing carbon, accounting for around 30 percent of all organic carbon storage on the planet. In addition, wetlands are important ecosystems for sequestering carbon from the atmosphere and storing that carbon in plants, detritus, and soils. Humans benefit from this service in the form of decreased

damages associated with climate change. Coral reefs (like humans) are net contributors of carbon to the environment however their physical association with seagrasses is still important as they often create the back-reef conditions that promote seagrass and mangrove proliferation.

The value of ecosystem services provided by a particular acre of forestland depends on the quantity and quality of the ecosystem functions and services provided, and the magnitude, preferences, and demographic characteristics of the population receiving those services, typically the nearby population. In addition to timber and other marketable wood products, coastal forests provide essential ecosystem services like water filtration, carbon storage, wildlife habitat, recreational opportunities and scenic beauty. The loss of these services can lead to risks to human health, accelerated climate change, increased watershed disruption, loss of water quality, and loss of biodiversity. However, because no market exists in which to trade many of these services, landowners have little incentive to consider their value when making land use decisions. Recently, market-based mechanisms (such as the carbon registry or nutrient trading programs) have been proposed and/or designed in order to provide the landowner with greater incentives to leave land in forest production. However, the value of these other ecosystem services is difficult to quantify, even if the physical nature of the service is well understood. This report attempts to highlight a few main ecosystem services found at the site, identify some value streams and provide some context for making decisions about mitigation approaches.

5 Ecosystem Service Values at the Site

Demonstrating value in economic terms is useful for policy and decision-making, particularly with respect to determining the costs and benefits of the use of an ecosystem. This is in contrast to only considering the cost or values that enter traditional markets in the form of private goods. It is important to emphasise here that valuation of natural systems is best applied for assessing the consequences of changes resulting from alternative management options rather than what is often attempted, the estimation of the total value of ecosystems.

5.1 Mangroves, Seagrass Beds and Coral Reefs: Economic Values

5.1.1 Mangrove Biodiversity Values

The empirical studies conducted on wetland valuation vary widely in their use of valuation techniques, the actual products and services being valued, and the type and geographical location of the wetlands being considered. However, in the case of wetland valuation, a standardized shadow price can be analyzed, such as the dollar value per year of 1 ha of wetland area (Brander et al, 2006). The economic values associated with wetland goods and services can be categorized into distinct components of the total economic value according to the type of use. Direct use values are derived from the uses made of a wetland's resources and services, for example wood for energy or building, water for irrigation and the natural environment for recreation. Indirect use values are associated with the indirect services provided by a wetland's natural functions, such as storm protection or nutrient retention. Non-use values of wetlands are unrelated to any direct, indirect or future use, but rather reflect the economic value that can be attached to the mere existence of a wetland (Pearce and Turner 1990). In addition to market and non-market valuation approaches other value streams exist such as the value per tonne of carbon sequestered and stored (social cost of carbon).

Using values from Brander *et al.* (2006) the most significant ecosystem service associated with coastal wetlands is biodiversity. Biodiversity services of wetlands are valued at US$17,000 per hectare per annum (ha^{-1} yr^{-1}). Other valuable services were water quality, recreational fishing, flood protection and amenity values. It is important to note however that directly transferring the values from one study area to another site must be done with caution. The Brander *et al* study used a global data set and accounts for some geographic and socio-economic differences. Brander's study showed highest values for wetlands in Europe and lowest for South America, (where Jamaica was grouped). The value per hectare reported must be understood within this context. Notwithstanding the lower valuation, there is clear evidence that the coastal wetlands of the north coast of Jamaica provide services that annually contribute value.

A meta-analysis by Salem and Mercer (2012) indicated that mangroves exhibit decreasing returns to scale, that GDP per capita has a positive effect on mangrove values and that using the replacement cost and contingent valuation methods produce higher estimates than do others. Their global meta-analysis showed median estimates of value for mangrove related ecosystem services. Table 2 below shows the range of median values.

Table 2 Summary statistics for mangrove valuations by type of ecosystem services

Service	**Observations**	**Median Value in US$ ha−1·yr−1).**
Fisheries	51	627
Forestry	35	576
Coastal protection	29	3,604
Recreation & tourism	14	1,079
Nutrient retention	1	-
Carbon sequestration	7	211
Nonuse	6	15,212
Biodiversity	1	-
Water and air purification/ waste assimilation	4	5,801
Traditional uses	1	-
Total	149	

(Adapted from Salem and Mercer 2012)

Comparing these studies shows some disparities in value given context and approach. Brander *et al.* (2006) showed that the most significant ecosystem service associated with coastal wetlands is biodiversity. Biodiversity services of wetlands are valued at US$17,000 per hectare per annum (ha^{-1} yr^{-1}). Other valuable services were water quality, recreational fishing, flood protection and amenity values. This large average value is however driven by valuation approaches that capture existence and intrinsic values associated with “biodiversity” which is by nature difficult for lay persons to put in a monetary context

It is important to note however that directly transferring the values from one study to a particular study site must be done with caution. The Brander *et al* study used a global data set and accounts for some geographic and socio-economic differences. However, the more recent meta-analysis by Salem and Mercer showed a mean of US $52 per US$ $ha^{-1} \cdot yr^{-1}$. These values must therefore be considered in the context they were valued and as such cannot be used as a one-to-one value transfer. For the Jamaican context and more specifically this project site, these estimates should be used as a bound within which to have a cogent discussion based on the functionality of the existing ecosystem, and likely mitigation requirements to be fulfilled by the project developers.

5.1.2 Mangrove and Seagrass Carbon Values

Coastal ecosystems such as mangrove forests and submerged aquatic vegetation (seagrass) have the potential to capture and store atmospheric carbon, both in their biomass and more importantly in the surrounding soils. Their contribution to the overall economic value at the site should also be considered. Carbon values should be included in the consideration of trade-offs. In fact, in many instances a significant portion of the value is derived from the carbon sequestration benefits of a fully functional mangrove wetland. The amount of Carbon that is stored within tidally influenced coastal vegetation can be used to improve the cost benefit analysis between different mitigation approaches. IPCC Guidelines can be used to guide estimates of Carbon value. The IPCC document identifies and reports on six land use categories: Forest Land (FL), Cropland (CL), Grassland (GL), Wetland (WL), Settlements (SL) and Other Land (OL).

The SCC is a concept that reflects the marginal external costs of emissions: it represents the monetized damage caused by each additional unit of carbon dioxide, or the carbon equivalent of another greenhouse gas, emitted into the atmosphere (Kotchen 2017). In more technical terms, the social cost of carbon is defined as the incremental impact of emitting an additional ton of carbon dioxide, or the benefit of slightly reducing emissions. It is usually estimated as the net present value of climate change impacts over the next 50-100 years (or longer) of one additional tonne of carbon emitted to the atmosphere today. This estimate reflects the marginal economic effects of CO_2 emissions and derives from multiple studies researching the welfare effects of climate change in terms of crop damage, coastal protection costs, land value changes, and human health effects (Tol, 2009). To calculate the social cost of carbon, the atmospheric residence time of carbon dioxide must be estimated, along with an estimate of the impacts of climate change. The impact of the extra tonne of carbon dioxide in the atmosphere must then be converted to the equivalent impacts when the tonne of carbon dioxide was emitted. In economics, comparing impacts over time requires a discount rate. This rate determines the weight placed on impacts occurring at different times.

There is a wide range of estimates of the value of carbon stored by wetlands, typically presented as a value per metric ton of carbon ($/tC). For the purposes of this report the IPCC recommended median value of $48/tC (~$12 /tCO_2) is used. This is the SCC price estimated for Latin America and the Caribbean region (Kotchen et al 2014). An amount of CO_2 pollution is measured by the weight (mass) of the pollution. Sometimes this is measured directly as the weight of the carbon dioxide molecules. This is called a tonne of carbon dioxide and is abbreviated "tCO_2". Alternatively, the pollution's weight can be measured by adding up only the weight of the carbon atoms in the pollution, ignoring the oxygen atoms. This is called a tonne of carbon and is abbreviated "tC". Estimates of the dollar cost of carbon dioxide pollution is given per tonne, either carbon, $X/tC, or carbon dioxide, $X/$tCO_2$. One tC is equivalent to 3.67 (44/12) tCO_2 (Edwards, 2019).

The approach described above was used to estimate the stock of carbon per tonne per annum (tCO_2 yr^{-1}) at the impacted areas (seagrass, groyne and wetland) at the site and following the examples above, calculate the estimated monetary value of these carbon services for the stock of stored carbon and carbon removed from the atmosphere per annum. These are usually reported as the Net Present Value (NPV) of annually sequestering carbon at the rate estimated over a given time frame (25-100 years). The tier 1 assessment of a carbon stock within a project area is achieved by multiplying the area of an ecosystem by the mean carbon stock for that ecosystem type. The mean value of 386 MgC Ha^{-1} for Mangroves and 241 MgC Ha^{-1} for seagrasses are multiplied by the respective site areas to provide estimates of carbon stock (Edwards 2019, World Bank 2019).

Please note that these values are based on the assumption of a fully functional, coastal ecosystem. The impacted state of the mangrove at the site, should be taken into consideration given the likely reduced ecological functionality of the site.

The basic calculations are as follows:

*Mean Carbon (MgC Ha^{-1}) * Area (Ha) = Mg (or T) of Blue Carbon in Study Site*

*Total Potential CO2 emissions per hectare (MgCO$_2$ Ha-1) = Mg C * 3.67*

*Carbon sequestration value = MgC * X$/MgC = X$*

The tables below (Table 3 to Table 5) show the calculation of Annual and (more importantly) Net Present Value (NPV) of annually sequestering carbon for a 25-year time frame. The sensitivity analysis of NPV compares discount rates ranging from 1% to 10%. Please note that the typical discount rates used for hotel and similar infrastructure development is 7-12%. These estimates are based on the Kotchen (2017) value of US$48 per tonne of Carbon. Using a social cost of carbon (SCC) of US$48 T^{-1} C the values of annual sequestration for the impacted site were estimated. The annual estimates can also be compared to the values estimated by Brander et al (2006) and Salen et al 2012.

Table 3 Annual values of sequestered carbon at the impacted site

Average Carbon Stock (MgC Ha^{-1})	**241**	**241**	**386**
	Overwater	**Groynes**	**Wetland**
Area (Ha)	**2.5**	**1.5**	**3**
Average Carbon Stock (MgC Ha^{-1})	604.5	361.5	1,158
Annual Value of Sequestered Carbon at impacted site			
Estimated Price T^{-1} C			
Market Rate - US$10	$6,045	$3,615	$11,580
Social Cost of Carbon (US$48)	$29,017	$17,352	$55,584

Table 4 25 Year Net Present Value (NPV) of annual C sequestration - Carbon Price

Carbon Market Rate (US$10 T^{-1}C)			
Discount Rates	**Overwater**	**Groynes**	**Wetland**
1%	$133,134.40	$79,613.71	$255,028.14
3%	$105,265.97	$62,948.53	$201,644.25
5%	$85,200.73	$50,949.61	$163,207.88
6%	$77,277.96	$46,211.83	$148,031.26
7%	**$70,448.25**	**$42,127.70**	**$134,948.49**
10%	$54,872.53	$32,813.50	$105,112.12

Table 5 25 Year Net Present Value (NPV) of annual C sequestration – Social Cost of Carbon

Social Cost of Carbon (US$48 T^{-1}C)			
Discount Rates	**Overwater**	**Groynes**	**Wetland**
1%	$639,045.11	$382,145.80	$1,224,135.09
3%	$505,276.68	$433,794.36	$1,389,581.94
5%	$408,963.48	$433,794.36	$1,389,581.94
6%	$370,934.18	$221,816.80	$710,550.07
7%	**$338,151.60**	**$433,794.36**	**$1,389,581.94**
10%	$263,388.14	$433,794.36	$1,389,581.94

Net Present Values were calculated for a 25-year time span. A sensitivity analysis using 6 different discount rates showed a range estimated values for keeping carbon sequestered. Value estimates are influenced by the choice of discount rate. Two Carbon Prices are used for comparison. The first, an average current market price of US $10 per Metric Ton of Carbon and the second, the Social Cost of Carbon (adjusted for the Latin America and Caribbean Region) of $48 T^{-1}C. It should be noted that the SCC represents the avoided costs to society of not releasing this stored carbon to the atmosphere. A typical range of discount rates for development projects such as this one is between 7-12%.

5.2 Nearshore Ecosystem Values (Wetlands and Seagrasses)

Mangrove fisheries benefits are typically derived from two key ecological mechanisms. The first, is the high level of primary productivity from the mangrove trees and from other producers in the mangrove environment that support secondary consumers. This high level of primary productivity forms the basis of food chains that support a range of commercially important species. The second is the physical structure (habitat) that they provide, creating attachment points for species that need a hard substrate to grow on, as well as shelter from predation and the physical environment. These two mechanisms combine to make mangroves and seagrasses particularly effective as nursery grounds for juveniles of species that later move offshore or to adjacent habitats such as coral reefs (Hutchinson et al 2014).
In addition to nursery services, these coastal ecosystems also support commercial harvest of fin and shellfish species. These include mullets, crabs, oysters and other nearshore and estuarine species. While some species use mangroves only at certain life history stages, for example snapper may live in the mangrove as juveniles before moving to coral reefs as adults, other species live outside the mangrove but enter it at high tide to feed. This highlights the potential importance of habitat linkages in enhancing fish productivity, while also making it challenging to isolate the role of mangroves in supporting fisheries in such mixed habitat systems. Estimating the economic value of mangrove-associated fisheries is challenging, particularly at regional or global scales (Hutchinson et al 2014). Estimation of the proportional contribution to commercial (or subsistence) fish harvest is typically very data limited. The additional challenge with these estimates is the underlying complexity and variability of the types of fisheries.

Using an approach utilized in a 2019 World Bank study (Forces of Nature) an estimated value for the fisheries benefits associated with the potentially impacted seagrass and wetland ecosystems was determined. The value transfer approach relies on linking the area of mangrove to its potential contribution to nearshore fisheries. These value transfers are based on studies that utilized a production function-based approach to derive estimates of fisheries value from mangroves. It is also dependent on objective measures of biophysical parameters that can then be tracked to corresponding changes in marketed output of the product - in this case, fish and seafood products.

The estimates of value per site outlined below (Table 6 and Table 7) are based on a review of related literature and subsequent benefit (value) transfer. There are studies with broad range estimates of mangrove-associated fisheries economic values often in excess of US$1000 per hectare per year. Based on a comparison of a variety of studies that included a range of mangrove types and fisheries, the global median value of US $77/ha/yr for (fin) fish, and US $213/ha/yr for mixed species fisheries (Hutchinson et al 2014) was used for this analysis. These median values are within the context of a wide variation value. For example, for mixed species fisheries the values ranged from $17.50 to $3,412 ha/yr. Using these median values we present value transfer estimates for the Jamaican mangrove sites.

Table 6 Estimated annual economic contribution of mangrove to small-scale mixed fisheries

	Overwater	**Groyes**	**Wetland**
Area	**2.5**	**1.5**	**3**
	$ Per Ha Per Annum		
Fin Fish ($77)	$192.50	$115.50	$231.00
Mixed Fisheries ($213)	$532.50	$319.50	$639.00

Table 7 Net Present Value of potentially impacted fisheries values

	Overwater	**Groyes**	**Wetland**
Net Present Value (7%) $ Per Ha (25 Years)			
Fin Fish ($77)	$2,250.84	$1,345.990	$2,691.98
Mixed Fisheries ($213)	$6,226.34	$3,723.32	$7,446.64

These estimates show that the economic contribution from these sites have very modest annual contributions to fisheries values. This confirms the assumption that given the small area, the ecosystems are limited in their ability to contribute more significantly to fishers' incomes. It should be noted again that the wetland area is severely impacted and does not appear to be serving as a nursery area for juvenile fish (minimal presence of red mangroves) given limited tidal inundation. Thus, economic values of coastal ecosystem such as mangroves and seagrasses should be taken in the context of the study, the method used to value, as well as the relative ecological health of the ecosystems being assessed. The estimates above provide some context within which decisions can be made about mitigating any impacts from the loss of these habitats. Noting that in many instances, the nearshore benthic ecosystems (seagrasses and wetland area) are currently severely degraded and are not providing the economic values as estimated for healthy climax communities in the tables above. For example, that the wetland area is not functioning as a classic wetland and is in fact largely ruinate and likely to be further degraded given the airport expansion project that has cut off hydrological connectivity and removed mangroves. This, underscores that valuation of these ecosystems based on health and ecological functionality at the site level, is critical.

5.3 Coral Reef Values

Coral reefs provide a diverse array of goods and services to the people and economy of Jamaica. They buffer coastlines from storms; slow erosion; provide habitat for commercial, artisanal, and sport fisheries; attract local and international tourists to the coast; and are a source of cultural and spiritual significance to many people. However, their value is often not reflected in policy and development decisions. Two examples of economic values are presented below.

Edwards (2009) conducted a non-market valuation survey of the recreational value of coral reefs and their associated ecosystems (seagrass beds and beaches). Using a contingent choice approach, an annual value of US$217 Million was estimated. The study was based on the value of the coral reefs located on the northern coast of Jamaica, in other words, those reefs that directly and indirectly support the coastal tourism product. Another study (Kushner et al 2011), examined the value of coastal protection services of coral reefs and demonstrated that, there would be a loss in economic value as a result of coral reef decline and expected beach degradation. The study also modelled the loss in economic value due to erosion; this was estimated at US$19 million for the three major tourism locations on the north coast of Jamaica (Ocho Rios, Montego Bay and Negril). The study showed that additional erosion caused by further reef degradation is estimated to increase the loss in value to US$33 million after 10 years. This represents an additional US$13.5 million loss of consumer welfare if the reef degrades further.

The relatively small coastline and patchy reef complex in this study do not support a per-unit-area coral reef valuation exercise. While the offshore reef crest does provide some ecosystem services such as coastal protection, fisheries habitat, and recreation (e.g., dive and snorkel tourism), the small coral colonies in the nearshore environment do not significantly contribute to these services. As such, attempting to estimate per-unit dollar values in this context would be theoretically inappropriate. A counterargument, however, could be made that a well-designed hybrid approach, for example, integrating groyne substrates with transplanted coral, or a "blue-grey" infrastructure model, could enhance ecosystem services and offer greater economic value than the current situation.

