Environmental Assessment

MIXED-USE DEVELOPMENT AT READING PEN, ST. JAMES

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Submitted to:	NATIONAL ENVIRONMENT & PLANNING AGENCY

ENVIRONMENTAL ASSESSMENT FOR MIXED-USE DEVELOPMENT AT READING PEN, ST. JAMES

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PROJECT DESCRIPTION

Background and Location

LCH Development Ltd. has embarked on a mission to provide sun-seekers who want to invest in paradise by formulating a team to execute a mixed-use residential development that will satisfy the investor's appetite. This development, named The Peninsula, will more importantly, change the landscape of what Jamaica has to offer in terms of real estate, offering both locals and non-residents an opportunity to enjoy a 1st world lifestyle.

The proposed development will be located at 2 Reading Pen, in the sub-urban community of Reading, St. James. It is located along the Bogue Main A1 Road, approximately 2 kilometres southwest of Montego Bay, the second largest city in Jamaica. The site is bounded to the north by the Caribbean Sea, to the south by Bogue Road, to east by Friendly Irons Shooting Range and to the west a vacant lot.

Project Features

The Peninsula in Reading, Montego Bay seeks to offer luxury residential living with supreme amenities to promote a lifestyle of wellbeing. The 7-hectare (17.5 acre) waterfront property entails 5 zones:

- Zone 1: The Villas at The Peninsula (80 habitable rooms)
- Zone 2: The Peninsula Bay
- Zone 3: The Towers at the Peninsula (1,356 habitable rooms)
- Zone 4: The Commercial spaces
- Zone 5: The General Ground Amenities and Project Management and Back of house buildings

Zone 1 encompasses 15 3000 sq. ft. modern 3-bedroom villas along the waterfront with large glazing and open-concept space to allow light from the morning sunrise. Garage space, staff quarters, pool and deck with pergola and 2 levels are included.

Zone 2 is located at the tip of the peninsula overlooking the Caribbean Sea facing northwest. The ground level which houses the restaurant has inside and outside dining. The outside dining has pathway access to the marina, which crosses over the site's main water feature. The clubhouse is on the 2nd level for members only to host events. This area also has an outside deck and bar overlooking the sea. The 3rd level hosts a karaoke lounge for mostly night-time fun. The fourth and fifth levels have guest units for residents who will host their guests in these units whenever they come to visit.

Other features in Zone 2 include:

- 7000 sq. ft. fine dining restaurant with panoramic views of the sea.

- 5000 sq. ft. clubhouse and lounge
- 3400 sq. ft. karaoke lounge
- 6 guest apartments
- Mini marina that has at least 8 berths for residents that own boats. Also, for the docking of restaurant patrons.

Zone 3 includes four high rise towers approx. 336 ft./102 m tall are proposed within Zone 3. The design is also modern, using the elements of a concrete structure wrapped in tinted glass to reflect the surrounding sea. The curved balconies create movement in the structures with a structure on top that mimics the waves in the sea. The towers are strategically placed on the site to accommodate the north trade winds that will flow between the towers and not to obstruct the view to the sea from the surrounding hillside. The towers themselves offer panoramic views of the sea for the proposed residents. Each building is designed to suit the residents' needs. One can enter each tower via the entrance roundabout covered by a porte-cochere into a double-height lobby adjourned with sleek minimalist contemporary furniture or via the bridge on the 7th floor leading from the parking and roof amenities building.

Zone 4 comprises a Supermarket/Deli with a mini food court in a 15,000 sq. ft. building. The entrance area to this building has a covered courtyard with a large canopy for patrons to enjoy outdoor seating set around planter boxes and landscaping with vending kiosks. Shops and offices in a three-storey building on either side of the supermarket are planned, to support the residences in the complex and the surrounding areas. These spaces are intended to be a doctor’s office, pharmacy, high-end retail and executive offices.

Zone 5 amenities on the ground will include two tennis courts and one basketball court. The property will also have recreational parks with jogging/walking trails and gazebos. Towards the east of the towers, there will be a meandering water feature with outdoor landscaped lounges and gazebos. The ponds are excavated spaces lined with heavy-duty pond liners to be filtered with fountain and pump systems.

Construction will be done on a phased basis. Phase 1 includes Towers 1 and 2 with parking garage, supermarket, offices and amenities. Phase 2 includes Towers 3 and 4, with parking garage, restaurant and marina. Phase 3 includes the Seaside villas. The work force for the site will at peak time be approximately 1,000 trade men and labourers during the construction phase.

<u>Auxiliary Project Activities</u>

Water for the development will be supplied by the National Water Commission (NWC). Wastewater for the proposed development will be collected via septic tanks, and then piped to the NWC municipal sewerage network where it will be treated at the Bogue Wastewater Treatment Facility.

Water consumption per day: 400 Litres (0.4 m^3) per person
Sewage discharge per day: 380 Litres (0.38 m^3) per person

Max water consumption per day: 1,022,000 Litres (1,022 m^3)
Max sewage discharge per day: 970,900 Litres (970.9 m^3)

Jetty/Marina Design

A marina will be designed to accommodate ten (10) forty-five foot (45 ft) (13.7 metre) vessels. The designs were prepared in accordance with various industry standards and codes of practice. For the purposes of the marina design, the specifications of the Ocean Alexander 45 Divergence boat were used as the design vessel.

The jetty was designed for a 50-year return period and took into consideration the design of the decking, decking piles and mooring piles. The key loads considered were:

1. Boat impact
2. Wind
3. Waves
4. Dead load of deck, beams and stringers
5. Anticipated live loads on decking

POTENTIAL IMPACTS AND RECOMMENDED MITIGATION

The potential impacts of the proposed project along with recommended mitigation measures are outlined in the tables below:

Site Preparation and Construction Phase

<table>
<tr><th colspan="2">CATEGORY</th><th>IMPACT</th><th>RECOMMENDED MITIGATION</th></tr>
<tr><td rowspan="5">Physical</td><td>Geotechnical</td><td>The presence of soft and susceptible to liquefaction layers near the surface may require the use of deep foundation to support all the structures.</td><td>Based on the subsurface conditions obtained from the field exploration, Horizon Construction Jamaica Ltd recommended using deep foundation for all the structures of the new development. It was recommended that Continuous Flight Auger (CFA) Piles be used for this project.

Fluid mortar shall be pumped using the “tremie” methodology through the augers, filling the hole from the tip as the augers are withdrawn. The tip of the auger shall be at all times submerged into the fresh mortar during the pumping process</td></tr>
<tr><td rowspan="2">Stormwater Discharge and Water Quality</td><td>Raw materials, for example marl used for filling and temporary roads, will be stored on site and used in various construction processes and may be prone to increased suspended solids from run-off as a result of rainfall events, and thus have the potential to increase marine water turbidity.</td><td rowspan="2">i. The project site will put in sediment control measures such as turbidity barriers/silt screens and should be erected around the active work area to prevent the dispersion of sediments and contaminants throughout the water column.
ii. A central area will be designated for the storage of raw materials. This area should be lined in order to prevent the leakage of chemicals into the sediment.
iii. Fine grained materials (sand, marl, etc.) will be stockpiled away from drainage channels and low berms will be placed around the piles which themselves will be covered with tarpaulin to prevent them from being eroded and washed away. Silt fences may also be utilized to prevent siltation.
iv. Stoppage of works during adverse weather conditions
v. Raw materials that generate dust should be covered or wetted frequently to prevent them from becoming air or waterborne.
vi. Raw material and equipment should be stored on impermeable hard stands surrounded by berms to contain any accidental surface runoff.
vii. Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored. In addition, these containers should be surrounded by bunds to contain the volume being stored in case of accidental spillage.
viii. Refuelling of boats should only be done at anchor out at sea if the sea conditions are calm, otherwise, all refuelling should be done when docked at land. Appropriate refuelling equipment (such as funnels) and techniques should always be used.
ix. Appropriate minor spill response equipment (for containment and clean- up) will kept on site, including oil absorbent pads and disposal bags.
x. In terms of transporting equipment, the paths of the planned roadways will be used, rather than creating temporary pathways just for equipment access.
xi. Raw materials such as marl and sand should be adequately covered within the trucks to prevent any escaping into the air and along the roadway.
xii. Vehicle refuelling facilities must be situated on impermeable surfaces served by an oil trap, run-off collection system. Sediment basins and oil water separators should be constructed to intercept storm water before it is discharged.</td></tr>
<tr><td>Plume dispersion modelling showed that a plume is generated at both sides of the Peninsula as the highest concentration of 360 mg/l at the shoreline. It then quickly dissipates to a 300m wide plume with TSS values ranging from 10 - 50 mg/l TSS returns to ambient conditions. The estimated turbidity of the plume is 15 - 65 NTU. This means the water is noticeably cloudy and slightly opaque, making that area unsightly and mildly dangerous to marine life in the short term.</td></tr>
<tr><td>Noise</td><td>Site clearance and construction necessitates the use of heavy equipment to carry out the job, including bulldozers, backhoes, jackhammers, etc. These activities and required equipment possess the potential to have a direct negative impact on the noise climate.</td><td>i. Use equipment that has low noise emissions as stated by the manufacturers.
ii. Use equipment that is properly fitted with noise reduction devices such as mufflers.
iii. Operate noise-generating equipment during regular working hours (e.g. 7 am – 7 pm) to reduce the potential of creating a noise nuisance during the night.
iv. Construction workers operating equipment that generates noise should be equipped with noise protection. A guide is workers operating equipment generating noise of ≥ 80 dBA (decibels) continuously for 8 hours or more should use earmuffs. Workers experiencing prolonged noise levels 70 - 80 dBA should wear earplugs.</td></tr>
<tr><td>Air Quality</td><td>Fugitive dust from the proposed construction areas and raw materials stored on or transported to site (potential for materials to become airborne). Fugitive dust has</td><td>i. Areas should be dampened every 4-6 hours or within reason to prevent a dust nuisance and on hotter days, this frequency should be increased.
ii. Minimize cleared areas to those that are needed to be used.</td></tr>
</table>