The studies referenced above demonstrate that there are significant values associated with coral reef and beach ecosystem services. This is particularly so for the near shore coral reef ecosystems of Jamaica's north coast given the recreational ecosystem services of reefs and their associated beaches. However the aggregate nature of these values and the different methods used to assess them are usually applicable over larger areas for example a tourism dive destination, regional or national scale (e.g. Bonaire's reefs) and as such are difficult if not impossible to extrapolate to a small unit area such as this project site.

We discuss below how establishing locally relevant values for key coastal ecosystems could be achieved. Although not easily "traded in the marketplace" it is important to consider these values when making development decisions including trade-offs. Notably, the project seeks to enhance the recreational attributes associated with the existing coastline which would effectively result in an increase in economic value of the coastal asset. Most of these benefits would accrue to the developer of this project.

6 Trade-Off Considerations for the Proposed Project

There are very few nonmarket economic valuation studies of mangroves, seagrasses and coral reefs in Jamaica and a few notable ones in the Caribbean. The most feasible valuation approach is to use the carbon value of these ecosystems as a proxy along with meta-analyses that may draw from studies outside the region. It is therefore incumbent on those using valuation information for decision making contexts to realize that values such as these may not be easily applied exactly to site specific contexts. The decision maker along with key stakeholders must take into consideration the status of existing resources, likely impacts and recommended restorative actions. The values presented in this report should be considered in this context. Primary studies to value these ecosystems are very expensive and would be better at national levels (e.g. valuation of all of Jamacia's mangroves) which may allow nationally specific per unit values that may allow for more accurate value transfer. However, given the limited data and studies, decision makers should use best judgments including applying appropriate weighting based on local or site specific contexts.

The developers of this project have proposed a number of activities that are expected to mitigate the negative impacts to the nearshore coastal ecosystems (corals, seagrasses and mangroves) from construction of the overwater structures. Firstly, the construction will negatively impact seagrass cover as a result of groyne construction, and construction of the overwater structures. The resulting conversion of seagrass areas to bare sand and silt represents a loss of ecosystem services including:

- loss of sequestered carbon
- loss of future sequestration of carbon
- decreased habitat complexity, reduced recruitment and juvenile habitat, reduced productivity
- reduced nutrient and detritus conversion rates

- reduced primary productivities
- loss of coastal protection services (wave attenuation and sediment accumulation)

However, there are proposed mitigation measures that, if implemented successfully could lead to some beneficial ecosystem services. These can also be considered a set of trade-offs, that is, some deleterious impacts compared to beneficial ecosystem improvements.

Mitigation and offsetting measures such as the replanting of seagrass beds and creation of additional wetland areas (offsite) could lead to benefits such as improved fish and shellfish nursery habitat leading to increased productivity. Increased rates of carbon sequestration through mangrove biomass would balance the loss in carbon sequestration from seagrass removal. It should be noted that a newly created wetland area with replanted mangroves will take a few years (approx. 15-20yrs) to be established and thus optimal sequestration benefits would not be achieved until such time.

Another trade-off for consideration is the conversion of seagrass beds to artificial reef structures (groynes) . The benefits being the creation of new habitat leading to increased fin fish and shellfish productivity. Other benefits could include increased (habitat and species) diversity within fishery thus building ecological and fishery resilience that can address impacts of global change.

Finally, the mitigation activity in response to the removal of live coral from the construction areas and incorporation into a bio-integrating reef structure (setting living coral to artificial reef) is another proposed activity. Some of the expected benefits from this action include: improved recruitment, improved habitat quality over time with coral growth, improved fishery diversity with habitat-specific species, improved hydrodynamic effects with growth through time, including sea level rise. Other ancillary benefits would include increased recreational activities such as snorkeling, glass bottom boat tours, and other tourism related opportunities.

7 Conclusions

This report presented a suite of potential ecosystem service values associated with the site. It presents some comparative ecosystem service values for the northern Jamaican coastal areas as well as outlines a potential approach for calculating the value of carbon storage and sequestration for mangrove and seagrasses. It should be noted that calculating a standardized per unit monetary value for small segments of the Jamaican coastline is not without challenges. Not all ecosystems are created equal and economic values are often linked to different contexts (demand, supply, quality and extent/area etc.). Instead of per unit dollar values for (corals or seagrasses) the alternative approach for examining these trade-offs should be to consider: 1) the existing suite of ecosystem service flows, 2) how they will be affected given the proposed construction activities and 3) how these flows will be restored and mitigated given ecological restoration.

The coral values and estimated fisheries values all rely on value transfer comparative approaches. These values provide additional information that can be used in a broader trade-offs decision making process including mitigation and offsets. It is theoretically and professionally inappropriate to assign per unit values to coral colonies that are demonstrable not performing services that can be reasonably valued given the small unit area. It is likely that with proper design a hybrid blue-grey infrastructure approach could result in enhancing existing ecosystem services. The developer should work with the regulatory agencies to come up with solutions that will result in enhanced services that extend over the long term. The same is true for any impacts to seagrass beds. Similarly, the former wetland area does not currently provide the level of ecosystem service of a fully functional and hydrologically connected ecosystem. This is in part due to development activities adjacent to the project site and a longer history of degradation through development and other human pressures. The economic value due to this change in use of this area should also be considered within this context.

This report demonstrates that the values of the potentially impacted coastal ecosystems associated with the overwater, groyne and wetland modifications are relatively modest, even considering a twenty-five-year net present value. Notably, the value of carbon is dependent on prevailing market conditions and presently, the market value for a ton of carbon is hovering near $10 per metric ton. Noting that the global carbon market is currently in a state of flux with mistrust due to poorly designed schemes, these potential market values should also be viewed within this larger international context, noting that Jamaica does not currently have a carbon trading market system. On the other hand, the Social Cost of Carbon represents the broader societal costs associated with carbon pollution, but these figures should not be considered in a tradeable market context.

It is incumbent on the developer to ensure that there is no net decrease in economic or ecosystem service value in addition to mitigating any reduced capacity of the ecosystem(s) to continue providing the related ecosystem services (recreation, food, biodiversity, carbon sequestration, flood and nutrient regulation etc.). The proposed mitigation activities must address the potential disturbances to the nearshore areas such as coral reefs and seagrass beds that could lead to deleterious fisheries impacts and changes to coastal sediment dynamics (erosion).

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13.5 Appendix 5 – Floral Species List (Staging and Storage Site)

	FAMILY	**GENUS**	**SPECIES**	**AUTHORITY**	**COMMON NAME**	**HABIT**	**STATUS**	**DAFOR STATUS**	**IUCN Status**	**Notes**
1	Acanthaceae	*Asystasia*	*gangetica*	(L.) T. Anderson	Chinese violet	H	Ex	F	NL	Inv
2	Acanthaceae	*Achyranthes*	*aspera var. aspera*	L.	evil's Horsewhip	H	Ex	R	NL	Med
3	Amaranthaceae	*Amarathus*	*spinosus*	L.	Wild Calaloo	H	Na	O	NL	Eco
4	Asteraceae	*Bidens*	*pilosa var. pilosa*	L.	Spanish Needle	H	Na	O	NL	Med
5	Asteraceae	*Chromolaena*	*odorata*	(L.) R. M. King & H. Rob.	Jack in the bush	H	Na	R	NL	Med
6	Asteraceae	*Cyanthillium*	*cinerum*	(L.) H. Rob.		H	Ex	O	NL	Eco
7	Asteraceae	*Flaveria*	*trinervia*	(Spreng.) C. Mohr		H	Na	O	NL	Eco
8	Asteraceae	*Lactuca*	*sativa*	L.		H	Ex	R	NL	Eco
9	Asteraceae	*Mikania*	*micrantha*	Kunth	Guaco	V	Na	O	NL	Med
10	Asteraceae	*Pluchea*	*carolinensis*	(Jacq.) G. Don	Wild tobacco	S	Na	O	LC	Med
11	Asteraceae	*Spilanthes*	*urens*	Jacq.	Pigeon Coop	H	Na	A	NL	Eco
12	Asteraceae	*Tridax*	*procumbens*	(L.) L.		H	Na	F	NL	Eco
13	Asteraceae	*Xanthium*	*strumarium*	L.	Burrweed	H	Ex	R	NL	Eco
14	Boraginaceae	*Heliotropium*	*angiospermum*	Murray	Dog's Tail	H	Na	O	NL	Med
15	Boraginaceae	*Tournefortia*	*gnaphalodes*	(L.) R. Br. ex Roem. & Schult.		H	Na	O	NL	Eco
16	Cannabaceae	*Trema*	*micranthum*	(L.) Blume	Jamaica nettle tree	T	Na	R	LC	Eco
17	Casuarinaceae	*Casuarina*	*Equisetifolia*	L.	Casuarina, Willow	T	Ex	O	LC	Inv
18	Cleomaceae	*Arivela*	*viscosa*	(L.) Raf.	Wild caia	H	Ex	R	NL	Eco
19	Combretaceae	*Terminalia*	*catappa*	L.	Almond	T	Na	A	LC	Foo
20	Combretaceae	*Conocarpus*	*erectus var. erectus*	L.	Button mangrove	T	Na	D	LC	Eco
21	Commelinaceae	*Commelina*	*diffusa*	Burm.f.	Watergrass	H	Na	O	LC	Med
22	Convolvulaceae	*Ipomoea*	*nil*	(L.) Roth	Kaladana	V	Na	R	NL	Eco
23	Convolvulaceae	*Ipomoea*	*pes-carpae*	(L.) R. Br.	Beach morning glory	V	Na	O	LC	Eco
24	Convolvulaceae	*Ipomoea*	*tiliacea*	(Willd.) Choisy	Wild potato	V	Na	F	LC	Eco
25	Convolvulaceae	*Merremia*	*dissecta*	(Jacq.) Hallier.f.	Know You	V	Na	O	NL	Eco
26	Convolvulaceae	*Merremia*	*quinquefolia*	(L.) Hallier f.	Rock Rosemary	V	Na	R	NL	Eco

	FAMILY	GENUS	SPECIES	AUTHORITY	COMMON NAME	HABIT	STATUS	DAFOR STATUS	IUCN Status	Notes
27	Convolvulaceae	*Merremia*	*umbellata*	(L.) Hallier f.		V	Na	F	NL	Eco
28	Cucurbitaceae	*Cucurbita*	*pepo*	L.	Pumpkin	V	Ex	R	LC	Foo
29	Cyperaceae	*Cyperus*	*ligularis*	L.		G	Na	F	NL	Eco
30	Cyperaceae	*Cyperus*	*odoratus*	L.		G	Na	O	LC	Eco
31	Cyperaceae	*Cyperus*	*rotundus*	L.	Nut grass	H	Ex	O	LC	Eco
32	Euphorbiaceae	*Astraea*	*lobata*	(L.) Klotzsch		H	Ex	O	NL	Eco
33	Euphorbiaceae	*Euphorbia*	*hirta*	L.	Milkweed	H	Na	O	NL	Med
34	Euphorbiaceae	*Euphorbia*	*heterophylla*	L.		H	Na	F	LC	Eco
35	Euphorbiaceae	*Euphorbia*	*hypericifolia*	L.		H	Na	O	NL	Eco
36	Euphorbiaceae	*Euphorbia*	*hyssopifolia*	L.		H	Na	F	NL	Eco
37	Euphorbiaceae	*Ricinus*	*cummunis*	L.	Oilnut	S	Ex	O	NL	Inv
38	Fabaceae	*Canavalia*	*rosea*	(Sw.) DC.	Seaside bean	V	Na	F	LC	Eco
39	Fabaceae	*Centrosema*	*virginianum*	(L.) Benth.	Blue bell	T	Na	O	NL	Eco
40	Fabaceae	*Chamaecrista*	*nictitans subsp. nictitans var. Jaliscensis*	(Greenm.) H.S. Irwin & Barneby		H	Na	F	LC	Eco
41	Fabaceae	*Delonix*	*regia*	(Bojer ex Hook.) Raf.	Poinciana	T	Ex	R	LC	Orn
42	Fabaceae	*Guilandina*	*bunduc*	L.	Gray Nickal	S	Na	F	LC	Eco
43	Fabaceae	*Leucaena*	*leucocephala*	(Lam.) de Wit	Lead Tree	T	Ex	A	NL	Inv
44	Fabaceae	*Macroptilium*	*lathyroides*	(L.) Urb.		H	Na	O	NL	Eco
45	Fabaceae	*Mimosa*	*pudica*	L.	Shame weed	H	Na	O	LC	Eco
46	Fabaceae	*Senna*	*occidentalis*	(L.) Link	Dandelion	S	Na	R	LC	Med
47	Fabaceae	*Tephrosia*	*cinerea*	(L.) Pers.		H	Na	O	NL	Eco
48	Fabaceae	*Vachellia*	*farnesiana*	(L.) Wight & Arn	Cassie flower	T	Na	R	LC	Eco
49	Goodeniaceae	*Scaevola*	*plumieri*	Vahl		H	Na	R	LC	Eco
50	Loganiacaea	*Spigelia*	*anthelmia*	L.	Worm grass	H	Na	R	NL	Eco
51	Malvaceae	*Corchorus*	*aestuans*	L.		H	Na	O	NL	Eco
52	Malvaceae	*Guazuma*	*ulmifolia*	Lam.	Bascedar	T	Na	R	LC	Lum
53	Malvaceae	*Malvastrum*	*americanum*	(L.) Torr.		H	Na	R	NL	Eco
54	Malvaceae	*Malvastrum*	*coromandelianum*	(L.) Garcke	Mallow	H	Na	O	NL	Eco
55	Malvaceae	*Melochia*	*nodiflora*	Sw.		S	Na	R	NL	Eco
56	Malvaceae	*Melochia*	*pyramidata*	L.		H	Na	R	LC	Eco

	FAMILY	GENUS	SPECIES	AUTHORITY	COMMON NAME	HABIT	STATUS	DAFOR STATUS	IUCN Status	Notes
57	Malvaceae	*Sida*	*acuta*	Burm.f.	Broom weed	S	Na	R	NL	Med
58	Malvaceae	*Sida*	*rhombifolia*	L.	Broomweed	H	Na	O	NL	Eco
59	Malvaceae	*Thespesia*	*populnea*	(L.) Sol. ex Correa	Seaside Mahoe	T	Na	D	LC	Eco
60	Malvaceae	*Waltheria*	*indica*	L.	Raichie	H	Na	O	LC	Med
61	Nyctaginaceae	*Boerhavia*	*erecta*	L.	Hogweed	H	Na	R	NL	Eco
62	Passifloraceae	*Turnera*	*ulmifolia*	L.	Ramgoat-dash-along	S	Na	R	LC	Med
63	Phyllanthaceae	*Phyllanthus*	*amarus*	Schumach. & Thonn.	Carry-me-seed	H	Na	O	NL	Eco
64	Poaceae	*Cenchrus*	*echinatus*	L.		G	Na	O	LC	Eco
65	Poaceae	*Chloris*	*barbata*	Sw.		G	Na	F	NL	Eco
66	Poaceae	*Chloris*	*radiata*	(L.) Sw.		G	Na	F	LC	Eco
67	Poaceae	*Cynodon*	*dactylon*	(L.) Pers. var. dactylon	Bermuda grass	G	Ex	O	NL	Eco
68	Poaceae	*Eleusine*	*indica*	(L.) Gaertn.	Yard grass	G	Ex	O	LC	Eco
69	Poaceae	*Megathyrus*	*maximum*	(Jacq.) B.K. Simon & S.W.L. Jacobs	Guinea grass	G	Ex	F	NL	Inv
70	Poaceae	*Melinis*	*minutiflora*	P. Beauv.	Wynne grass	G	Ex	F	NL	Inv
71	Polygonaceae	*Coccoloba*	*uvifera*	(L.) L.	Sea grape	T	Na	F	LC	Eco
72	Portulacaceae	*Portulaca*	*oleracea*	L.	Pussley	H	Na	O	LC	Foo
73	Rhamnaceae	*Colubrina*	*asiatica*	(L.) Brongn.	Hoop with	S	Ex	F	LC	Eco
74	Rubiaceae	*Spermococe*	*laevis*	Lam.	Buttonweed	H	Na	R	LC	Med
75	Rubiaceae	*Morinda*	*citrifolia*	L.	Noni	T	Ex	R	LC	Med
76	Sapindaceae	*Melicoccus*	*bijugatus*	Jacq.	Guinep	T	Ex	R	LC	Foo
77	Solanaceae	*Physalis*	*angulata*	L.	Wild gouma	H	Na	O	LC	Med
78	Verbenaceae	*Priva*	*lappulacea*	(L.) Pers.	Clammy bur	H	Na	R	NL	Med
79	Verbenaceae	*Stachytarpheta*	*jamaicensis*	(L.) Vahl.	Vervine	H	Na	R	NL	Med
80	Zygophylaceae	*Kallstroemia*	*maxima*	(L.) Hook, & Arn.		H	Na	R	NL	Eco

Key

HABIT	H= Herb, V= Vine, S= Shrub, T= Tree
STATUS	Na= Native, Ex= Exotic
DAFOR scale (Site specific)	D= Dominant, A= Abundant, F= Frequent, O= Occasional, R= Rare
IUCN	LC= Least concern, NL= Not Listed
NOTES	Inv = Invasive, Med= Medicinal, Lum= Lumber, Eco= Ecological, Foo= Food

13.6 Appendix 6 – Flora (Plates)

PLATE 1

Coccoloba uvifera – Sea Grape

Centrosema virginianum

Phyllanthus amarus – Egg woman

Merremia dissecta

PLATE 2

Euphorbia heterophylla

Ipomoea nil

Heliotropium angiospermum – Cold withe

Spigelia anthelmia – Worm grass

PLATE 3

Ipomoea tiliacea

Flaveria trinervia

Colubrina asiatica

Cyperus ligularis

PLATE 4

Physalis angulata

Ricinus communis

Thespesia populnea

Turnera ulmifolia

PLATE 5


Morinda citrifolia


Conocarpus erectus var. erectus


Scaevola plumieri


Guilandia bunduc

13.7 Appendix 7 – RIAM Methodology

The RIAM method (Pastakias and Jensen 1998) is a tool used to organise, assess and present the results of environmental impact assessments. The tool relies on standard definitions of assessment criteria and provides a semi-quantitative approach for assigning values to each criteria to provide a score for site condition or a project scenario(s). Project activities are evaluated against environmental components and for each component a score (using defined criteria) is calculated, which provides a measure of the impact expected from the component.