CATEGORY		IMPACT	RECOMMENDED MITIGATION
		the potential to affect the health of construction workers, the resident population and the vegetation.	iii. Cover or wet construction materials such as marl to prevent a dust nuisance. iv. Where unavoidable, construction workers working in dusty areas should be provided and fitted with N95 respirators.
	Vibration	Persons occupying the Friendly Irons Shooting Range located 40 m away would barely perceive any vibrations from the majority of the construction activities/equipment. However, vibration from the vibratory pile driver and the vibratory roller is considered unacceptable for people exposed to it continuously (pile driver) and in the case of the roller, vibrations may become annoying to persons	i. Sequence of operations: ○ Phase earth-moving and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately. ○ Avoid night-time activities. People are more aware of vibration during the night-time hours. ii. Avoid impact pile driving where possible in vibration-sensitive areas. Drilled piles or vibratory pile driving causes lower vibration. iii. Have regular meetings or devise a communication strategy to inform the surrounding residents and businesses of construction activities.
		From a building standpoint, there is no effect on the shooting range from vibration emissions from the majority of the construction equipment including the roller, however pile driving has the potential to cause damage to weak or sensitive structures.	
		For persons occupying the commercial area across the road, located 90 m away, vibrations from the majority of construction equipment would be imperceptible. Vibrations from the roller and pile driver would become annoying if continuous.	
		From a building standpoint, there is no effect on the commercial buildings from vibration emissions from construction.	
Biological	Mangrove Community	There will however be some pruning of mangrove trees along eastern boundary to ensure the building footprints do not encroach on the mangroves.	i. An arborist with experience in the pruning of mangrove trees must be consulted and contracted by the developer, to conduct an assessment of the areas to be pruned and develop a pruning methodology to ensure the continued survival of the trees. ii. Signage indicating no removal of main mangrove tree trunks, as well as conservation/educational signage along the impact areas. iii. Perimeter fencing around pruned mangroves
		The proposed development may result in the loss of approximately 269.6 m^2 (0.0269 hectares) of mangrove forest as a result of the jetty construction toward the north-western property boundary	Rehabilitation of 269.6 m^2 of mangrove toward the east of the property where there is an existing area of thinning mangrove. This area should be filled with sand and then rehabilitated with mangrove saplings.
	Fauna	Possible presence of crocodiles and danger to workers and crocodiles on site from interaction	The contractors and construction crew should be aware of their surroundings. The site should be fenced, and signage should be placed around the site informing and educating construction crews about the possibility of crocodiles and what to do if one is observed. Any sighting of a crocodile in the area at any stage of the project should be reported to the National Environment and Planning Agency (NEPA).
	Marine Environment	Seagrass, fish, urchins and other invertebrates may be impacted by sedimentation and smothering, habitat fragmentation/loss, increased water turbidity and suspended solids and some species loss.	1. During construction, the project site should include sediment control measures such as turbidity barriers/silt screens and should be erected around the entire work area to prevent the dispersion of sediments and contaminants throughout the water column. These should be placed so as to reduce/contain the resultant sediment plume during the activities. Construction activities should only continue when these barriers are fully operational, that is; placed correctly; calm to moderate sea conditions; without damage. These barriers are particularly important when operations occur near or may influence sensitive ecosystems and species such as coral reefs and seagrass beds and or filter feeding organisms and fish. 2. Weekly monitoring of water quality parameters such as temperature, salinity, pH, Dissolved Oxygen, light irradiance, turbidity and Total Suspended Solids (TSS) in and around the project area should be conducted during construction for the first 3 months of construction. Monitoring can be conducted fortnightly thereafter. 3. Conduct sediment dispersal calculation rates in seagrass beds within 200 meters of the jetty and at control stations, on a monthly basis, for comparison to background levels. Pre-construction sedimentation rates should therefore also be conducted and used as a baseline for comparison.

CATEGORY		IMPACT	RECOMMENDED MITIGATION
			4. All activities should be limited to the minimal working area, and as such reducing the extent of the footprint. No activities and or placement of anchors or materials should be done placed outside the approved area. 5. Relocation of sensitive species should be done if; they are suitable for relocation (that is suitable substrate, health and over all viability), those species fall within the potential impact area; and if mobile invertebrates are in or around the potential impact area. Sensitive organisms and systems in and outside the impact area include; hard and soft corals, sponges, seagrass and mobile invertebrates such as urchins, sea cucumbers, starfish and conch. Detailed Seagrass Removal and Relocation Plans, if required, as well as a Post-Relocation Monitoring Plan, must be prepared for approval by NEPA. 6. Alternative mitigations should be proposed when relocation is unlikely to be successful. 7. Where possible, as little of the natural environment should be relocated or removed. Habitat fragmentation and species displacement should be temporary, with the placement of silt screens, construction materials and equipment as well as general human activity in the area. 8. Structures placed on the seafloor may cause habitat fragmentation and displace some species, however they may also serve to add ecological volume, providing substrate for organisms to settle and colonize and eventually may serve some ecosystem functions. 9. Any temporary floating structures and /or vessels should be placed in areas with less sensitive species where possible. Floating structures anchored or moored over seagrass beds or coral colonies should not be left for prolonged time periods as the resulting shading effects may cause deterioration in overall health of the seagrass bed and coral colonies.
	Sea Turtles	Temporary displacement of any sea turtles that utilize the general area for foraging and nesting from construction activity. Displacement may occur as a result of; silt screens and other barriers and equipment being utilized, this may prevent/limit access to various habitats and pathways (fragmentation).	i. Attempts should be made to schedule the majority of the construction period outside of turtle nesting season (May – October). ii. All staff and workers should be sensitized to all sensitive ecosystems and species in the area, in particular turtles. The site should be inspected daily for any signs of turtle activity. If a nest is suspected or found, all activity nearby should stop until an expert can determine if there is a nest and how to relocate the eggs. iii. The stakeholders, proponents and the NEPA should develop clear lines of reporting and communication in the event that action needs to be taken. iv. Silt screens should be used to prevent sedimentation but should be removed promptly along with any other construction debris and material upon completion. v. Night-time activities should be limited or avoided when possible. No lights should be pointed out to sea confusion and disorientation of turtles or any other species that maybe affected by lunar activity. vi. Fixtures in direct line-of-sight from the beach should be shielded down-light only fixtures or recessed fixtures having low wattage "bug" type bulbs and non-reflective interior surfaces.

CATEGORY		IMPACT	RECOMMENDED MITIGATION
			vii. Fixtures mounted as low in elevation as possible through use of low-mounted wall fixtures, low bollards and ground level fixtures. viii. Floodlights, up-lights or spotlights for decorative and accent purposes that are directly visible from the beach or which indirectly or cumulatively illuminate the beach shall not be used. ix. For high intensity lighting applications such as providing security and similar applications shielded low-pressure sodium vapour lamps and fixtures shall be used.
Human/Social	Employment	The work force for the site will at peak time be approximately 1,000 trade men and labourers and during construction. This should create indirect and induced jobs during construction. This represents a significant level of employment within the study area and has the potential to be a significant positive impact. It is anticipated that some labourers will be from sourced from nearby communities.	None Required
	Solid Waste	During this construction phase of the proposed project, solid waste generation may occur mainly from general construction activities including site clearance and excavation.	i. A Solid Waste Management Plan will be done and is to be approved by the National Environment and Planning Agency (NEPA) and the National Solid Waste Management Authority (NSWMA). ii. Skips and bins should be strategically placed within the campsite and construction site. iii. The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour. iv. The skips and bins at both the construction campsite and construction site should be emptied regularly to prevent overfilling. v. Disposal of the contents of the skips and bins should be done at an approved disposal site – Retirement Disposal Site, St. James.
	Wastewater	With every construction site comes the need to provide construction workers with sanitary conveniences. Portable toilets and the disposal of same have the potential to contaminate the marine environment in the event of accidental spillage	i. Provision and maintenance of portable sanitary conveniences for the construction workers for control of sewage waste by a licenced contractor. A ratio of approximately 25 workers per chemical toilet should be used. ii. Portable toilets should be located at a distance away from the shoreline to avoid discharge into the marine environment in the event of accidental spillage.
	Vending and Food Hygiene	The establishment of a construction site may cause a proliferation of "cook shops" (food vendors) to provide the construction workers with meals. Improper food preparation and the failure to practice proper hygiene can result in certain pathogens entering the food supply and cause food borne illness.	i. Provision of adequate supply of potable water. ii. The monitoring of the various "cook shops" by public health authorities and the construction management team, to ensure proper hygiene is being followed. iii. The provision of areas to adequately wash hands and utensils.
	Road Traffic	Increased delay and wait times observed at the Bogue/Long Hill Intersection.	i. Increasing the number of lanes on Bogue Road between the Long Hill and Scarlett Road intersection to facilitate the acceptance of a higher flow capacity of vehicles. This would of course diminish the signal time needed to move similar volumes of traffic. ii. Implement designated short lanes to allow traffic to leave the Bogue Main Road and enter site without impeding the main road traffic. iii. A signalized intersection would be required to safely and effectively facilitate movement into the site during construction as opposed to an unaltered roadway.
		It is expected that the development process will generate varying patterns of vehicle flow and movement over the period of construction. Hazards are also generated by slow moving vehicles associate with the construction site.	To minimize the negative impacts that the construction flows could have on the background traffic, events such as the delivery of materials and equipment can be scheduled in off peak hours. (Outside the regions of 7:00-9:30 AM and 3:00-6:00 PM). It should also be noted that accommodations should be made to allow for prompt entry to the site area, by the implementation of a short lane and a deep enough ingress to prevent queueing from bleeding in main lanes. Movements such as oversized truck movements will

CATEGORY		IMPACT	RECOMMENDED MITIGATION
			also need to communicate with the NWA and authorities within the parish for the requisite approval and planning. It is also required that signs be placed to warn oncoming motors of the hazards generate by the site such as but not limited to slow moving vehicles and open trenches. It may also be beneficial to implement speed decrease signs or flashing amber signals to prompt road users to slow upon approach to the site entry.
		Large units including tankers, and trucks carrying building and operation machine parts will pose challenges because of their sizes and weight.	All trucks are expected to adhere to the National Works Agency standards as per the expected loads per vehicle axle.
	Maritime Traffic	Construction activity on the jetty may have the potential to negatively impact fishing and other maritime activities taking place at sea due to vessels, machinery and equipment in the water being used during the construction process. Accident potential is also increased due to presence of vessels, structures and equipment at sea.	The use of highly visible marker buoys demarcating an exclusion zone should be used to keep out other marine traffic and fishers from the work area to prevent potential accidents.
	Health and Safety	Construction activities have the potential for accidental injury, whether major or minor. This may also include fire safety, safe access routes, clearly defined pedestrian pathways, electrical hazards, eye hazards and radiation hazards. In addition, disasters such as earthquakes, floods and hurricanes are real possibilities.	i. The provision of lifelines, personal safety nets or safety belts and scaffolding for the construction workers (if necessary) ii. Ensuring that workers wear personal protective equipment (hard hats, reflective vests, safety shoes, eye protection etc.) iii. Where unavoidable, construction workers working in dusty areas should be provided and fitted with N95 respirators. iv. Areas should be dampened every 4-6 hours or within reason to prevent a dust nuisance and on hotter days, this frequency should be increased. v. There should be onsite first aid kits and arrangement for a local nurse and/or doctor to be on call for the construction site. vi. Make prior arrangements with staff at the Cornwall Regional hospital and/or health centre to accommodate any eventualities. vii. Make prior arrangements with the closest police and fire stations (Freeport) to accommodate any eventualities. viii. Material Safety Data Sheets (MSDS) should be stored onsite. ix. A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to the construction workers. x. Trench Excavation • A trench 1.2m or more in depth must have a means of egress (ladders/ stairways/ramps) and should be located at 8m intervals. • Excavated materials must be stored 0.6m or more from the open trench (not to be measured from the crown of the spoil). • Spoil should be placed so that the channels rainwater and other runoff water away from the excavation. • Take precautions regarding Tension Cracks – Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench. – Sliding or sloughing may occur as a result of tension cracks. [1] xi. Ensure that construction safety nets (catch nets) are installed that will catch personnel, debris, and small tools xii. Designing and implementing an Emergency Response Plan (ERP) in the event of any emergency. This should include:

[1] Worker Health and Safety Guidelines as per OSHA #510 Construction Industry Standard 29 CFR Part 1926.

CATEGORY		IMPACT	RECOMMENDED MITIGATION
			○ Hurricane ○ Earthquake ○ Flooding ○ Fire ○ Civil Unrest and Riots ○ Bomb Threats and Acts of Sabotage ○ Acts of Terrorism and Armed Attacks ○ Petroleum and Hazardous Material Stockpiling ○ Security and Safety Information ○ Medical Emergency Information ○ Technological Emergencies
	Aesthetics	Construction activities may decrease the aesthetic appeal of the area; however, this will be for a short-term period during construction. In particular, trucks leaving the construction site have the potential to deposit marl and mud onto the main road, making the main road aesthetically unappealing and in the process, affecting the conditions of other vehicles traversing the main road.	i. Good housekeeping activities and adherence to other mitigative measures. ii. An area of gravel should be placed on site (just before exiting onto the main road) to help remove mud/marl from truck wheels. iii. A wheel wash area on site (just before exiting onto the main road) should be implemented to rid wheels of as much mud/marl as possible