Environmental Components

The environmental components for a site or projects are identified and grouped according to sectors, namely:

- **Physical/Chemical (P/C)**: Physical and chemical aspects of the environment including natural resources (non-biological), and degradation of the physical environment by pollution, solid waste
- **Biological/Ecological (B/E)**: Biological aspects of the environment (terrestrial, freshwater and marine), including conservation of biodiversity, impact on flora and fauna, as well as habitat alteration/degradation (e.g., pollution)
- **Sociological/Cultural (S/C)**: Social aspects of the environment social issues affecting individuals and communities including, land use, community services and infrastructure, perception of the attraction as well as cultural aspects, including community development and conservation of heritage.
- **Economic/Operational E/O**: Economic consequences of environmental change, both temporary and permanent, as well as the complexities of operational

Assessment Criteria

The assessment criteria using in RIAM fall into two groups:

1. Criteria that are of importance to the condition, and which can individually change the score obtained.
2. Criteria that are of value to the situation, but individually will not be capable of changing the score obtained.

The criteria, together with their appropriate judgment scores are as follows:

Group (A) Criteria

Spatial Importance of condition (A1)

A measure of the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect.

The scales are defined as follows:

4 = important to national/international interests
3 = important to regional/national interests
2 = important to areas immediately outside the local condition (aspect-specific study areas)
1 = important only to the local condition
0 = no importance

Magnitude of change/effect (A2)

Magnitude is defined as a measure of the scale of benefit/dis-benefit of an impact or a condition:

+3 = major positive benefit
+2 = significant improvement in status quo
+1 = improvement in status quo
0 = no change/status quo
-1 = negative change to status quo
-2 = significant negative dis-benefit or change
-3 = major dis-benefit or change.

Group (B) criteria

Permanence (B1)

This defines whether a condition is temporary or permanent, and will be seen only as a measure of the temporal status of the condition. (e.g.: an embankment is a permanent condition even if it may one day be breached or abandoned; whilst a coffer dam is a temporary condition, as it will be removed).

1 = no change/not applicable
2 = temporary
3 = permanent

Reversibility (B2)

This defines whether the condition can be changed and is a measure of the control over the effect of the condition. It will not be confused or equated with permanence.

1 = no change/not applicable
2 = reversible
3 = irreversible.

Cumulative (B3)

This is a measure of whether the effect will have a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions. The cumulative criterion is a means of judging the sustainability of a condition, and is not to be confused with a permanent/irreversible situation.

1 = no change/not applicable
2 = non-cumulative/single
3 = cumulative/synergistic

It is possible to change the cumulative component to one of synergism, if the condition warrants consideration of additive effects.

The value ascribed to each of these groups of criteria is determined by the use of a series of formulae. These formulae allow the scores for the individual components to be determined on a defined basis.

The scoring system requires simple multiplication of the scores given to each of the criteria in group (A). The use of multiplier for group (A) ensures that the weight of each score is expressed (since summation of scores could provide identical results for different conditions).

Scores for the value criteria group (B) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all values in group (B) is fully taken into account.

The scoring (Environmental Score- ES) uses a formula whereby the scores given to each of the criteria in group (A) are multiplied and the result multiplied with the sum of group (B) scores:

- **$A_1 \times A_2 = aT$**
- **$(B_1) + (B_2) + (B_3) = bT$**
- **$(aT) \times (bT) = ES$.**

Where:

(A1) and **(A2)** are the individual criteria scores for group **(A)**
(B1) to **(B3)** are the individual criteria scores for group **(B)**
aT is the result of multiplication of all **(A)** scores
bT is the result of summation of all **(B)** scores
ES is the assessment score for the condition.

Positive and negative impacts are depicted by using scales that go from negative to positive values through zero for the group (A) criteria. Zero signifies ‘no-change’ or ‘no-importance’ value. The use of zero in group (A) criteria allows a single criterion to isolate conditions which show no change or are unimportant to the analysis.

Zero is avoided in the group (B) criteria. If all group (B) criteria score zero, the final result of the ES will also be zero. This condition may occur even where the group (A) criteria shows a condition of importance that will be recognised. To avoid this, scales for group (B) criteria use ‘1’ as the ‘no-change/no-importance’ score.

Overall Assessment

The various ES values are grouped into ranges and assigned alphabetic or numeric codes (see **Table A1**) so they may be more easily assessed and compared.

Table A1: Range Value Codes for the Environmental Score (ES)

Environmental Score (ES)	Range value (RV) (Alphabetic)	Range value (RV) (Numeric)	Description of Range
72 to 108	E	+5	Major positive change/impact
36 to 71	+D	+4	Significant positive change/impact
19 to 35	+C	+3	Positive change/impact
10 to 18	+B	+2	Moderate Positive change/impact
1 to 9	+A	+1	Slight positive change/impact
0	N	0	No change/status quo/not applicable
-1 to -9	-A	-1	Slight negative change/impact
-10 to -18	-B	-2	Moderate Negative change/impact
-19 to -35	-C	-3	Negative change/impact
-36 to -71	-D	-4	Significant negative change/impact
-72 to -108	-E	-5	Major negative change/impact

13.8 Appendix 8 – Seagrass Relocation

Seagrass relocation/restoration is typically recommended for ecosystem service recovery or habitat enhancement (e.g., fish habitat, reduction in coastal erosion) or as a means of mitigating habitat loss (Rezek et al. 2019).

Site selection

Selecting an appropriate planting or recipient site is an important step to successful seagrass restoration and mitigation initiatives (Fonesca et al. 1998, Calumpong & Fonseca, 2001). Physical conditions such as sand depth, water depth, water quality (nutrient loading, clarity, and light availability) and wave energy influence coverage and growth patterns of seagrass beds, and since these characteristics vary from one site another, it is important to survey the potential recipient areas to ensure that essential criteria required for successful seagrass planting are met. Site suitability will be based on the following criteria:

I. **Presence/absence of dominant seagrass species and condition of existing seagrass beds.** Given the differential natural recovery time and growth patterns of various seagrass species, it is very difficult to predict the long-term viability and persistence of transplanted seagrass material. When considering a site for planting, historical as well as present day seagrass coverage and distribution patterns can serve as indicators of potential success for seagrass transplanting. Historical absence of seagrass in an area point to physical constraints that may preclude seagrass colonisation in the area, rendering the area unsuitable for seagrass replanting.

II. **Availability (type and estimated density) of nearby donor material.**
The proximity of donor grass beds to the planting site decreases the cost of the operation. Donor sites should have similar physical characteristics (depth, salinity, turbidity) as the recipient site.

III. **Type and depth of substrate**
Soft (sandy) sediment is required for successful rooting and subsequent coalescing of transplanted seagrass material. Sediment thickness must be considered when selecting a planting site and determining the type of seagrass to be planted. Deeper sediment layers are required for the slower growing *Thalassia* testudinum (Zieman 1982) which usually supports a

thicker root and rhizome system, whereas *H. wrightii* and *S. filiforme* beds have been established at relatively quiet sites with as little as 15 cm of loose carbonate sand over bedrock (Fonseca et al. 1987).

IV. **Evidence of bioturbation**

Bioturbation is the disturbance of sediment layers caused by burrowing shrimp, sea urchins, stingrays, turtles, etc. Excessive bioturbation can create barren patches of sediment in established seagrass beds (Valentine and Heck 1991) and can also interfere with newly planted seagrass material and in so doing, hinder the recovery and promote patchy distribution of a seagrass beds (Townsend and Fonseca 1998).

V. **Proximity to wetlands or shallow reef areas**

Wetland areas provide protection from land-based sources of pollution while coral reefs provide protection from wave energy. Together these ecosystems act as sources of juvenile fish and crustaceans to ensure maximum ecological benefit from establishing seagrass sites.

VI. **Ease of access**

(From shore or by boat) Ease of access to recipient and donor sites is essential for project planning and implementation, and subsequently for adaptive management and monitoring.

Donor Material

The results of the assessment will inform the decision whether the seagrass beds within the project footprint would best be relocated to a nearby location that meets all the site selection criteria. Alternative donor sites may be evaluated. The following criteria will be considered:

I. Similarity of environmental conditions of donor and recipient beds
II. Choice of species (i.e., fast-growing (*Halodule* sp.) vs. slow growing (*Thalassia* sp.)
III. Growth habit
IV. Presence of bioturbation (i.e., presence of seagrass grazers)
V. Quality of donor material. The success of seagrass transplantation is contingent on the quality of the donor material. It is essential to use donor material that has not been damaged before or during harvesting. The size of the donor bed will be assessed to ensure that any removal will not inadvertently prevent recovery at the site or cause damage to nearby seagrass beds.

Seagrass Harvesting and Transplantation

Seagrass harvesting and transplantation methods will be evaluated for site suitability. The following criteria will be considered in selection the appropriate transplanting methodology:

I. **Cost**. Available funds for transplanting, post-transplanting adaptive management and long-term monitoring will ultimately influence the type of methodology that is most appropriate for the project.

II. **Species**. Using both fast- and slow-growing species to mimic natural succession.

III. **Method**: The following methods will be evaluated for suitability:

c) Sediment-free Method

Once the donor material is harvested, the sediments are removed to expose the roots and rhizomes. At the recipient site, the harvested planting units (PUs), comprising up to four apical rhizome meristems, are transplanted directly into the sandy substrate or anchored using metal rods (rebar) or similar devices. Alternatively, the PUs can be woven into biodegradable mesh and secured to the sediment.

d) Sediment Method

Sod or turf entails the removal of seagrass along with the sediment and rhizomes intact and ready for planting without additional manipulation. For *Thalassia* with deep root-rhizome systems, this method will require careful harvesting to ensure that the depth of the root-rhizome system is intact. Specialised harvesting equipment may be required.

Plugs, which consist of seagrass plants with roots and rhizomes, can be harvested using coring devices such as PVC pipes or specialised sod plugger. Similar to the sod/turf method, the plugs can be transplanted into peat pots and then into holes created at the recipient site.

IV. **Time of the year**. Transplanting should be planned to avoid periods of high seasonal stress (i.e., storms, high temperatures).

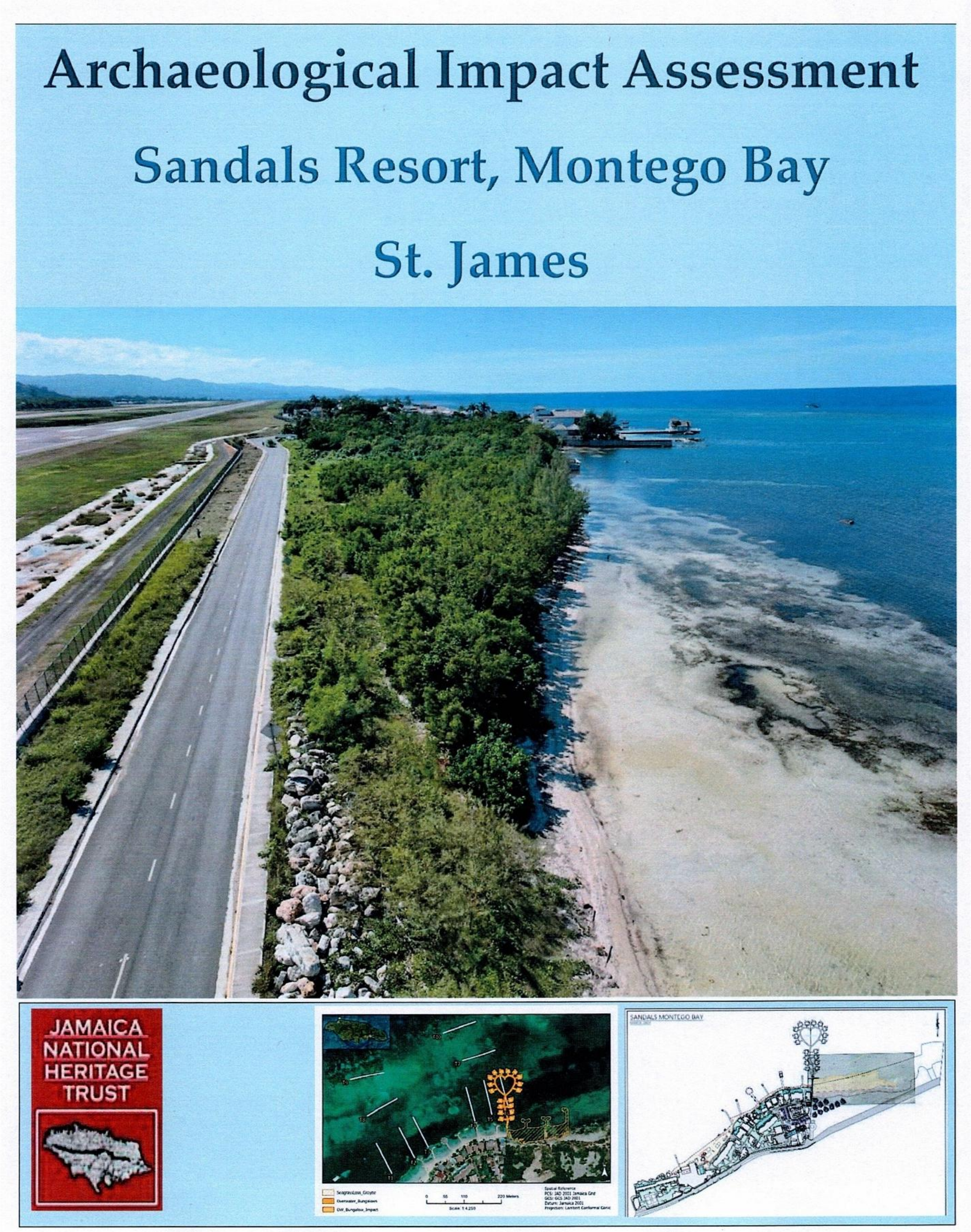
Monitoring

An integral part of any seagrass restoration programme is the provision for long-term monitoring (i.e., minimum 5 years). Monitoring is required initially to monitor the post-planting success and to identify requirements for remedial planting. Monitoring should be carried out at regular intervals at 2-, 6- and 12-months post transplanting, every six months for a period of two years, and annually thereafter. Monitoring should include, as a minimum, the following metrics:

a) **Seagrass metrics**: survivorship (# of live PUs), shoot density (#/PU), blade condition (length in cm) and spatial coverage (m^2) (i.e., intended acreage), coalescence between PUs
b) **Physical parameters**: water quality (nutrients and salinity), temperature, sedimentation rates and total suspended solids (TSS), light readings
c) Bioturbation
d) Anthropogenic disturbances

Long-term success criteria may, in addition to the basic metrics, also include the provision of basic ecosystem functions, including biomass productivity, sediment stabilisation, habitat provision, and secondary productivity.

13.9 Appendix 9 – Archaeological Impact Assessment



Archaeological Impact Assessment

Sandals Resort, Montego Bay

St. James

JAMAICA
NATIONAL
HERITAGE
TRUST

ARCHAEOLOGICAL IMPACT ASSESSMENT

FOR

Sandals Resorts International

November 2024

Prepared by:

JAMAICA NATIONAL HERITAGE
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List of Maps, Satellite Imagery, Plans, Figures, Plates

List of Maps

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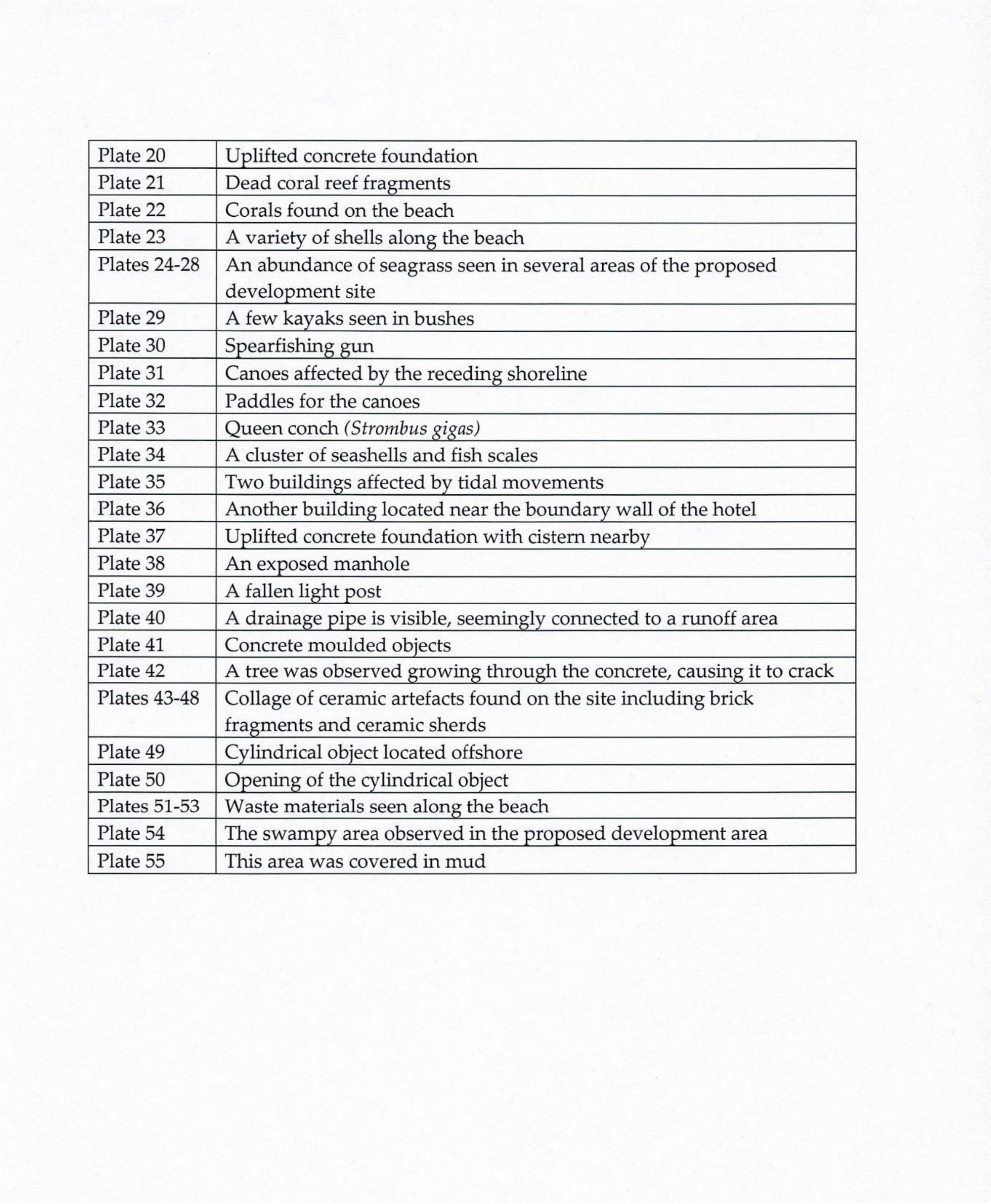

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Glossary

Archaeological Appraisal	An archaeological reconnaissance of an area or site to identify whether a development proposal has a potential archaeological dimension requiring further investigation.
Archaeological Impact Assessment	A systematic analysis of a project and/or development's potential effect on all aspects of the material cultural heritage, in order to provide information for the deciding agency to consider in the decision-making process, and further give bodies with relevant environmental responsibilities the opportunity to comment before consent is given or denied.
Artefact	An object produced or shaped by human craft especially a tool, weapon or ornament of archaeological or historical interest
Assemblage	A group of similar types of artifacts, artifacts from a similar time period, or a group of artifacts from a particular context.
Context	Position and associations of an artifact, feature, or archaeological find in space and time.
Cropmark	The pattern of differential growth of plants over an archaeological site no longer easily visible on the ground due to the removal of upstanding remains. Crop marks, parch marks and soil marks can reveal buried material culture.
Deposit	A specific physical structure or element within a soil matrix.
Desk-based Assessment	An assessment of the known or potential archaeological resources within a specified area or site on land or underwater, consisting of a collection of existing written and graphic information in order to identify the likely character, extent, quality and worth of the known or potential archaeological resources in the local, regional, national or international context as appropriate.
Disturbance	An event or sequence of events, either natural or cultural, that dislodges and disrupts archaeological deposits.

Ecofacts	Material which can demonstrate the interaction between the environment of a site/area and human exploitation within the site/area such as pollen samples, grain, nuts, fish etc.
Evaluation	A limited programme of non-intrusive and/or intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site, and if present defines their character and extent, and relative quality. It enables an assessment of their worth in a local, national, regional or international context as appropriate
Excavation	Intrusive fieldwork with a clear purpose, which examines and records archaeological deposits, features and structures and recovers artefacts, ecofacts and other remains within a specified area or site. This will lead to both a further programme of Post Excavation and Publication and perhaps further excavation.
Fieldwalk Survey	A form of evaluation that provides details of surface features visible during a physical search of the site area and is a systematic observation of the ground surface during the recovery of artefacts that may indicate periods of occupation (also termed walkover survey or pedestrian survey).
Feature	A particular activity area or construction site within an archaeological site. Features cannot be easily moved.
GIS	(Geographical Information System): a range of techniques using the graphic capabilities of computers for an integrated analysis of maps, images, sites and finds.
Geophysical Survey	A method of seeing beneath the ground surface using a number of methodologies, including Ground Penetrating Radar (GPR), Resistivity and Magnetometry.
in situ	In its original position or place (Original deposition of artefact)
Material Culture	Any remains from the past manipulated by people, including physical objects and landscapes
Midden	A domestic waste dump usually consisting of bone, shells, other organic material and oftentimes artifacts.

Mitigation	A process in which archaeologists work with contractors, developers, government offices, and stakeholders to avoid damaging archaeological resources during a project.
Monitoring	The process of an archaeologist physically being present at a construction site to ensure archaeological resources are not disturbed by the work being conducted.
Secondary Deposition	A deposit is considered secondary when at least one of the artefacts within it was transported from another location where it was part of a primary deposit.
Stratigraphy	The study of strata, layers or contexts of soil, sediment and material culture at an archaeological site.
Watching Brief	A formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons within a specified area or site on land or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed.

S NON-TECHNICAL SUMMARY

S.1 The Jamaica National Heritage Trust (JNHT) has concluded an Archaeological Impact Assessment on lands adjoining and owned by the Sandals Resort Montego Bay in St. James. This proposed development project will include eighteen (18) overwater villas and the construction of ten (10) single storey villa style units. This development is being proposed by Sandals Resorts International.

S.2 This Archaeological Impact Assessment was carried out in response to a request made by Sandals Resorts International (SRI).

S.3 The research objectives of the Archaeological Assessment are to ascertain the presence or absence of historical and archaeological resources and describe the status of these resources, along with any other socio-economic attributes and appraise their worth in context of the proposed development, legislative and regulatory considerations. In addition, to identify and predict any potential positive, negative, reversible, irreversible, short- and long-term impacts and to indicate possible mitigation to negative impacts, as well as recommendations to enhance positive impacts, also to outline possible alternatives to the project and/or aspects of it. Where necessary indicate suitable management and monitoring plan for the earth breaking stage of the project.

S.4 There are a number of pertinent policies, legislation, regulations and environmental standards of the Government of Jamaica (GOJ) relating to environmental protection that are applicable to any development and that a developer will need to consider when embarking on a particular scale and type of development. There are several government agencies mandated with the authority to control certain types of development that may have potential negative impact on the natural and cultural environment. These are Natural Resources Conservation Authority, National Environment and Planning Agency, Parish Council, The National Solid Waste Management Authority, National Land Authority, Ministry of Health and the Jamaica National Heritage Trust (JNHT).

The Jamaica National Heritage Trust Act of 1985 established the JNHT. The Trust's functions outlined in Section 4 include the following responsibilities:

- To promote the preservation of National Monuments and anything designated as Protected National Heritage for the benefit of the Island;
- To carry out such development as it considers necessary for the preservation of any National Monument, or anything designated as Protected National Heritage;
- To record any precious objects or works of art to be preserved and to identify and record any species of botanical or animal life to be protected. Section 17 further states that it is an offence for any individual to:
    - Wilfully deface, damage or destroy any national monument or protected national heritage or to deface, damage, destroy, conceal or remove any mark affixed to a national monument or protected national heritage;
    - Alter any national monument or mark without the written permission of the Trust;
    - Remove or cause to be removed any national monument or protected national heritage to a place outside of Jamaica.

S.5 Historically, the area is part of the Providence Estate and forms part of the now Mahoe Bay Area. Providence Estate was utilized for the cultivation and production of sugar and rum.

S.6 Local fishermen use the beach for their fishing activities, while craft vendors store their wares on the shore before heading out in boats to sell at the nearby resorts. Additionally, the Sandals Resort Hotel occupies the space, attracting hotel guests who use the area for sightseeing, kayaking, sailing, glass bottom boating and other hotel activities.

S.7 The survey techniques employed in this project were dictated by the nature of the topography, vegetation cover, nature of the tide, accessibility and time allowed for the survey. It is believed that these techniques were deemed appropriate to provide the best possible coverage and accuracy of the results. The background information on the site was derived from primary documentary sources supported by secondary narratives.

S.8 The JNHT team conducted a random field walk survey on the site of the proposed development. A few artefacts, including brick fragments and ceramic sherds, were found at the site. There were no significant tangible cultural assets observed; the field survey found no significant historical or archaeological resources that will be affected.

S.9 **The archaeological evidence available at this time is not significant enough to warrant *in situ* preservation. As such the JNHT Archaeology Division has no objection to the proposed development.**

1 INTRODUCTION

1.0 The purpose of this document is to present the findings of an Archaeological Impact Assessment conducted at a property adjoining the Sandals Montego Bay Resort, St. James from November 21-22, 2024. The developers have proposed the construction of several overwater villas along with other hotel amenities at the proposed development area.

The report seeks to collate the best available information relating to the study area, both in terms of formal data sets and local knowledge to ensure informed decision making and guaranteeing a sustainable project. The study was done in accordance with the Jamaica National Heritage Trust stipulated standards and guidelines.

1.1 Objectives

The research objectives of the assessment are to ascertain the presence of historical and archaeological resources and describe the status of these resources, along with any other socio-economic attributes and appraise their worth in context of the proposed development, legislative and regulatory considerations. In addition, to identify and predict any potential positive, negative, reversible, irreversible, short- and long-term impacts and to indicate possible mitigation to negative impacts, as well as recommendations to enhance positive impacts, also to outline possible alternatives to the project and or aspects of it.

1.2 Scope of Work

Scope of work for this assessment includes the following:

Task 1: Desk-Based Assessment – (a) Research relevant historical documentations: maps, plans, estate accounts, correspondents, titles, and deeds; (b) Research published and unpublished narratives, studies and data sets of the study area, adjoining areas and associated projects; (c) Analysis of satellite images and aerial photographs.

Task 2: Site Survey – Conduct archaeological field walk, dive, cultural heritage contexts interpretation and analysis and recording significant cultural assets to be affected.

Task 3. Description of Proposed Project- Provide a full description of the project and its existing setting, using plans, maps and photographs. This includes: location, development area along with those areas immediately outside the property but are of cultural significance and will be impacted indirectly.

Task 4: Description of the Project Area – Assembles, evaluates and presents baseline data on the relevant environmental characteristics of the study area, including (a) Physical environment: geology, topography, soils and drainage system; (b) Biological environment: flora and fauna that have cultural implications; (c) Socio-cultural environment: communities, infrastructures, land-use and community perception and attitudes towards the proposed project.

Task 5: Determination of Potential Impacts – presents major issues of archaeological and socio-economic concerns and indicates their relative importance.

1.3 Structure of the Report

The Archaeological Assessment Report is a concise collation of significant cultural environmental issues. Its main text focus on impact, mitigation and monitoring management plans. The report is organized into ten (10) sections as outlined below:

- Non-Technical Summary
- Introduction
- Description of Proposed Project
- Description of Project Area
- Methodology
- Desk-Based Assessment Results
- Site Assessment Results
- Impact Summary
- Discussion and Recommendation
- Bibliography

1.4 Policy and Legislative Framework

There are a number of pertinent policies, legislation, regulations and environmental standards of the Government of Jamaica (GOJ) relating to environmental protection that are applicable to any development and that a developer will need to consider when embarking on a particular scale and type of development. There are several government agencies mandated with the authority to control certain types of development that may have potential negative impact on the natural and cultural environment. The powers of control and regulation are typically exercised through a system of permits that include checks and balances on what kind and form of development can occur. A developer therefore must be prepared to present, explain, and in some cases alter aspects of a development proposal in order to comply with the permitting requirements. This section therefore highlights the relevant authorities, legislation and regulations that must be considered in order to acquire the necessary permit applicable to the development.

1.4.1 Natural Environment

1.4.1.1 Natural Resources Conservation Authority Act (1991)

The Natural Resources Conservation Authority Act was passed in the Jamaican Parliament in 1991 and provided the basis for the establishment of the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development in Jamaica through the protection and management of Jamaica's natural resources and control of pollution. Sections 9 and 10 of the NRCA Act stipulate that an Environmental Impact Assessment

(EIA) is required for new projects and existing projects undergoing expansion. The body is also responsible for investigating the effect on the environment of any activity that may cause pollution or which involves waste management. Sections of the Act that relate specifically to pollution control state that:

(i) No person shall discharge on or cause or permit the entry into waters, on the ground or into the ground, of any sewage or trade effluent or any poisonous noxious or polluting matter.

(ii) No person is allowed to construct or reconstruct or alter any works designed for the discharge of any effluent.

The Act also empowers the authority to require of any owner or operator of a pollution control facility to provide information on the performance of the facility, the quantity and condition of effluent discharged and the area affected by the discharge of such effluent. The Authority has the right to consult with any agency or department of Government having functions in relation to water or water resources to carry out operations to:

(a) Prevent pollutants from reaching water bodies.

(b) Remove and dispose of any polluting matter or remedy or mitigate any polluted water body in order to restore it.

1.4.1.2 Environmental Review and Permitting Process (1997)

The Environmental Permit and License System (P&L), introduced in 1997, is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L System is administered by NEPA, through the Applications Secretariat of the Application Branch. Permits are required by persons undertaking new development which fall within a prescribed category. Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of approval stipulated. An applicant for a Permit or License must complete an application form as well as a Project Information Form (PIF) for submission to the NRCA.

1.4.1.3 Wildlife Protection Act (1945)

The Wildlife Protection Act of 1945 prohibits removal, sale or possession of protected animals, use of dynamite, poisons or other noxious material to kill or injure fish, prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries and streams, and authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act are six species of sea turtle, one land mammal, one butterfly, three reptiles and several species of birds including rare and endangered species and game birds.

1.4.1.4 The Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000)

This Act deals with restriction on trade in endangered species, regulation of trade in species specified in the schedule, suspension and revocation of permits or certificates, offences and penalties, and enforcement. Many species of reptile, amphibian and birds that are endemic to Jamaica but not previously listed under national protective legislation, or under international legislation, are listed in the Appendices of this Act.

1.4.1.5 The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)

The island of Jamaica and the Territorial Sea of Jamaica have been declared a Prescribed Area. No person can undertake any enterprise, construction or development of a prescribed description or category except under and in accordance with a permit. The Natural Resources Conservation (Permits and Licenses) Regulations (1996) give effect to the provisions of the Prescribed Areas Order.

1.4.1.6 Water Resources Act (1995)

The Water Resources Act of 1995 established the Water Resources Authority (WRA). This Authority is authorized to regulate, allocate, conserve and manage the water resources of the island. The Authority is also responsible for water quality control and is required under Section 4 of the Act to provide upon request to any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources. It is the responsibility of the WRA as outlined in Section 16 to prepare, for the approval of the Minister, a draft National Water Resources Master Plan for Jamaica. Areas to be covered in this Draft Master Plan of 1990 included objectives for the development, conservation and use of water resources in Jamaica with consideration being given to the protection and encouragement of economic activity, and the protection of the environment and the enhancement of environmental values. Section 25 advises that the proposed user will still have to obtain planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, Section 21 of the Act stipulates that if the water to be used will result in the discharge of effluents, an application for a license to discharge effluents will have to be made to the Natural Resources Conservation Authority or any other relevant body as indicated by the Minister.

With regard to underground water, Section 37 states that it is unlawful to allow this water to go to waste. However, if the underground water "interferes or threatens to interfere with the execution or operation of any underground works", it will not be unlawful to allow the water to go to waste in order to carry out the required works provided that there is no other reasonable method of disposing of the water. The Authority also has the power to determine the safe yield of aquifers (Section 38).

1.4.1.7 **Country Fires Act (1942)**

Section 4 of the Country Fires Act of 1942 prohibits the setting of fire to trash without prior notice being given to the nearest police station and the occupiers of all adjoining lands. In addition, a space of at least 4.5 metres (15 feet) in width must be cleared around all trash to be burnt and all inflammable material removed from the area. Section 6 of the Act empowers the Minister to prohibit, as may be necessary, the setting of fire to trash without a permit. Offences against this

Act includes:

- Setting fire to trash between the hours of 6.00 p.m. and 6.00 a.m. (Section 5a);
- Leaving open-air fires unattended before they have been completely extinguished (Section 5b);
- Setting fires without a permit and contrary to the provisions outlined in Section 6 (Section 8);
- Negligent use or management of a fire which could result in damage to property (Section 13a);
- Smoking a pipe, cigar or cigarette on the grounds of a plantation which could result in damage to property (Section 13b).

1.4.1.8 Quarries Control Act (1983)

The Quarries Control Act of 1983 established the Quarries Advisory Committee, which advises the Minister on general policy relating to quarries as well as on applications for licenses. The Act provides for the establishment of quarry zones, and controls licensing and operations of all quarries. The Minister may on the recommendation of the Quarries Advisory Committee declare as a specified area any area, in which quarry zones are to be established and establish quarry zones within any such specified area.

Section 5 of the Act states that a license is required for establishing or operating a quarry though this requirement may be waived by the Minister if the mineral to be extracted is less than 100 cubic metres. Application procedures are outlined in Section 8. The prescribed form is to be filed with the Minister along with the prescribed fee and relevant particulars. The applicant is also required to place a notice in a prominent place at the proposed site for a period of at least 21 days starting from the date on which it was filed.

1.4.1.9 The Pesticides (Amendment) Act (1996)

The Pesticides (Amendment) Act of 1996 amended sections of the principal act, which came into effect in 1975 and established the Pesticides Control Authority. This Act gives the Authority the responsibility of controlling the importation, manufacture, packaging, sale, use and disposal of pesticides. Section 11 states that the Authority is required to keep a register or record of all relevant information such as registered pesticides, restricted pesticides, pest control operators and persons licensed to import or manufacture pesticides. Under

Section 16 of the Act, the Authority may also, with the approval of the Minister, make regulations which relate to areas such as:

- Aerial application of pesticides;
- Supervision required for the use of pesticides, the prescribed protective clothing to be worn and other precautionary measures;
- The permissible levels of pesticides to be used;
- The periods during which particular pesticides may or may not be used on certain agricultural crops;
- The disposal of pesticides and packages.

1.4.1.10 **Clean Air Act (1964)**

This act refers to premises on which there are industrial works, the operation of which is in the opinion of an inspector likely to result in the discharge of smoke or fumes or gases or dust in the air. An inspector may enter any affected premise to examine, make enquiries, make tests and take samples of any substance, smoke, fumes, gas or dust as he considers necessary or proper for the performance of his duties.

1.4.1.11 **The Natural Resources Conservation Authority (Air Quality) Regulations, 2002**

Part I of this Act stipulates license requirements and states that every owner of a major facility or a significant facility shall apply for an air pollutant discharge license. Part II speaks to the stack emission targets, standards and guidelines.

The Act states that no person shall emit or cause to be emitted from any air pollutant source at a new facility, any visible air pollutants the opacity or pollutant amount of which exceeds the standards. Every owner of a facility with one or more air pollutant source or activity shall employ such control measures and operating procedures as are necessary to minimise fugitive emissions into the atmosphere, and such owner shall use available practical methods which are technologically feasible and economically reasonable and which reduce, prevent or control fugitive emissions so as to facilitate the achievement of the maximum practical degree of air purity. Under this Act a "major facility" is described as any facility having an air pollutant source with the potential to emit:

(a) One hundred or more tonnes of any one of total suspended particulate matter (TSP);
(b) Particulate matter with a diameter less than ten micrometres (PM10);
(c) Sulphur oxides measured as sulphur dioxide (SO2);
(d) Carbon monoxide (CO);
(e) Nitrogen oxides (NOx) measured as equivalent nitrogen dioxide;
(f) Five or more tonnes/y lead;
(g) Ten or more tonnes per year of any single priority air pollutant; or
(h) Twenty-five or more tonnes per year of any combination of priority air pollutants;

1.4.1.12 **Noise Standards**

Jamaica has no national legislation for noise, but World Bank guidelines have been adopted by the National Environment and Planning Agency (NEPA), and are used for benchmarking purposes along with the draft National Noise Standard that is being prepared. The guidelines for daytime perimeter noise are 75 decibels and 70 decibels for night time noise.