Operational Phase

CATEGORY		IMPACT	RECOMMENDED MITIGATION
Physical	Runoff and Flooding	From the flood plain model, it was observed that flooding due to pluvial and fluvial processes was more prevalent in areas south of the Peninsula. Site-specific flooding is not significant and was mainly a result of existing elevations.	A 2.8m floor level elevation is recommended for buildings closer to the south of the property to protect from only rainfall flood damage. The final recommended floor level is 3.3m to account for both rainfall flooding and storm surge.
		53% of the site is expected to be green space. Using the SCS method for runoff calculation, the peak flows of a future 2-yr rainfall event for the pre- and post-development scenarios were determined to be 0.72 to 1.37 (cubic metres per second) cms	The implementation of the planned drainage infrastructure should be focused on managing upstream and onsite flows to prevent them from interfering with activities and assets within the footprint of the development. According to NWA guidelines for Preparing Hydrologic and Hydraulic Design Reports, the recommended design period for minor drainage systems is a 10-year return period. As such based on the site generated flows, small channels, and swales for collecting runoff onsite for conveyance to larger external drainage systems should be able to convey 3.1 cms of runoff.
		Expected increase in runoff conveyance due to the impervious surface area on the site. However, with the Peninsula's location downstream of the watershed and relative elevation to adjacent land, the alteration of the site has minimal impact on flooding of assets external to the site.	
		Activities south of the Bogue Main Road, would directly impact runoff conveyed to regions adjacent to the site. Analysis of these upstream flows revealed areas south of the main road that were heavily inundated. It is expected that any adjustments to the drainage infrastructure or landscape in this area to reduce inundation, will have a direct impact on the flows seen to the west or east of the Peninsula.	
	Stormwater Discharge and Water Quality	The site-specific catchment's runoff will change significantly between the construction and operational phases. Resultant TSS plume with TSS values ranging from 10 - 30 mg/l (ambient conditions).	Silt traps should be integrated into the stormwater drainage network during the operational phase to filter suspended sediment inflows conveyed to the bay via the site. This is beneficial as the change in site surface area may increase the area's hydraulic carrying capacity of flows. It is expected that oil, grease, and heavy metal concentrations will generally be in low concentrations. They generally come from low concentration sources such as parking lots and roofs. The exception is that of extenuating circumstances such as spills. In this regard, mitigation steps should include using absorptive and adsorptive materials to remove pollutants from a surface before being impacted by runoff for treatment. Grease traps and interceptors are recommended to remove oils from domestic waste generated onsite.
		A build-up of heavy metals is expected to occur due to the vehicle traffic from the residents and service staff. During a rainfall event, total heavy metal concentrations of approximately 1.5mg/l are expected to be found in the runoff from the site. The heavy metals quickly dissipate into the bay and return to ambient levels within 12 hours of a rainfall event	
		Oil and grease are other pollutants captured in the stormwater runoff during minor rainfall events. This oil will be washed from the parking area and washed into the marine environment via the stormwater outlet. Due to the low concentrations of expected oil and grease, any effects experienced is expected to be minor and short-lived.	
Biological	Seagrass and other benthic habitats	Jetty pilings provide some ecological volume in the water column. These hard structures will provide substrate for colonization of sessile organisms. may also benefit from the pilings as these will act FADs (Fish Aggregation Devices).	i. Marine vessel pathways/channels and usage areas should be clearly defined and marked with surface marker buoys. ii. Refuelling of boats should only be done at anchor out at sea if the sea conditions are calm, otherwise, all refuelling should be done when docked at land. Appropriate refuelling equipment (such as funnels) and techniques should always be used. iii. Appropriate minor spill response equipment (for containment and clean- up) should be available by each vessel owner, including oil absorbent pads and disposal bags. iv. All spills or incidents should be reported. v. Solid waste should be collected and stored away from the marine environment. Bins should be sufficient and covered to reduce access by rodents and feral animals. vi. Additional patrolling by the MBMP may be required. Reporting of illegal activities by staff and users to the MBMP should be encouraged vii. Signage in and around the areas to include both marine and terrestrial sensitive species, allowable activities and reporting guidelines should be placed around the property.
		The jetty, along with vessels can result in shading of benthic species, such as seagrass. This may reduce the ability of seagrass to colonize these areas. Seagrass in the general area is sparse and this impact is likely to be minimal.	
		Propeller-induced currents from boats may also reduce some larval settlement. This impact is expected to be minimal.	
		The operation of vessels and water sport activities may impact the benthic communities in and around the area. This may include groundings, propeller and anchor damage, spills of toxic/hazardous fuels and materials. There is also a risk of increased solid waste during operations on land and from vessels.	
		Increased marine vessels may result in activities which are prohibited in the protected area such as fishing.	
Natural Hazards	Wind	The projected wind speeds generated show increases of 20.7% for the 100yr wind speeds to 25.7% for 10yr wind speeds. This means that in some instances, wind speeds are likely to increase by up to 17.5m/s more than the present climate.	The project area is projected to experience high winds ranging between 70-90 m/s during extreme weather events. Due to the severe damage that these types of wind speeds can cause to structures it is recommended that hurricane proofing to the buildings be implemented, such as roof strapping and wind shutters, to reduce the likelihood of damage.

	CATEGORY	IMPACT	RECOMMENDED MITIGATION
	Sea Level Rise	IPCC projections show SLR increasing by 0.5m by 2050 and 0.98m by 2100 for Caribbean islands. The effect of these significant increases in sea level would affect large sections of project area	The minimum recommended floor level is 3.3m (accounts for SLR) and the road levels are recommended to be at an elevation of 2.6m above MSL. These floor level elevations will mitigate against damage due to both storm surge and rainfall flood events.
	Ocean Currents	The marina/jetty placement is not anticipated to cause any significant effect on circulation within the bay due to the nature of the foundation i.e. Piles.	None Required
	Operational and Swell Waves	Operational waves were propagating from predominantly the Eastern (E) direction while future climate swell waves are predicted to approach the marina from the North (N) and North-Western (NW) direction. It must be noted that wave heights are more significant at the northern-most section of the Peninsula	i. All construction to be completed according to drawings. Notably, the minimum deck height of the jetty is to be 1m above MSL to be operational in swell conditions and the minimum depth of mooring is to be 3m. ii. Construction monitoring to be done by registered professionals. iii. Operational considerations should be given to assigning a hurricane shelter for the vessels
	Hurricane Waves	The results of the modelling showed that present extreme waves for 100 Yr. Return Period ranged between 1.36-1.96m arriving at the shoreline from varying directions. While for the future 100 Yr. the heights of the waves ranged between 1.5 - 2.2 m. During the hurricane conditions, the southwest (SW) direction posed the least threat to the shoreline while the northwest (NW) and west (W) direction pose a greatest threat. It was observed that the project area would be completely inundated due to it low lying nature.	
	Storm Surge	The analysis deduced that the site would be fully inundated by storm surge under 50 and 100 Yr Return Period, present and future climate.	The minimum recommended floor level is 3.3m (accounts for SLR) and the road levels are recommended to be at an elevation of 2.6m above MSL. These floor level elevations will mitigate against damage due to both storm surge and rainfall flood events.
	Long Term Coastal Erosion	The movement of the 25-year shoreline will not affect the major structural elements of the project area	It is recommended that the client considers shore stabilization works such as T-Groynes. This would trap the sediments moving NW and stabilize the coastline against long-term erosion.
	Storm Induced Erosion	The general trend of the hurricane scenarios are landward movements of the shore as the heavy waves erode the berm of the land, flattening the beach profile and moving the sediments via cross-shore erosion	To protect the project area from the threat of storm-induced erosion, it is recommended that the client considers the design and construction of a coastal protection structure such as a revetment. This should be considered in addition to the raising of floor elevations above the 100yr SS elevation to 3.3m
Human/Social	Water Supply	There is the potential for the development to further burden the water supply in the area in the event of drought conditions.	In order to alleviate any potential burden on water supply in the area particularly during times of drought, it is recommended that various storage and conversation measures be put in place at the development such as: i. Low flow fixtures ii. Dual flush toilets iii. Faucets fitted with aerators iv. Electronic spigots and flush valves
	Solid Waste Generation and Disposal	The operation of the development has the potential of significantly increasing the solid waste in the area.	i. Provision of solid waste storage bins and skips. ii. Provision of adequately designed bins and skips to prevent access by vermin. iii. Monitor beach garbage. iv. Contracting a private contractor to collect solid waste in a timely fashion to prevent a build-up. v. Ensure that the solid waste collected is disposed in an approved disposal site - Retirement Disposal Facility, St. James.
	Health and Safety	The operation of the proposed development will involve workers and residents who may become ill or have accidents. In addition, disasters such as earthquakes, floods, storm surge and fires are real possibilities.	i. Have first aid kits located in various sections of the development ii. Design and implement an emergency response plan. iii. Arrange mutual assistance and make prior arrangements with: a. Health care facilities (Cornwall Regional Hospital) and associated doctors and nurses to accommodate any eventualities. b. Freeport Fire Station c. Freeport Police Station
	Traffic	The performance of the Bogue Main Road is expected to remain within satisfactory bounds within the initial operational years of the development. However, it is expected that future conditions are expected to significantly stress the capacities of	

CATEGORY		IMPACT	RECOMMENDED MITIGATION
		the road network. It was also highlighted that that Long Hill approach towards Bogue Road is the most susceptible to the effects of traffic volume increases.	
	Maritime Traffic	The existence of the jetty may have the potential to negatively impact other maritime activities taking place. There is also the potential for accidental collision with the structure during the night-time	The existence of the jetty may have the potential to negatively impact other maritime activities taking place. There is also the potential for accidental collision with the structure during the night-time

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND AND CONTEXT

Montego Bay, Jamaica is promoted to be the home away from home with sun, sand and sea with excellent weather all year round, pristine white sandy beaches, and crystal-clear blue seas. The Sangster International Airport, located in the city, creates easy accessibility with direct flights and easy connections from many cities worldwide. With the fast-growing hotel industry for the past two decades, the city is now attracting people from all over the world to purchase property. Benefits in purchasing property in Jamaica include reduction in taxes for real estate, long term income gains and property affordability.

LCH Development Ltd. has embarked on a mission to provide sun-seekers who want to invest in paradise by formulating a team to execute a mixed-use residential development that will satisfy the investor's appetite. This development, named **The Peninsula**, will more importantly, change the landscape of what Jamaica has to offer in terms of real estate, offering both locals and non-residents an opportunity to enjoy a 1st world lifestyle.

1.2 LOCATION AND STUDY AREA

The proposed development will be located at 2 Reading Pen, in the sub-urban community of Reading, St. James. It is located along the Bogue Main A1 Road, approximately 2 kilometres southwest of Montego Bay, the second largest city in Jamaica (Figure 1-1). The site is bounded to the north by the Caribbean Sea, to the south by Bogue Road, to east by Friendly Irons Shooting Range and to the west a vacant lot (Plate 1-1 to Plate 1-4).

The land is registered in Certificates of Title referred to in Volume 1251 Folio 08 and Volume 1224 Folio 505.The property to the West (Vol.1251 Folio 907), Water Garden Realtors Limited and land to the east is Morewood Limited.

Figure 1-1 Location of the project site for the proposed development, The Peninsula

Plate 1-1 Aerial view of project site (looking toward the south)

Plate 1-2 Aerial view of project site showing the main site entrance along the Bogue Main A1 Road (looking toward the south southeast)

Plate 1-3 Aerial view of project site (looking toward the north northwest)

Plate 1-4 Aerial view of Friendly Irons Shooting Range to the east of project site

1.3 ORGANISATIONAL PROFILES

C. L. Environmental Company Limited is the environmental consultant for the proposed project; other project roles for the project are listed below in Table 1-1 . C. L. Environmental provides consultancy services to both governmental and non-governmental agencies, local and overseas, and has been incorporated in Jamaica as a Limited Liability Company since August 2000. The company comprises a range of professional skills and includes environmental scientists, marine ecologists, environmental engineers, waste management specialists, planners, industrial hygienists, environmental management systems specialists, environmental educators and quality Consultants. The team of Consultants and Scientists associated with C.L Environmental Company have over the years, worked on numerous environmental projects of which some were of national importance, such as the Southern Coastal Highway Improvement Project (SCHIP), Highway 2000 North South Link: Caymanas to Linstead and Moneague to Ocho Rios legs, National Programme of Action for Land Based Sources and Activities that Impact the Marine Environment, the Remediation of the American Airlines Flight 331 Accident Site at Norman Manley International Airport, the Ausjam Gold Mine Cyanide Spill in Clarendon, Road Rehabilitation Works for the Moneague Lake Flooding in St. Ann and the Environmental Monitoring of the Falmouth Cruise Pier Development in Falmouth, Trelawny, to name a few.

Table 1-1 Organizational roles and contact details

Role	Organization and contact information
Project Proponent	**LCH Development Ltd.** 14 Bogue Industrial Estate Montego Bay
Architect	**Design HQ Ltd.** Unit 32, The Annex Plaza Fairview, Montego Bay Email: info@designhdltd.com Phone: (876) 952-8252
Structural/ Civil Engineer	**South China Construction Ltd (JAMAICA)** 202 Annette Crescent Kingston 10 Email: 001@sccgoble.com Phone: (876) 283-4746
Environmental Consultant	**CL Environmental Co. Ltd.** 20 Windsor Avenue Kingston 5 Email: info@clenvironmental.com Phone: (876) 756-0338
MEP of Record Engineering Consultant	**GBCD Company Ltd.** 32 Brunswick Street Suite 9, AJ's Supermarket Complex Spanish Town, St. Catherine Email: bryawayne85@gmail.com Phone: (876) 410-1727

2.0 LEGISLATION AND REGULATORY CONSIDERATION

The national policies, laws and regulations relevant to the proposed mixed-use development at Reading Pen Peninsula are examined in the below grouped sections:

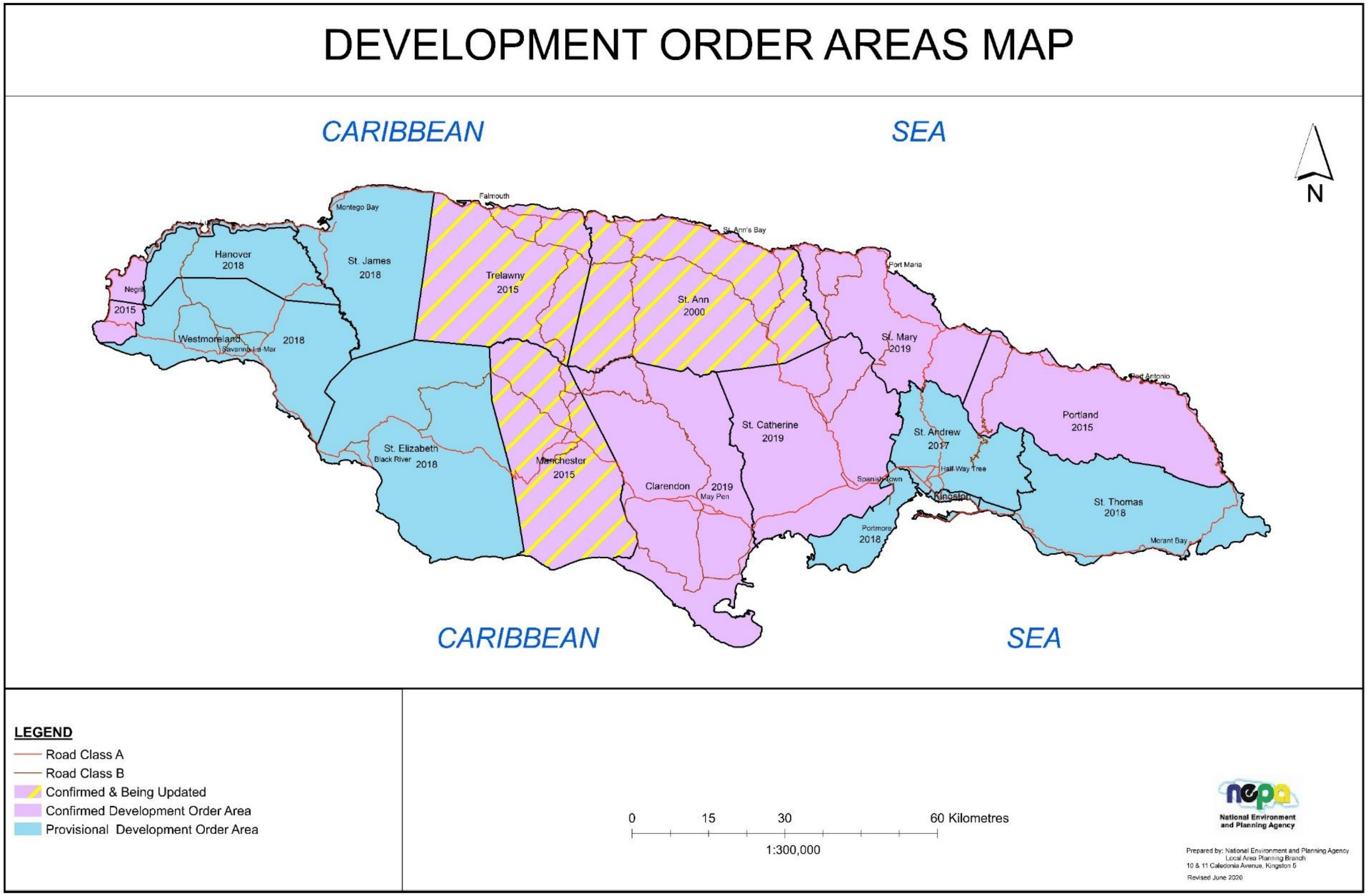
1. Development control and planning
2. Environmental conservation
3. Public health & waste management