1.4.2 Social Environment

1.4.2.1 Town and Country Planning Act (1958)

Section 5 of the Town and Country Planning Act authorizes the Town and Country Planning Authority to prepare, after consultation with any local authority, the provisional development orders required for any land in the urban or rural areas, so as to control the development of land in the prescribed area. In this manner, the Authority will be able to coordinate the development of roads and public services and conserve and develop the resources in the area. Any person may, under Section 6 of the Act, object to any development order on the grounds that it is:

- Impractical and unnecessary;
- Against the interests of the economic welfare of the locality.

However, if the Minister is satisfied that the implementation of the provisional development order is likely to be in the public interest, he may, under Section 7 (2) of the Act, confirm it with or without modification by publishing a notice in the Gazette. Section 8 of the Act also gives the Minister the authority to amend a confirmed development order. Section 10 of the Act states that a development order must include:

- Clearly defined details of the area to be developed;
- Regulations regarding the development of the land in the area specified;
- Formal granting of permission for the development of land in the area.

If the provisions of section 9A of the Natural Resources Conservation Authority (NRCA) Act apply to the development, the application can only be approved by the Planning Authority after the NRCA has granted a permit for the development (Section 11 (1A)). The Authority may impose a "tree preservation order" under Section 25 of the Act if it considers it important to make provision for the preservation of trees and woodlands in the area of the development. This order may:

- Prohibit the cutting down, topping, lopping or wilful destruction of trees;
- Secure the replanting of any section of the woodland area in which trees were felled during the forestry operations permitted under the order.

The tree preservation order is not applicable to the cutting down of trees which were already dead, dying or had become dangerous and the order can take effect only after it has been confirmed by the Minister. The Minister can, under Section 26 of the Act, make regulations to restrict and regulate the display of advertisements in any area to be developed if he considers this to be in the interest of public safety. Section 28 of the Act empowers the local authority to require the owner or occupier of land in the development area to take the steps necessary to ensure its proper maintenance.

1.4.2.2 Land Development and Utilization Act (1966)

Under Section 3 of the Land Development and Utilization Act (1966), the Land Development and Utilization Commission is authorized to designate as agricultural land, any land which because of its "situation, character and other relevant circumstances" should be brought into use for agriculture. However, this order is not applicable to land, which has been approved under the Town and Country Planning Act for development purposes other than that of agriculture. Among the duties of the Commission outlined in Section 14 of the Act is its responsibility to ensure that agricultural land is "as far as possible, properly developed and utilized".

1.4.2.3 **Public Health Act (1976)**

The Public Health (Air, Soil and Water Pollution) Regulations 1976, aim at controlling, reducing, removing or preventing air, soil and water pollution in all possible forms. Under the regulations given:

i. No individual or corporation is allowed to emit, deposit, issue or discharge into the environment from any source.
ii. Whoever is responsible for the accidental presence in the environment of a contaminant must advise the Environmental Control Division of the Ministry of Health and Environmental Control, without delay.
iii. Any person or organization that conducts activities which release air contaminants such as dust and other particulates is required to institute measures to reduce or eliminate the presence of such contaminants.
iv. No industrial waste should be discharged into any water body which will result in the deterioration of the quality of the water.

1.4.2.4 **The National Solid Waste Management Authority Act (2001)**

The National Solid Waste Management Authority Act (2001) is “an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority and for matters connected therewith or incidental thereto”. The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste. The SWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.

1.4.2.5 Jamaica National Heritage Trust Act (1985)

The Jamaica National Heritage Trust Act of 1985 established the Jamaica National Heritage Trust (JNHT). The Trust's functions outlined in Section 4 include the following responsibilities:

- To promote the preservation of National Monuments and anything designated as Protected National Heritage for the benefit of the Island;
- To carry out such development as it considers necessary for the preservation of any National Monument or anything designated as Protected National Heritage;
- To record any precious objects or works of art to be preserved and to identify and record any species of botanical or animal life to be protected. Section 17 further states that it is an offence for any individual to:
- wilfully deface, damage or destroy any national monument or protected national heritage or to deface, damage, destroy, conceal or remove any mark affixed to a National Monument or Protected National Heritage;
- alter any National Monument or mark without the written permission of the Trust;
- remove or cause to be removed any National Monument or Protected National
  Heritage to a place outside of Jamaica.

1.4.2.6 **Land Acquisition Act (1947)**

Section 3 of the Land Acquisition Act (1947) empowers any officer authorized by the Minister to enter and survey land in any locality that may be needed for any public purpose. This may also involve:

- Digging or boring into the sub-soil;
- Cutting down and clearing away any standing crop, fence, bush or woodland;
- Carrying out other acts necessary to ascertain that the land is suitable for the required purpose.

The Minister is authorized under Section 5 of the Act to make a public declaration under his signature if land is required for a public purpose provided that the compensation to be awarded for the land is to be paid out of the:

- Consolidated Fund or loan funds of the Government;
- Funds of any Parish Council, the Kingston and St. Andrew Corporation or the National Water Commission.

Once the Commissioner enters into possession of any land under the provisions of this Act, the land is vested in the Commissioner of Lands and is held in trust for the Government of Jamaica in keeping with the details outlined in Section 16. The Commissioner shall provide the Registrar of Titles with a copy of every notice published as well as a plan of the land. The Commissioner will also make an application to the Registrar of Titles in order to bring the title of the land under the operation of the Registration of Titles Act.

1.4.2.7 Registration of Titles Act (1989)

The Registration of Titles Act of 1989 is the legal basis for land registration in Jamaica, which is carried out using a modified Torrens System (Centre for Property Studies, 1998). Under this system, land registration is not compulsory, although once a property is entered in the registry system the title is continued through any transfer of ownership.

1.4.3 International Legislative and Regulatory Considerations

1.4.3.1 Convention on Biological Diversity

The objectives of the Convention on Biological Diversity are "the conservation of biological diversity, sustainable use of its components and the fair equitable sharing of the benefits arising out of the utilization of genetic resources". This is the first global, comprehensive agreement which has as its focus all aspects of biological diversity: genetic resources, species and ecosystems. The Convention acknowledges that the "conservation of biological diversity is a common concern of humankind and an integral part of the development process". In order to achieve its goals, the signatories are required to:

- Develop plans for protecting habitat and species.
- Provide funds and technology to help developing countries provide protection.
- Ensure commercial access to biological resources for development.
- Share revenues fairly among source countries and developers.

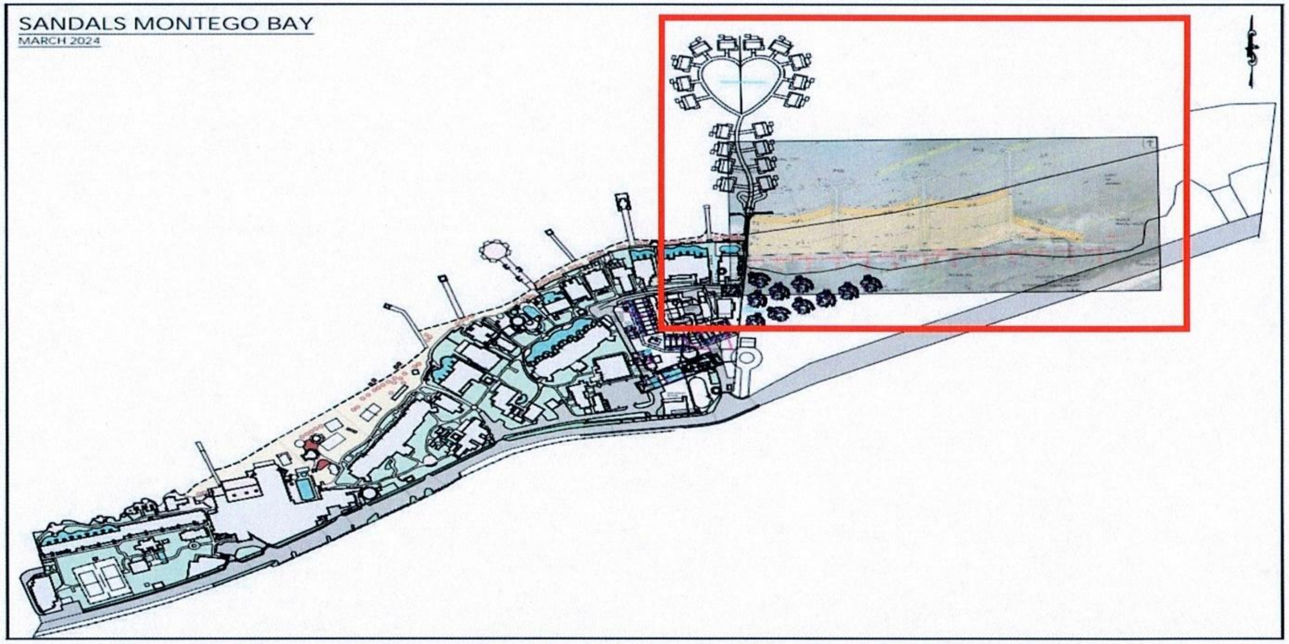
- Establish safe regulations and liability for risks associated with biotechnology Development.

Jamaica's Green Paper Number 3/01, entitled *Towards a National Strategy and Action Plan on Biological Diversity in Jamaica,* and speaks to Jamaica's continuing commitment to its obligations as a signatory to the Convention.

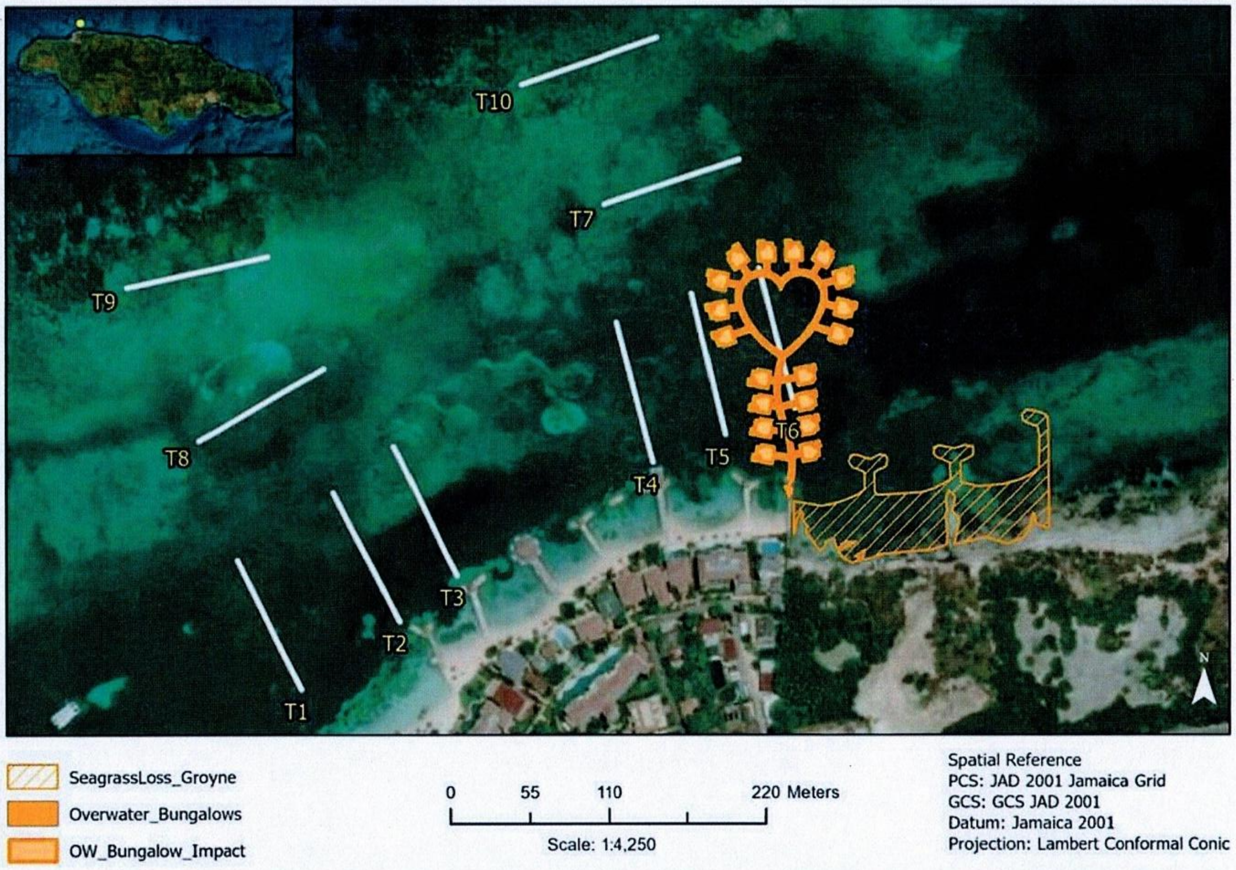
2. PROPOSED PROJECT

2.1 Sandals Montego Bay Overwater Suites Development Project

The developer has proposed the construction of eighteen (18) single storey overwater villas/suites and the modification of an existing wetland area adjoining the existing property with the construction of ten (10) single storey villa style units.

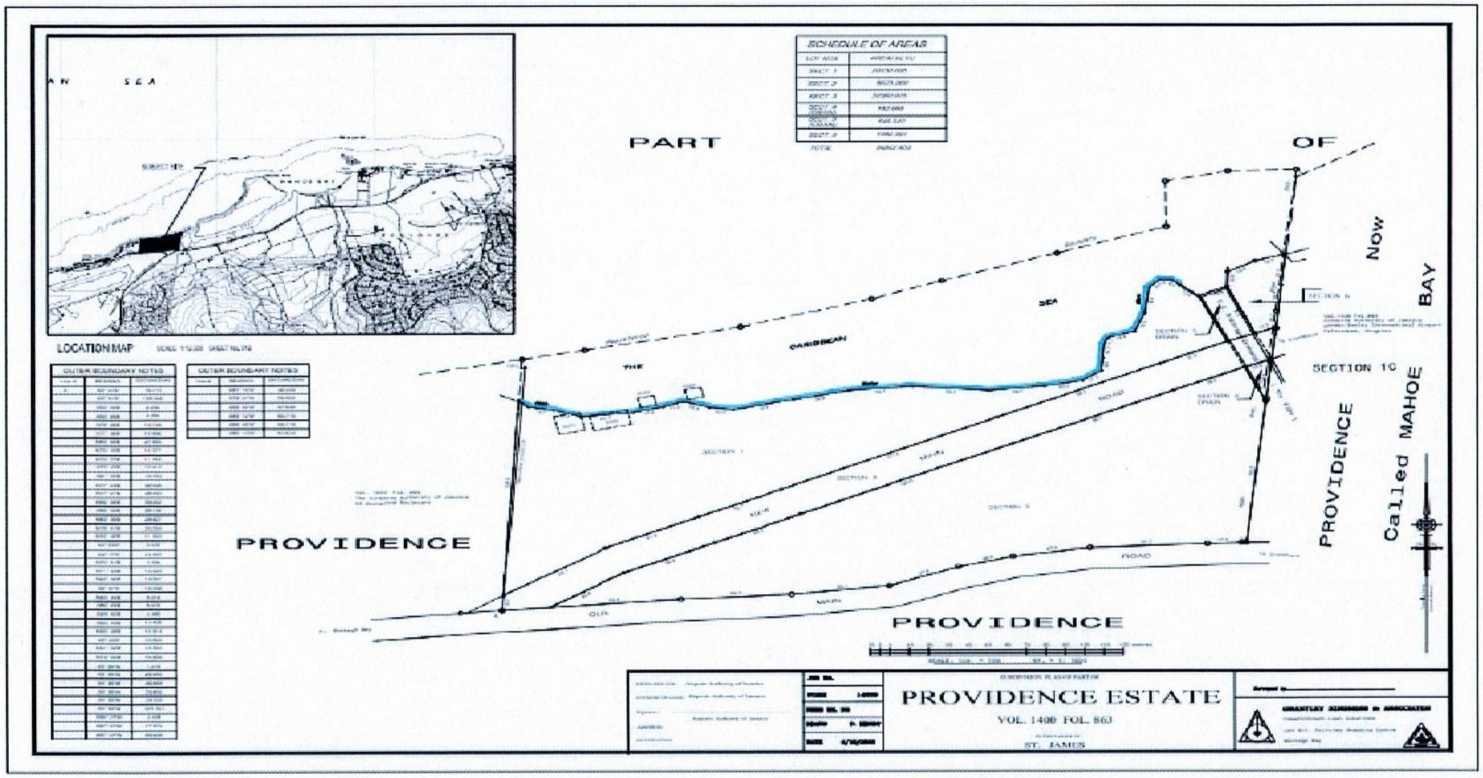


Plan 1: Overview of the proposed development highlighting the overwater villa and wetland area (Courtesy of Sandals Resorts International)



Plan 2: Location of the Benthic Survey at the Sandals Montego Bay Location (Courtesy of Sandals Resorts International)

The proposed project will involve coastal modifications aimed at enhancing the beach and will feature the construction of a sea wall, rock groynes, a rock revetment on the property's eastern side and the expansion of the beach area through the addition of sand fill.