2.1 DEVELOPMENT CONTROL AND PLANNING

2.1.1 Town and Country Planning Act (TCP Act), 1957 (Amended 1987)

The Town and Country Planning Act (TCP Act) 1957 (Amended 1987) provides the statutory requirements for the orderly development of land through planning, as well as guidelines for the preparation of Development Orders. A Development Order is a legal document which is used to guide development in the area to which it applies, and the TCP Act is only applicable in an area where a Development Order exists. It constitutes land use zoning map/s, policy statements and standards relating to land use activities. Tree Preservation Areas and Conservation Areas (as specified areas the gazetted Development Orders) are two types of protected areas associated this Act. Matters addressed in the order include: Roads; Buildings and other structures; Community Planning; Amenities; Public Services; Transportation and Communications; and Miscellaneous.

The Town and Country Planning Act also establishes the Town and Country Planning Authority, which in conjunction with the Local Planning Authorities (LPAs), also referred to as Municipal Corporations, are responsible for land use zoning and planning regulations as described in their local Development Orders. The local planning authority for this project is the **St James Municipal Corporation** and as seen in Figure 2-1, the proposed project falls within **The Town and Country Planning (St. James Parish) Provisional Development Order, 2018** and specifically within the Montego Bay Local Planning Area. Preceding this 2018 Provisional Development Order, **The Town and Country Planning (St. James Parish) Provisional Development Order (Confirmation) Notification, 1982** and **The Town and Country Planning (St. James Parish) Provisional Development Order, 1978** were in effect. Section 4.4.7.3 provides further details regarding zoning according to these orders.



Source: NEPA

Figure 2-1 Development Order Areas in Jamaica

2.1.2 Local Governance Act 2016

This Act is a consolidation of the following existing Acts, which were repealed once the new legislation was enacted:

- The Parish Councils Act (1887)
- The Kingston and St. Andrew Corporation Act (1923)
- The Municipalities Act (2003)
- The Parochial Elections (Modifications) Act (1979)

This Act introduces new concepts and tenets which reflect a modern approach to local governance, and which strengthen local self-management. Local Authorities (formerly referred to as Parish Councils) are categorised as Municipal Corporations and City Municipalities or Town Municipalities. The **St James Municipal Corporation** is the Local Authority with responsibility for development within the study area.

2.1.3 Office of Disaster Preparedness and Emergency Management Act 1998

This Act established the Office of Disaster Preparedness and Emergency Management (ODPEM). The ODPEM's main responsibility is to develop and implement policy and programmes to achieve and maintain an appropriate state of national and sectoral preparedness for coping with emergency situations. The proposed project should ensure that it collaborates with this agency in the preparation of the appropriate emergency response plans in relation to natural hazard events such as hurricanes.

2.1.4 Tourist Board (Water Sports) Regulations 1985

These regulations govern the operation and conduct of water sports.

2.2 ENVIRONMENTAL CONSERVATION

2.2.1 Protected Areas System Master Plan: Jamaica 2013 – 2017

The Protected Areas System Master Plan (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 (National Environment and Planning Agency, n.d.). The PASMP is consistent with several national policies and plans, including the Policy for Jamaica's System of Protected Areas 1997, the National Strategy and Action Plan on Biological Diversity in Jamaica (2003) and Vision 2030 Jamaica: National Development Plan (2009). It is also a requirement under the Convention for Biological Diversity's (CBD's) Programme of Work for Protected Areas (PoWPA).

Existing protected area categories in Jamaica are listed in Table 2-1, Table 2-2 and Table 2-3. The NRCA/NEPA is responsible for areas declared/designated under the acts it administers, including the Wild Life Protection and Natural Resources Conservation Authority Acts. In addition, a number of other government entities (such as the Forestry Department, Fisheries Division and Jamaica National Heritage Trust), local management entities, non-governmental entities, private sector and individuals are outlined as important role players as well. Indeed, responsibility for protected area management has been a shared endeavour and this collaborative approach to protected area management will continue under the PASMP (National Environment and Planning Agency, n.d.).

Specific to this project, the following areas are protected under various legislation (Figure 2-2 and Figure 2-3):

- Bogue Lagoon Creek Game Reserve
- Bogue Islands Lagoon SFCA
- Montego Bay Marine Park

Table 2-1 Existing categories of protected areas in Jamaica (January 2012) - protected area system categories

Source: (National Environment and Planning Agency, n.d.)

CATEGORY	RESPONSIBLE AGENCY	LAW
Protected Area	Forestry Department: Ministry of Economic Growth and Job Creation (MEGJC).	Forest Act, 1996 and Forest Regulations
	National Environment and Planning Agency (NEPA): MEGJC	NRCA Act, 1991
	NEPA: MEGJC	Beach Control Act, 1956
National Park	NEPA: MEGJC	NRCA Act, 1991
Marine Park	NEPA: MEGJC	NRCA Act, 1991
Environmental Protection Area	NEPA: MEGJC	NRCA Act, 1996
Forest Reserve	Forestry Department: MEGJC	Forest Act, 1996 and Forest Regulations
Special Fishery Conservation Area	Fisheries Division: Ministry of Industry, Commerce, Agriculture and Fisheries (MICAF)	Fisheries Act, 2018
National Monument	Jamaica National Heritage Trust (JNHT) Ministry of Youth and Culture (MYC)	JNHT Act, 1985
Protected National Heritage	JNHT: MYC	JNHT Act, 1985
Game Sanctuary	NEPA (NRCA): MEGJC	Wildlife Protection Act, 1945
Game Reserve	NEPA (NRCA): MEGJC	Wildlife Protection Act, 1945

Table 2-2 Existing categories of protected areas in Jamaica (as at 1 January 2012) - other designations not considered part of the system

Source: (National Environment and Planning Agency, n.d.)

CATEGORY	RESPONSIBLE AGENCY	LAW
Tree Order Preservation	Local Authority (Town and Country Planning Authority): MEGJC and Local Government Department, through Local Authorities	Town and Country Planning Act, 1958
Conservation Area	NEPA (Town and Country Planning Authority, Local Authorities): MEGJC	Town and Country Planning Act, 1958
Protected Watershed	NEPA (NRCA): MEGJC	Watershed Act, 1963 Protection

Table 2-3 Existing categories of protected areas in Jamaica (January 2012) - international designations

Source: (National Environment and Planning Agency, n.d.)

CATEGORY	RESPONSIBLE AGENCY	CONVENTION
Ramsar Site	NEPA (NRCA): MEGJC	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)
World Heritage Site (no existing sites, however submissions have been made)	Jamaica National Heritage Trust: MYC	World Heritage Convention

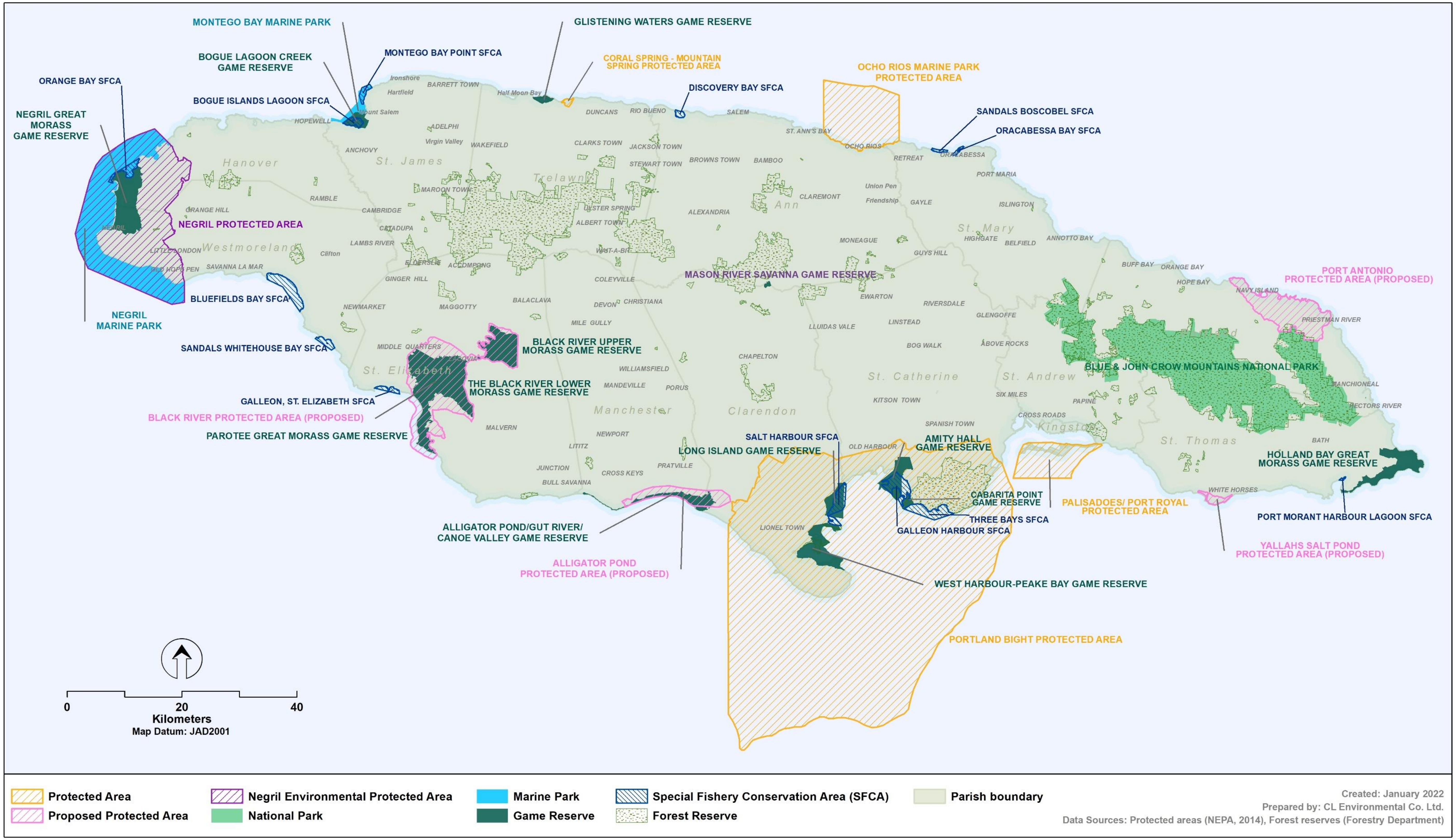
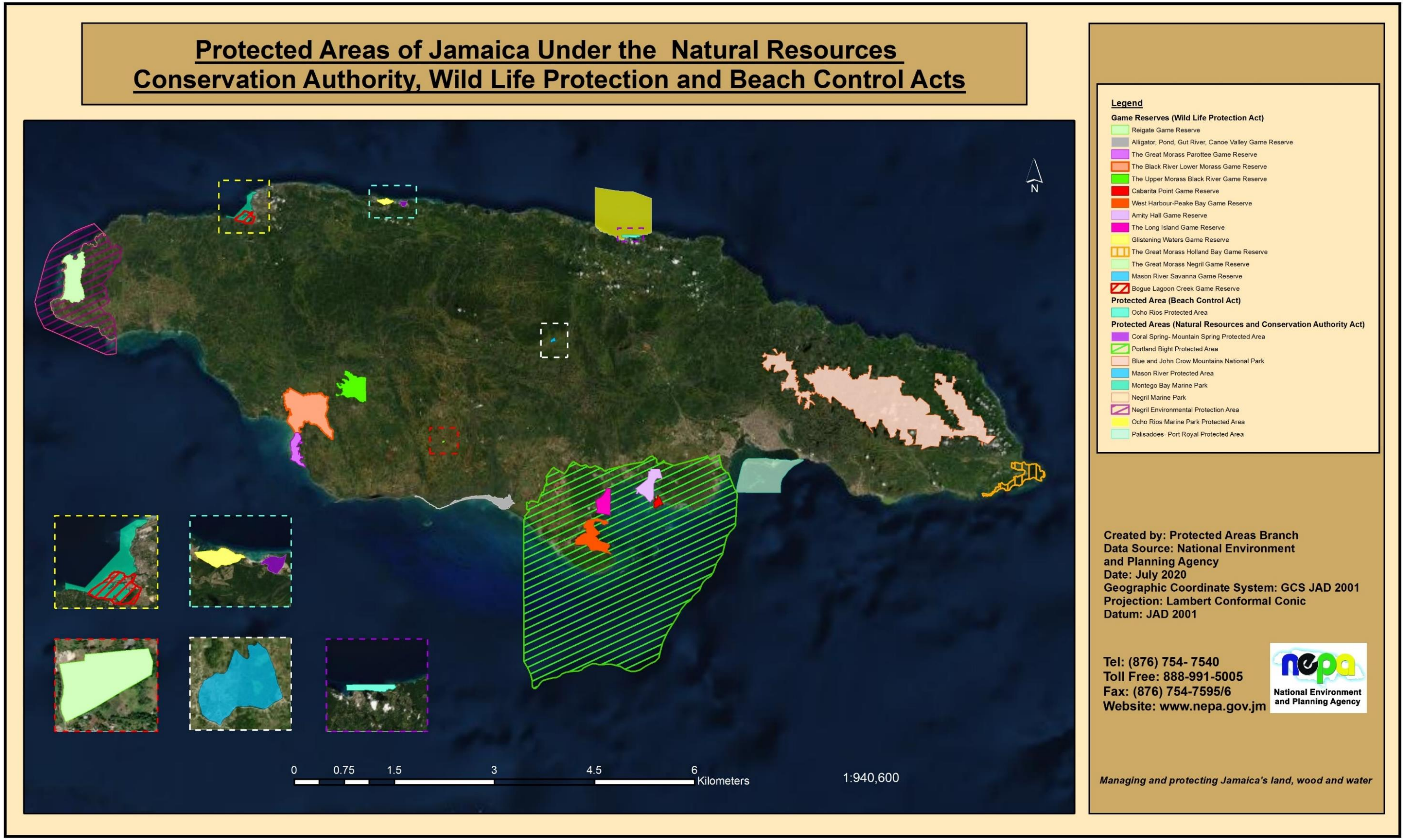


Figure 2-2 Areas protected under various Jamaican legislation including existing and proposed protected areas, national parks, marine parks, game reserves, forest reserves and Special Fishery Conservation Areas



Source: National Environment and Planning Agency, 2020

Figure 2-3 Protected areas of Jamaica under the Natural Resources Conservation Authority, Wildlife Protection and Beach Control Acts

2.2.2 Natural Resources Conservation Authority Act 1991

The Natural Resources Conservation Authority Act (NRCA) is considered Jamaica's umbrella environmental law and is the main environmental legislation that relates to the proposed project. This Act establishes the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development through the protection and management of the country's natural resources and the control of pollution. This is done mainly through an environmental permit and licence system. The Act empowers the Authority to:

- Issue permits to the person responsible for undertaking any enterprise, construction or development of a prescribed category in a prescribed area [Section 9]. This section, the Prescribed Area Order, designates all of Jamaica as being within the prescribed area.
- Issue licences for discharge of trade or sewage effluent or for construction or modification of any works for such discharge [Section 12 (1) (a) and (b)]; • request information or documents as the Authority thinks fit [Section 10 (1) (a)].
- Request an environmental impact assessment containing such information as may be prescribed [Section 10 (1) (b)].
- Request information on pollution control facilities [Section 17]; and
- Revoke or suspend permits.