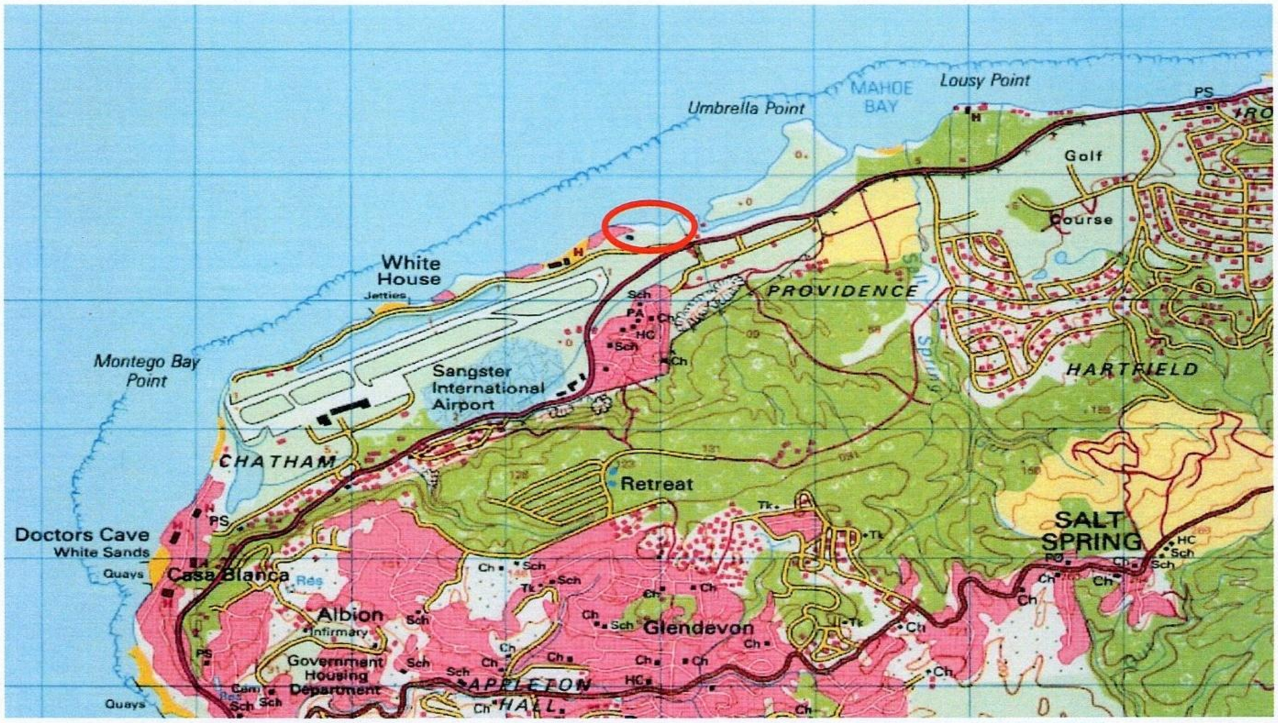
Map 1: Location map showing location of the proposed development area on the Providence Estate (Courtesy of Sandals Resort International)

3. PROJECT AREA

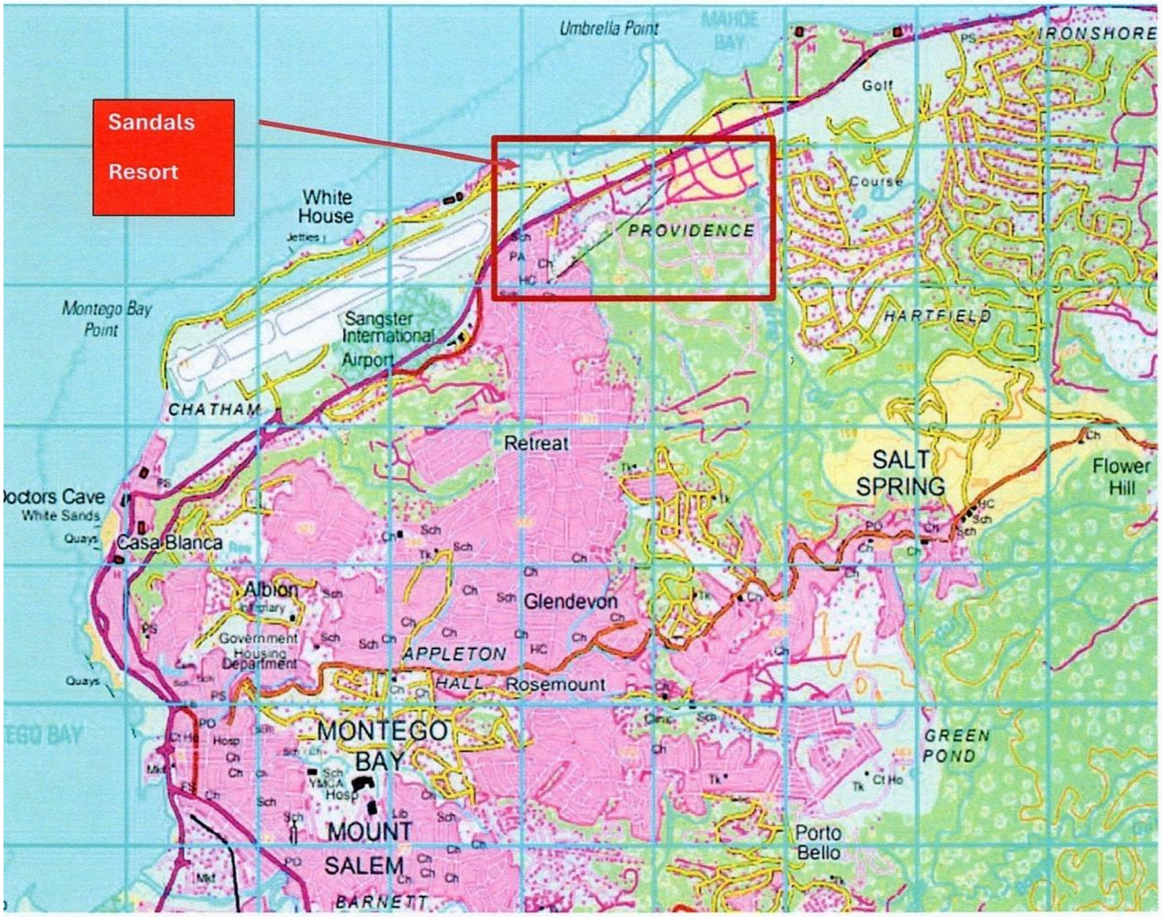
3.1 The proposed development area is a narrow stretch of land along the coastline, with sections characterized by swampy terrain and a mangrove-like environment.

3.1.1 Location

The proposed development site is part of the Providence Estate along the northwestern coastline of Jamaica in the parish of St. James. The parcel of land proposed for development is Volume 1400 and Folio 863. It is a small coastal area situated east of White House and northeast of the Sangster International Airport. Its western boundary adjoins the existing Sandals Resort property.



Map 2: Location map showing the proposed area and its immediate environs



Map 3: Sandals Montego Bay Resort and the proposed development area within the Providence Estate

3.1.2 Topography

The site for the proposed development primarily consists of coastal lowland, with visible evidence of uplifted coral platform. The area can be best described as a flat, rugged and highly eroded coastline. The land features a mangrove wetland environment, alongside a white sand beach. Most of the site is at sea level and may become inundated by hightide and storm surge.

Plate 1: Overview of the proposed area

The area is a relatively narrow piece of land with a maximum width of about 124m, the area narrows moving eastward with lows of 9.7m. The proposed development area has been impacted by major wave action in the past causing erosion and the loss of sections of the beach. Satellite imageries 1 and 2 below show how the eastern segment of the land parcel has deteriorated over time due to climate change impacts, leading to the current rugged features and narrow coastline appearance.

Satellite Imagery 1: Google earth image showing coastline prior to 2010

Satellite Imagery 2: Google earth image showing more recent image of the coastline dated Februarv 23. 2024

The aesthetic of the coastline has changed overtime and now displays coastal damage with washed up refuse and exposed rocks. It was observed that Satellite imagery 1 displayed two large distinctive ponds whereas the on later Satellite imagery 2 the ponds are not as evident because of the existing vegetation that has covered the area.

3.1.3 Vegetation

The vegetative cover of the area is dominated by wetland vegetation, including various types of mangroves and other hydrophytes. Hydrophytes thrive in water or in soil that is periodically oxygen-deficient due to excessive water content.

Several trees and shrubs, predominantly featuring mangroves and other coastal plant species were observed. Some of these plant species are bay cedar (Suriana maritima), beach cabbage (*Scaevola taccada*), black mangroves (*Avicennia germinans*), white mangroves (*Laguncularia racemosa)*, lead (*Leucaena leucocephala*), noni (*Morinda citrifolia*), sea grapes (*Coccoloba uvifera*), seaside mahoe (*Thespeia papulnea*), red birch (Betula occidentalis), West Indian almond (*Terminalia catappa*), and Willow tree *(Casurina Equisetifolia)*.

Plate 2: Beach Cabbage *(Scaevola taccada)*

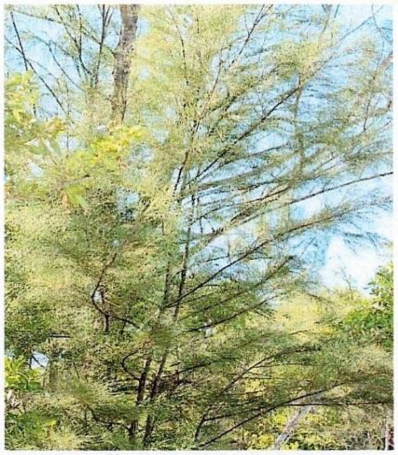
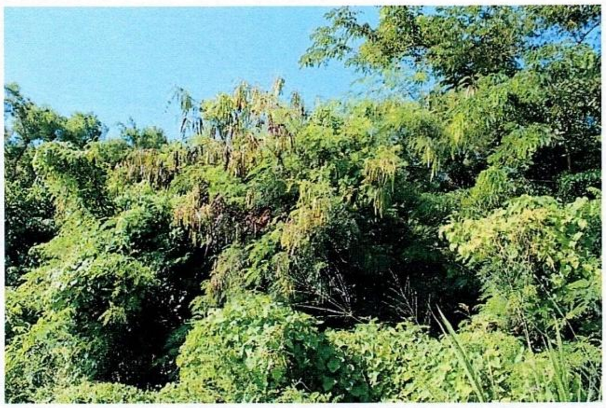


Plate 3: Willow Tree *(Casurina Equisetifolia)*

Plate 4: Lead Tree (Leucaena *leucocephala)*



4. METHODOLOGY

A multifaceted approach was taken in conducting the study. This included documentary research, terrestrial field walk survey, a marine survey, vegetation analysis, photographic analysis and interviews.

4.1 Desk- Based Assessment

4.1.1 This is a thorough review of all available written and graphic information relating to the area in order to identify the likely character, extent and relative quality of the actual or potential archaeological and architectural resources. It includes relevant historical documents, journals and books, aerial photographs and or satellite imagery, maps and other contemporary data found in the nation's repositories such as the Island Record Office, National Archives, National Library of Jamaica, University of Technology (UTECH), University of the West Indies (UWI) and private collections. Web sites were also consulted.

- Historical documentation including, maps, plans, estate accounts, correspondence, titles, deeds, just to list a few.
- Published and unpublished results of any previous archaeological work on the site or in its vicinity.
- Satellite images and aerial photographs.

4.2 Terrestrial/ Marine Survey

4.2.1 The archaeology team surveyed the proposed development area by conducting a random field walk sample survey which extended into the water. A linear transect survey could not be employed due to vegetation cover and a swampy terrain in the study area on land. A brief survey of the sea was employed due to the very low tide and stagnant water.

Plate 5: Random Field Walk Survey

A JNHT diver explored the proposed location of the overwater suites for archaeological resources. Low tides greatly facilitated this venture.

4.3 Recording and Analysis of Archaeological features

4.3.1 The archaeological features were recorded by means of digital photographs, GPS, survey and field notes.

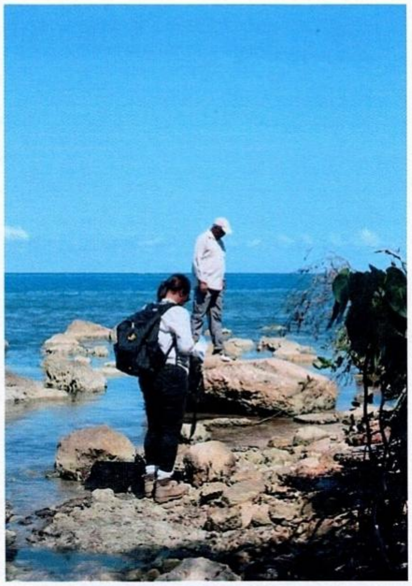


Plate 6: Notes being taken after making observations

Plate 7: Archaeological Field Assistant/ diver taking measurement of the metal object in sea previously observed during high tide

4.3 Non-Intrusive Technique

4.3.1 A metal detector was used to locate buried metallic artefacts, helping archaeologists efficiently pinpoint historically significant objects that would otherwise be difficult to uncover. This method not only saves time but also minimizes the disruption of the surrounding soil, preserving the integrity of the site.

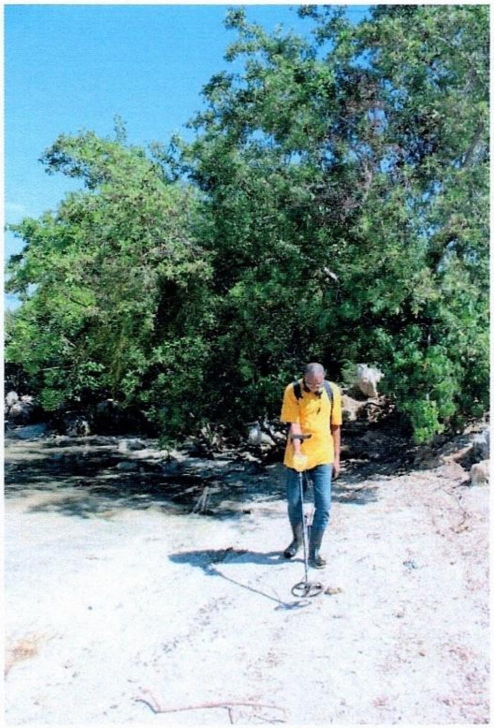
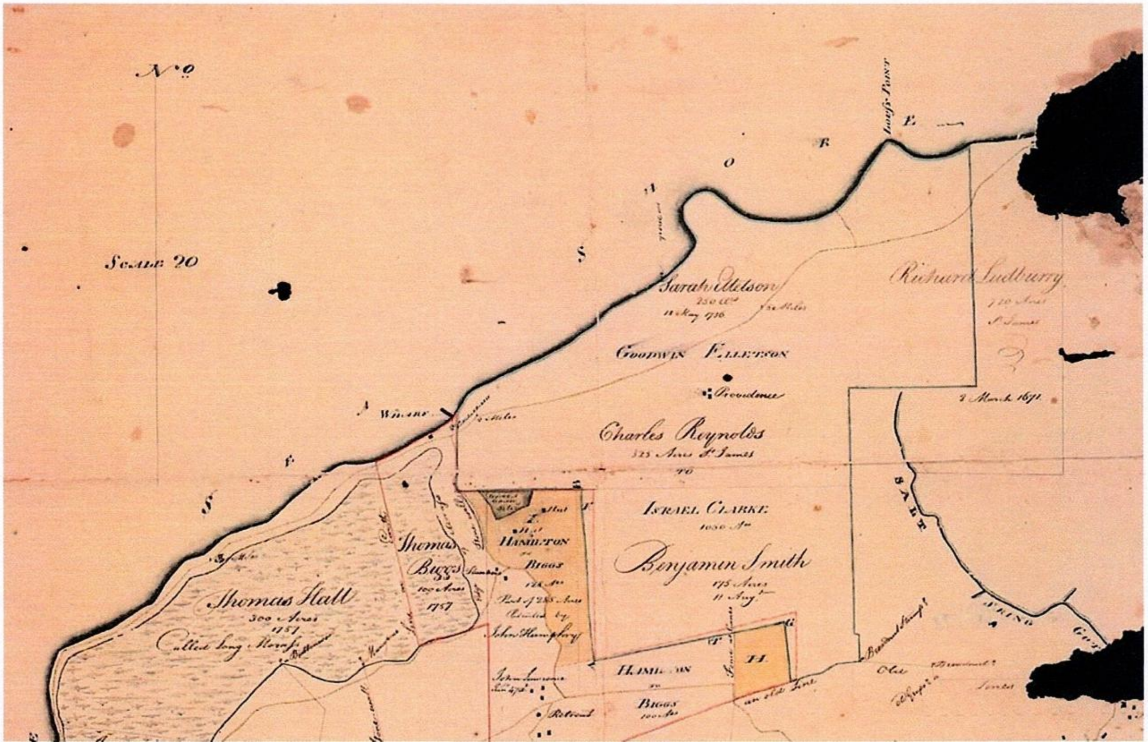


Plate 8: JNHT Archaeological field assistant using the metal detector

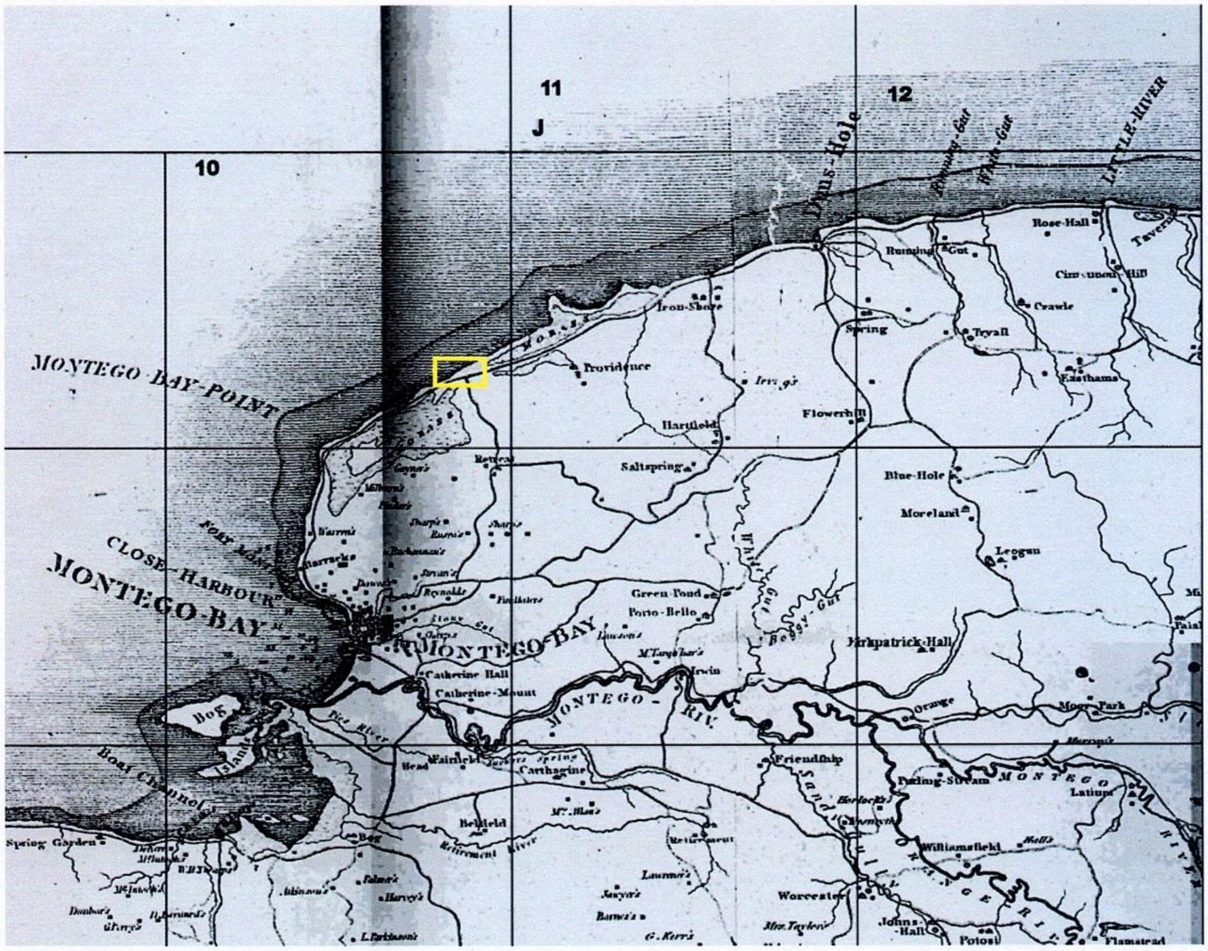
5. DESK BASED ASSESSMENT RESULT

5.1 Historical Background

5.5.1 The proposed development area is part of the Providence Estate. A 1785 Survey of the area shows that the land was owned by Sarah Elletson and Goodwin Elletson in 1736. The 1763 Craskell and Simpson map shows no sign of activity in the area. Later on, James Robertson's 1804 map shows the name 'Morass' in the vicinity of the proposed development area. The Thomas Harrison's 1889 map displays new names such as 'Umbrella Point' and 'Mahoe Bay' while the Providence Estate plan labels the area as seashore (see maps 4, 5, 6, 7 and plan 3). The historical maps also show wharfs that were in the area.

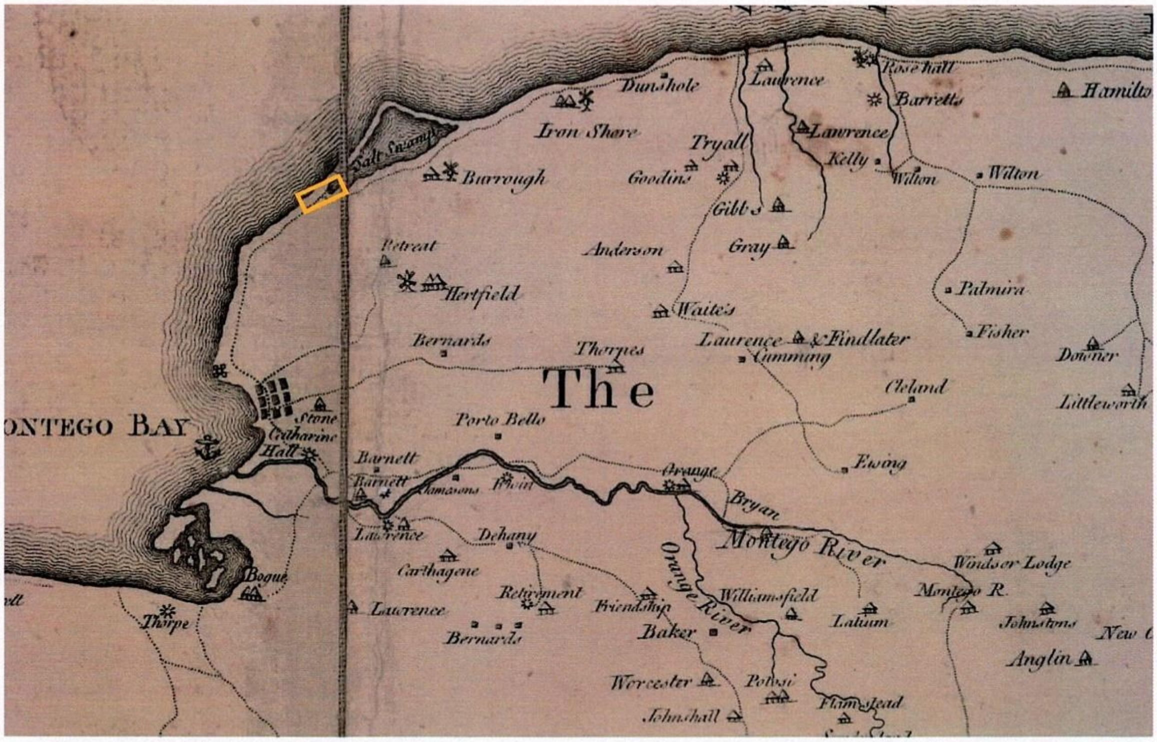


Map 4: 1785 Survey map done by H. Sheriff

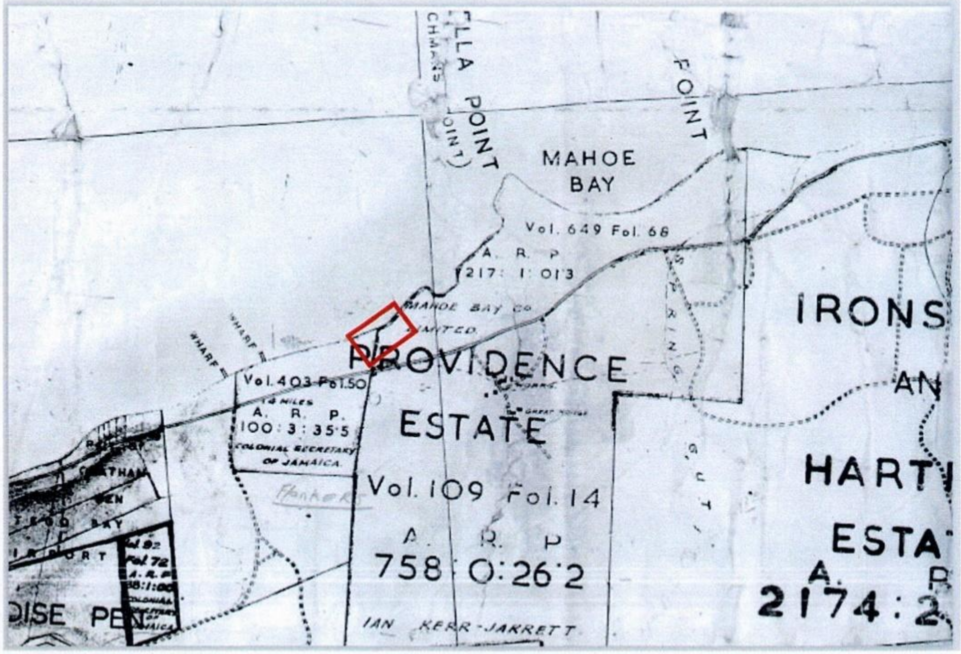


Map 5: James Robertson's 1804 map

"Mahoe Bay" is named after the Seaside Mahoe (*Hibiscus populneus*) introduced to Jamaica from the East Indies by Hinton East in 1784. "Mahoe" is also derived from a Kalinago Indian word. Aircrafts taking off from the **Sir Donald Sangster International Airport** must turn left to avoid a hill and must pass over Mahoe Bay. As a result of this, any hotel built there is restricted in height to 3 storeys. Contrary to its permit, in 2008 the Spanish hotel chain RIU built a 4-storey hotel there and had to demolish the offending top floor.



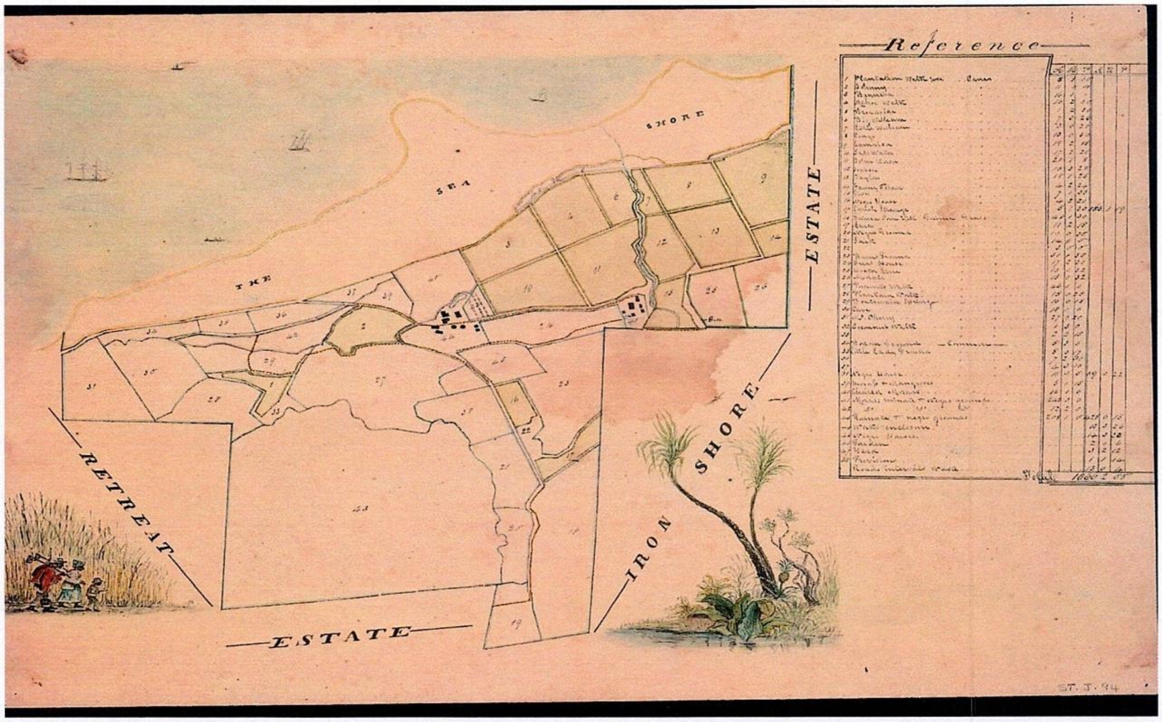
Map 6: 1763 Craskell and Simpson Map showing the approximate location of the proposed development area



Map 7: Thomas Harrison's 1889 Cadastral Map

Providence Estate was a sugar estate with a mill, Great House and Slave village (See Map 5, 6 and plan 3). John Sill, deceased, is recorded as the owner of Providence Estate in 1811. The estate had 219 enslaved persons and 59 heads of stock. Between 1815 and 1832 Ann Sill was the chief owner. In 1815 she had 207 enslaved persons and 127 heads of stock. In 1817 and 1818 there were 197 enslaved persons and 165 heads of stock. There was a slight decrease by 1824 when she had 193 enslaved persons and 163 heads of stock and further decrease in 1824 with 184 enslaved persons and 161 heads of stock.

Elizabeth Stennett owned 27 enslaved persons and 1 head of stock in 1815. Several other persons are listed for 1817; Isaac Simon had 11 enslaved persons, Duncan Sinclair had 20, Jane Sinclair had 6, James Spence had 3, Spence and Jones 4, the heirs of Elizabeth Stennett 22, Jacob Solomon had 4 enslaved persons and 4 heads of stock, Alexander Spalding 11 enslaved



Plan 3: Plan of the Providence Estate

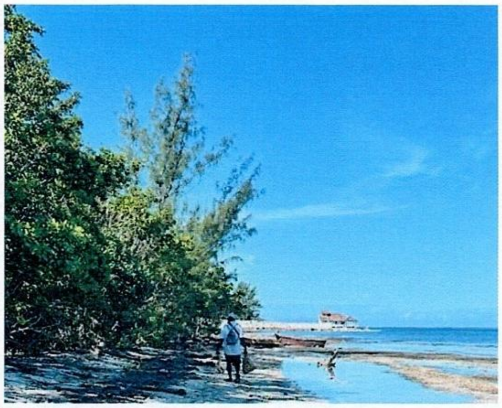
persons and 1 head of stock, William Morris Spence 8 enslaved persons and 5 heads of stock, Thomas Stennett had 9 enslaved persons and 2 heads of stock and Grace Trought 4 enslaved persons and 2 heads of stock.

In 1818 Isaac Simon had 11 enslaved persons, Duncan Sinclair had 20, Jane Sinclair had 6, Spence and Jones 8, heirs of Elizabeth Stennett 8 enslaved persons and 5 heads of stock, Jacob Solomon had 4 enslaved persons and 4 heads of stock, Alexander Spalding 11enslaved persons and 1 head of stock, William Morris Spence 4 enslaved persons, Thomas Stennett had 22 enslaved persons. In 1824 the heirs of John Smith had 1 enslaved person, Alexander Spalding 10 enslaved persons and 5 heads of stock, William Thomas had 7 enslaved persons and 3 heads of stock, Patrick Spence had 1 enslaved person and 10 heads of stock and Elizabeth Stennett 10 enslaved persons.

The extent of the property in 1882 was 1066 acres with 154 acres in canes, 95 acres in ground provisions, 201 in common pastures and pimento and 616 acres in wood and ruinate. One Mr. Broadwood was the owner with D'B.S. Heaven as his attorney and Richard Cooke in occupation. In 1881 the estate produced 100 hogsheads of sugar and 60 puncheons of rum and in 1882 148 hogsheads of sugar and 78 puncheons of rum. The estate employed 3 Free Coolies. W. G. and H. King owned the sugar estate in 1912 with W. L. Kerr in occupation. The estate was valued at £2,800. In 1954 Ian Kerr Jarrett owned the 758-acre property.

5.2 Present Land Use

5.2.1 The proposed development area is situated near the White House Fishing Village, where fishermen engage in line fishing and diving for spearfishing and conch. It also serves as a harbour for paddle canoes. The area is used for the harvesting of seashells and dumping of collected seagrass. It is also used by vendors as a holding area for their craft items such as carvings. The



aeroplanes that leave the Donald Sangster International Airport pass directly over this area therefore the proposed site is affected by noise pollution.

Plate 9: Craft vendor seen walking on the beach

Plate 10: Fishermen at the beach

7. SITE ASSESSMENT RESULTS

The proposed site covers a narrow stretch of land, featuring a beachfront view to the north, and the southern portion which is more densely vegetated is adjacent to the Donald Sangster International Airport.

7.1 The coastline in this area is marked by a receding water level, particularly in the morning hours, causing the water to retreat further from the shoreline. According to local fishermen from the White House fishing village, this has delayed their early morning activities, as there is not enough water to paddle their boats. As a result, they have resorted to spear fishing until the water levels return to normal.

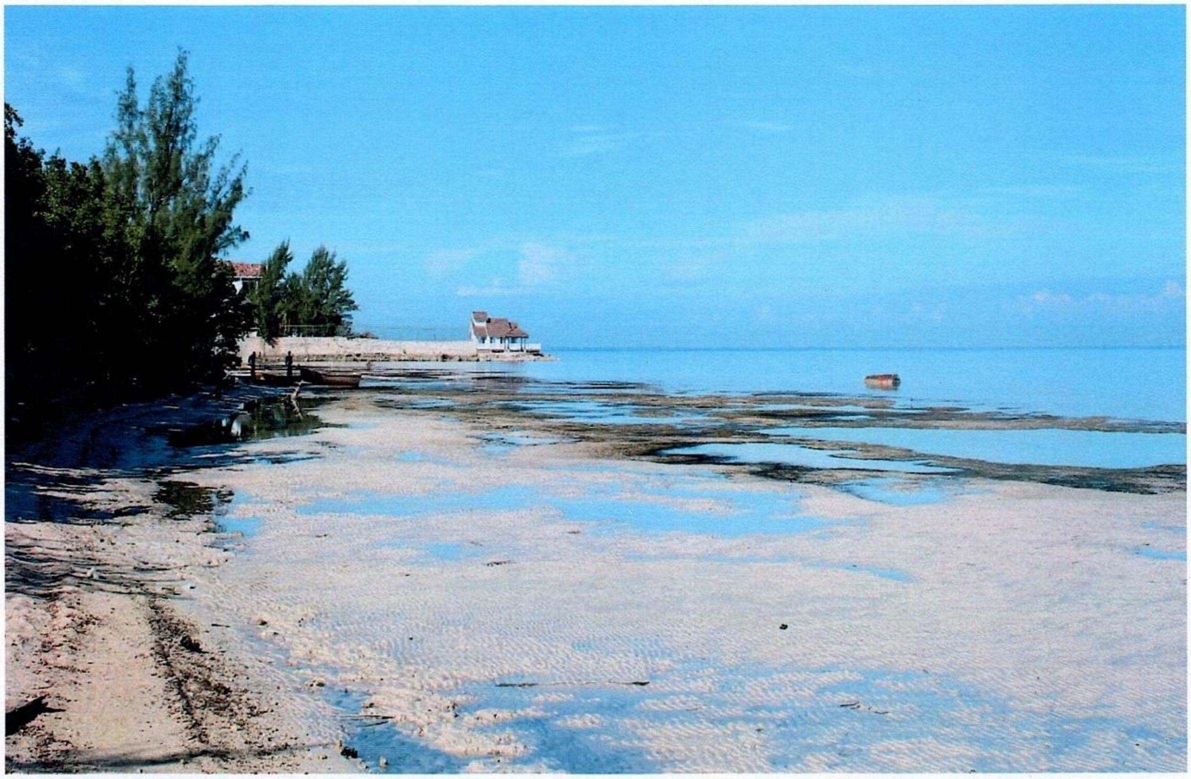


Plate 11: Low tide causing shoreline to recede

Plate 12: Sea grass exposed during low tides

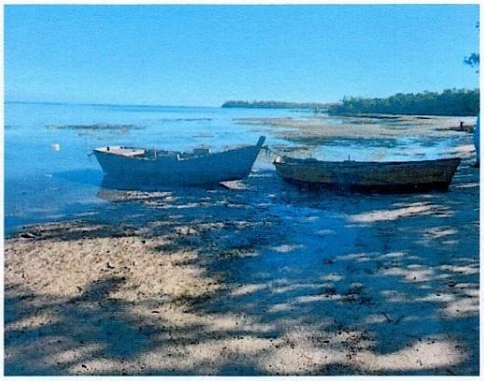
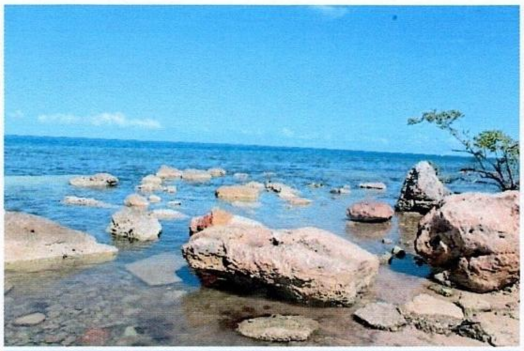


Plate 13: Canoes immobilized due to low tide

The area appears to have been artificially altered in the past, as boulders seem to have been brought in and deposited there. This may have been an effort aimed at supporting the revetment. To the east of the proposed development area is the airport canal/channel, which take excess water from the airport runway and discharges it into the sea.

Plate 14: An overview of the coastline, featuring boulders and stones

However, while some boulders were transported from elsewhere, there is evidence of natural deposits as well. These natural deposits of large rocks and boulders were observed closer to the shoreline and within the receding waterline.



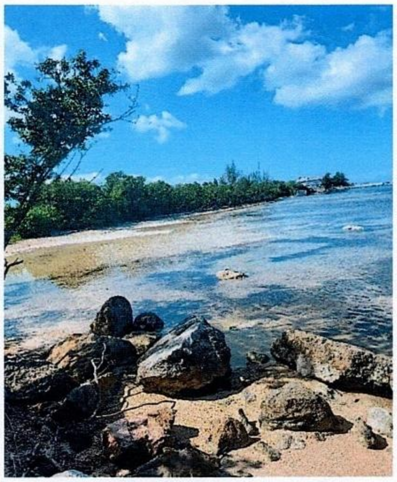
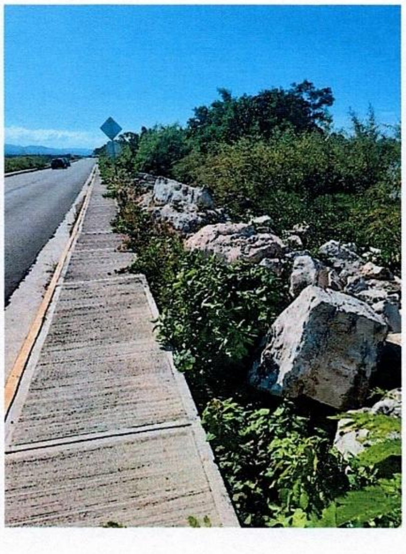
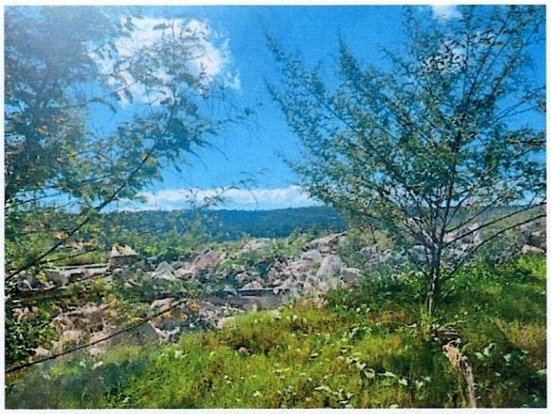


Plate 15-16: Large rocks visible during low tide

Boulders were also present in the southern development area which is along the roadside adjacent to the Donald Sangster International Airport runway.





Plates 17-18: Boulders along the side of the roads, possibly used as a revetment

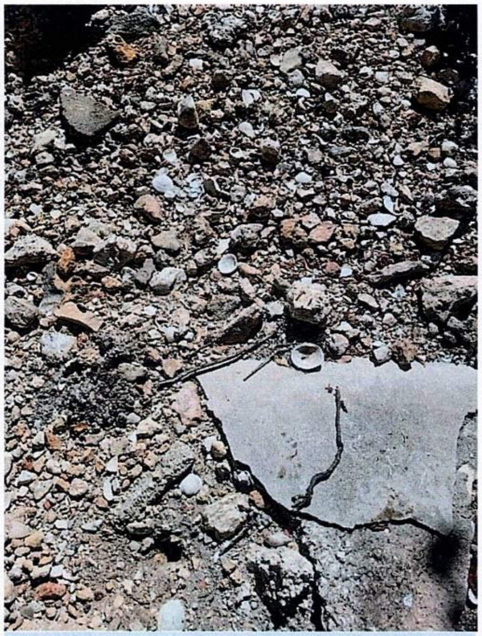


Plate 19: Displaced concrete foundations

Uplifted concrete slabs are also observed at various sections throughout the property. The displacement of these slabs suggests that some building foundations may have been located within the vicinity.

Marine fossils, in the form of coral and shells, were observed scattered across the proposed development area. Based on observations, it appears that geological processes, such as the tidal actions of high and low tides, have contributed to its presence.

Plate 20: Uplifted concrete foundation

Plate 21: Dead coral reef fragments

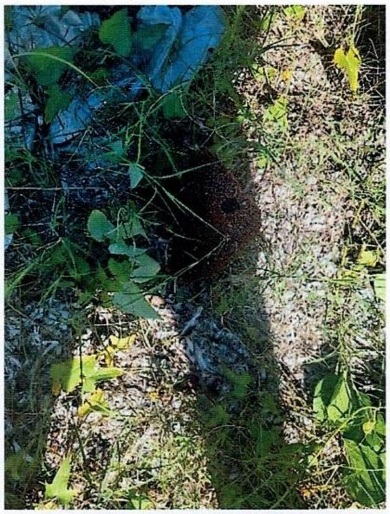
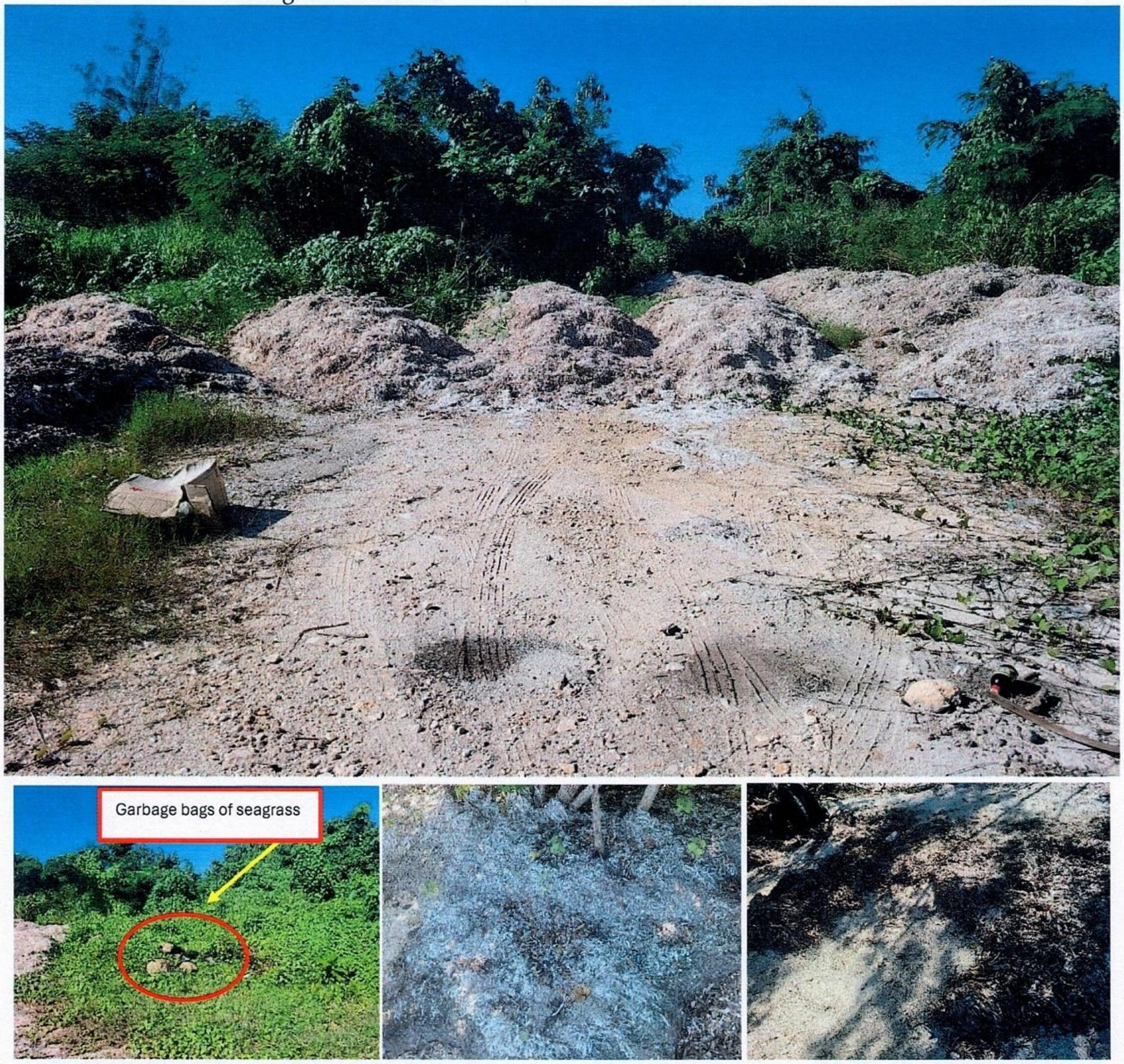


Plate 22: Coral found on the beach

Plate 23: A variety of shells along the beach

A significant number of marine debris, primarily sea grass, was observed. This was particularly noticeable in the southern section of the development area, along a pathway leading from the road to areas where piles and garbage bags of sea grass were seen.



Plates 24-28: An abundance of seagrass seen in several areas of the proposed development site

The area provides a livelihood for fishermen from the White House fishing village. They use spearfishing techniques, small paddle canoes, and kayaks to fish further from the coastline. Additionally, the area is used by craft vendors who take their items out to tourists using kayaks.

Plate 29: Few kayaks seen in bushes

Plate 30: Spearfishing gun

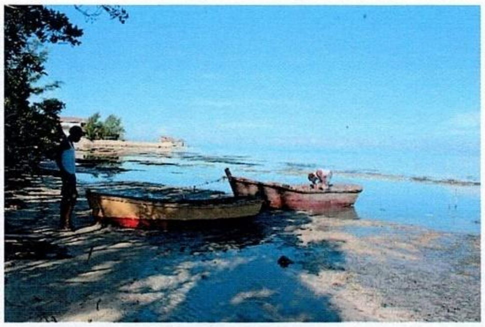


Plate 31: Canoes affected by the receding shoreline

Plate 32: Paddles for the canoes

There are clear indications that fishermen in the area are involved in conch harvesting, as evidenced by the presence of broken conch shells. Additionally, fish scaling is also being carried out, as there are visible traces of fish scales and fish guts found at the site.

Plate 33: Queen conch *(Strombus gigas)*

Plate 34: A cluster of seashells and fish scales

Several abandoned concrete structures were identified, which were once used as public beach changing rooms and possible restrooms. Over time, land reclamation by the sea and constant wave action have eroded these buildings, causing some of the concrete foundations to be lifted and displaced.

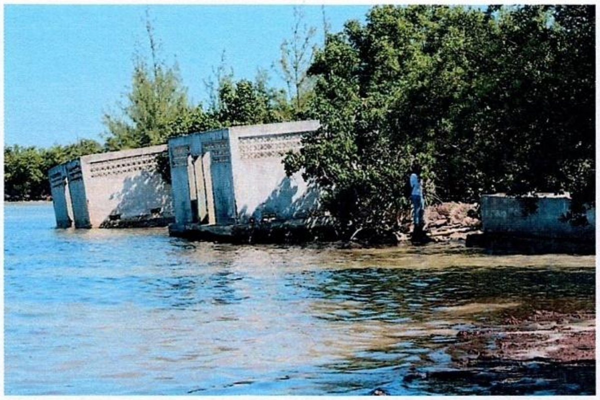


Plate 35: Two buildings affected by tidal movements

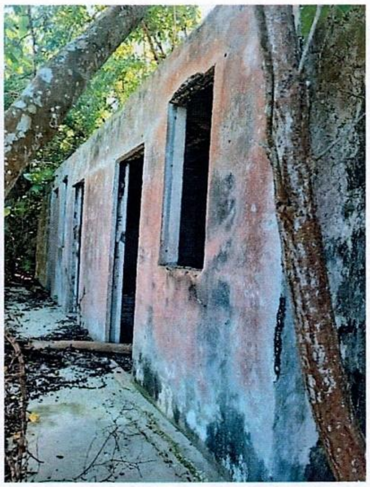


Plate 36: Another building located near the boundary wall of the hotel

Plate 37: Uplifted concrete foundation with cistern nearby

In addition, there are visible electrical conduits and old pipes still present. Notably, a strong stench emanates from this area, suggesting the presence of a nearby sewage system. It is evident that the sewage system is contaminating the seawater, particularly during high tides.

Plate 38: An exposed manhole

Plate 39: Fallen light post

Plate 40: A drainage pipe is visible, seemingly connected to a runoff area

Plate 41: Concrete moulded objects

Plate 42: A tree was observed growing through the concrete, causing it to crack

Regarding the artefactual evidence found on the surface of the site, only a few fragments of brick and ceramic sherds were discovered. These pieces were found along the beach and at the shoreline. In the swampy area, additional ceramic fragments were also observed.

Plates 43-48: Collage of ceramic artefacts found on the site including brick fragments and ceramic sherds

A metal cylindrical object was observed several meters offshore, approximately 152.8 feet from the shoreline. Local fishermen believe the object holds little value and is likely debris from a ship. One fisherman mentioned that it has been in the area for over twenty years.

Plate 49: Cylindrical object located offshore

The object features an opening with a diameter of 4 feet 6 inches and a length of 8 feet. Additionally, there are perforations at its base.

Plate 50: Opening of the cylindrical object

Several waste materials have been observed throughout the site, including areas along the shoreline and in the swamp regions. There is also a build-up of debris washed ashore by high tides. Some of the waste materials observed included plastic bottles, tyres, Styrofoam boxes amongst other materials. Additionally, tiles, old pipes, and wires were seen within the interior sections, scattered among the concrete foundation, which likely would have been part of the flooring.

Plates 51-53: Waste materials seen along the beach

There was a noticeable change in the type of vegetation within the mangrove/swamp area, which runs in close proximity to the southern boundary of the site and is visible from the sidewalk.

Plate 54: The swampy area observed in the proposed development area

There are some dry areas and muddy sections, but the fishermen pointed out that whenever it rains or during high tides, the water in this area takes several days to recede to normal levels.

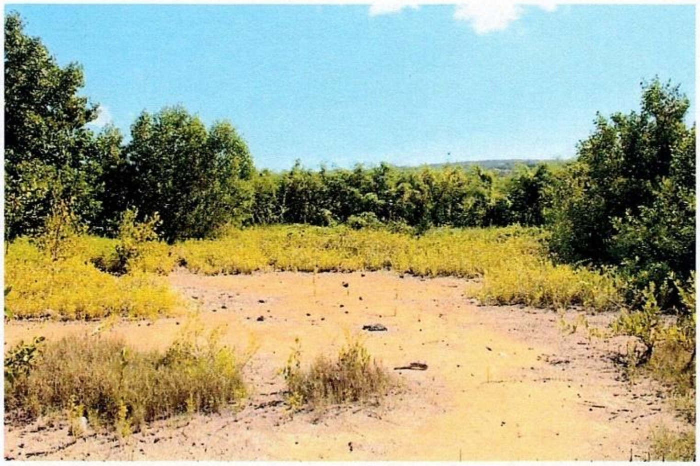


Plate 55: This area was covered in mud

9. Impact Summary

Table 1: Summary of Potential Impacts due to Proposed Project

No.	Impact	Negative		Positive		No Impact
		Short Term	Long Term	Short Term	Long Term	
A	**Project Setting**					
I.	Displacement of People		√			
II.	Change of land use		√		√	
III.	Loss of trees/vegetation		√			
IV.	Shifting of utilities					√
V.	Impact on archaeological/historical property					√
B	**Construction Phase (including pre-construction activities)**					
I.	Pressure on local infrastructure		√			
II.	Impact on water quality				√	
III.	Impact on air quality (including dust generation)	√				
IV.	Noise pollution	√				
V.	Traffic congestion	√				
VI.	Staking and disposal of construction material	√				
VII.	Public health and safety	√				
VIII.	Social impact				√	
C	**Operational Phase**					
I.	Change in ambient air quality		√			
II.	Increase in noise levels				√	
III.	Induced infrastructure development				√	
IV.	Quality of life				√	

10. DISCUSSION, RECOMMENDATION and CONCLUSION

According to the historical maps and plans the proposed development area forms part of the Providence Estate. The historical plan of the estate also shows that this area was labelled "the seashore" and the areas immediately adjoining in the south labelled as cane fields. One map also indicates that sections along the coastline of the estate are now referred to as Mahoe Bay Lands. In addition to this, there is presently no evidence of occupation by Jamaica's indigenous population, the Taíno in this area. Excepting for a wharf in the vicinity there is little evidence to show that the proposed development area was utilized much during the plantation era. The historical maps also show that morass or swamp was in this area, and this is still evident today.

The archaeological survey has shown that although there were recreational activities based on the modern abandoned structures, it is now used as a holding area for fishing boats, kayaks and craft items. The wet mangrove environment would have impeded development as well as the fact that the land is at sea level and is prone to flooding.

In addition to the shells, corals, and crabs observed, a few fragments of brick were also noted. The area however has a history of being used as a dumping ground, with materials brought in from other locations, disrupting the context of any archaeological deposits. A few brick fragments were also identified along the shoreline, likely influenced by tidal movements that have affected the area in more recent times, causing materials to be carried from land into the sea during high tide.

While this area may have been underutilized in the past, it is possible that some of these brick fragments found could be linked to another section of the Providence Estate.

The development will however result in the loss of vegetation as the wetland will be destroyed. Aside from this, the other developments/ businesses from the adjoining areas will be affected by dust and noise pollution. The sea and canal could be potentially polluted by the impending construction. The development could however provide more jobs, accommodation for leisure and an increase in foreign exchange to Jamaica. Aeroplanes from the Donald Sangster International Airport fly over the site regularly and this results in a noise nuisance. This proximity to the airport results in limitations as the floors of any development should not exceed three floors.

The proposed development area has no historical structures although there are a few brick fragments and artefacts the sparse archaeological contexts present on the site are insignificant to the proposed development.

Based on the archaeological evidence available at this time it is not significant enough to warrant *in situ* preservation. As such the JNHT Archaeology Division has no objection to the proposed development.

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