The Act also gave power of enforcement of a number of environmental laws to the NRCA, namely the *Beach Control Act*, *Watershed Act* and the *Wildlife Protection Act*, as well as a number of regulations and orders including:

- *The Natural Resources (Permit and Licences) Regulations 1996 and* (Amendment) Regulations *2015;*
- *Natural Resources (National Parks) Regulations 1993 and (Amendment) Regulations 2003;*
- *The Natural Resources (Marine Parks) Regulations 1992, (Amendment) Regulations 2003,* and *(Amendment) Regulations, 2015;*
- *The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order 1996* and *(Amendment) Order 2015; and*
- *The Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013.*

2.2.2.1 Natural Resources Conservation (Permit and Licences) Regulations 1996 and (Amendment) Regulations 2015

A permit and licencing system was established under these regulations to control the undertaking of any new construction or development of a prescribed nature in Jamaica and the handling of sewage or trade effluent and poisonous or harmful substances discharged into the environment.

2.2.2.2 Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order 1996 and (Amendment) Order 2015

The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996) and the Permits & Licensing Regulations was passed because of section 9 of the NRCA Act. Section 9 of the NRCA Act declare the entire island and the territorial sea as a 'prescribed area', in which specified activities require a permit, and for which activities an environmental impact assessment may be required. The major amendment made in 2015 was the substitution of the Categories of Enterprises, Construction and Development (Column A), which lists the various activities, by category, for which a permit is required.

2.2.2.3 Natural Resources Conservation (Sewage Effluent) Regulations (Draft)

These regulations, when brought into effect, will cover the discharge of sewage effluent, and the operations, monitoring, and reporting mechanism of sewage treatment facilities.

2.2.2.4 Natural Resources Conservation (Montego Bay Marine Park) (Declaration) Order (1992)

The Montego Bay Marine Park was established in 1992. The Order describes the area and its boundaries. This order bans dredging, excavating, discharge of pollutants, littering, use of explosives and poisons and fishing within the protected area boundaries except subject to permit, and allows research and collection for educational and research purposes under permit.

2.2.3 Beach Control Act 1956 and the Beach Control (Amendment) Act 2004

This Act was passed in 1956 to ensure the proper management of Jamaica's coastal and marine resources by means of a licensing system. This system regulates the use of the foreshore and the floor of the sea. In addition, the Act speaks to other issues including access to the shoreline, rights related to fishing and public recreation and establishment of marine protected areas. Under section 5 of this act, it is an offence to encroach on the foreshore or floor of the sea for a public or commercial purpose without a licence.

The Beach Control (Licensing) Regulations 1956 require a permit for any works on a beach, coastline or foreshore. Application for this permit must be made to NEPA. The requirements of the permit include a Notice of Application to be posted on the landward and seaward sides of the property and said Notice should be served on adjoining neighbours. Member of the Natural Resources Conservation Authority or any officer authorised by the Authority may conduct investigations to ensure compliance with licence and require information to be furnished. An application will be made to NEPA for BCA Licence for use of the foreshore and floor of the sea for commercial/recreational activities.

2.2.4 Wildlife Protection Act 1945 and Wildlife Protection (Amendment of Second and Third Schedules) Regulations 2016

The Wildlife Protection Act of 1945 is mainly concerned with the protection of specified faunal species and is the only statute in Jamaica specifically designated to this. This Act protects several rare and endangered faunal species and the Wildlife Protection (Amendment of Second and Third Schedules) Regulations 2016 provides substitutions for the Second and Third Schedules of the principal Act which lists these species

The establishment of two types of protected areas, namely Game Sanctuaries and Game Reserves are authorized under this Act. A Game Sanctuary / Game Reserve is a parcel of land, body of water or area comprising both land and water within which, the hunting of animals (including birds) removal of eggs or the nest of any bird and the use or possession of any dog, gun, catapult, or any other weapon which could be used to hunt any animals or birds is prohibited. In addition, all Forest Reserves are also designated as Game Reserves and form part of the Protected Areas System of Jamaica.

This Act has undergone review particularly around increased fines and the number of animals having a protected status. Further amendments are being undertaken to address a variety of issues relating to the management and conservation of these natural resources, and the inclusion of flora. It prohibits the removal, sale or possession of protected animals, the use of dynamite, poisons or other noxious material to kill or injure fish, and it prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries, and streams. Protected under the Wildlife Protection Act, *inter alia*, are six species of sea turtles. At least one of these reportedly nests at the Seawind Key site.

2.2.5 Endangered Species (Protection, Conservation and Regulation of Trade) Act 2000 and (Amendment of First, Second and Third Schedules) Order 2021

The Endangered Species (Protection, Conservation and Regulation of Trade) Act was created in 2000 to ensure the codification of Jamaica's obligations under the Convention for the International Trade in Endangered Species of Wild Fauna and Flora. This Act governs international and domestic trade in endangered species in and from Jamaica and generally provides for the conservation and management of endangered fauna and flora.

The regulations associated with Endangered Species (Protection, Conservation and Regulation of Trade) Act were most recently amended in 2021. This included revised listings of endangered species threatened with extinction, species which could become extinct, or which have to be effectively controlled, and species which any contracting Party regulates within its own jurisdiction for the purpose of preventing or restricting over-exploitation and require the cooperation of other Parties for the control of trade in such species.

2.2.6 The Fisheries Act 2018

The Fisheries Act, 2018, is the overarching instrument relating to fishing activities within Jamaica. This Act repeals the previous Fishing Industry Act, 1975. The Fisheries Act, 2018 speaks to provision of efficient and effective management and sustainable development of fisheries, aquaculture and other related activities in accordance with internationally recognized norms, standards and best practices. The Fisheries Act, 2018 gives the Fisheries Division, of the Ministry of Industry, Commerce, Agriculture and Fisheries (MICAF), the responsibility for licensing fisher folk and fishing boats (whether for sport, recreation or commercial), creation and demarcation of Special Fishery Conservation Areas (formerly known as fish sanctuaries), protection of the various fisheries resources via establishment of closed seasons, and fines/penalties for illegal catching or selling of fish.

The Bogue Islands Lagoon has been declared as a SFCA and this is now incorporated within the boundaries of the Montego Bay Marine Park.

2.2.7 National Policy for the Conservation of Seagrasses 1996

This policy guides the issuing of licenses or permits for activities such as dredging, disposal of dredged material, beach development, and effluent disposal, which directly or indirectly affect seagrass communities.

2.2.8 Mangrove and Coastal Wetlands Protection - Draft Policy and Regulations 1996

This policy provides a review of the issues affecting wetlands in Jamaica as well as the Government's role and responsibility. Five main goals are outlined which include guidelines for wetlands development, cessation of destructive activities, maintenance of natural diversity, maintenance of wetland function and values and integration of wetland functions in planning and development. There is a mangrove island located at the edge of the site facing the Bogue Lagoon.

2.2.9 Coral Reef Protection and Preservation – Draft Policy and Regulations 1996

This document reviews the ecological and socio-economic functions of coral reefs, the issues affecting coral reefs, and the Government's role and responsibility in their protection. Five main goals are outlined which include reduction of pollutants, reduction of overharvesting of reef fish, reduction of physical damage from recreational activities, improving the response capability to oil spills, and control of coastal zone developments.

The proposed resort project must endeavour to ensure that its onsite and shoreline reclamation activities do not threaten or harm the remaining coral reefs around the headland.

2.2.10 Water Resources Act 1995

The Water Resources Act (1995) established the Water Resources Authority (WRA), which is authorized to regulate, allocate, conserve, and manage the water resources of the island. It is also responsible for water quality control and to provide technical assistance for any projects, programmes or activities relating to development, conservation, and the use of water resources.

Section 25 advises that a proposed user will need to obtain planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, under Section 21 it states 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.

2.2.11 The Jamaica National Heritage Trust Act 1985

The Jamaica National Heritage Trust Act established the Jamaica National Heritage Trust (JNHT) and has been in operation since 1985. The JNHT provides for protection of areas, structures, and objects of cultural significance to Jamaica by declaration of any structure as a national monument where preservation is of public interest due to historic, architectural, traditional, artistic, aesthetic, scientific or archaeological importance. This includes the floor of the sea within the territorial waters or the

Exclusive Economic Zone. There are no known historical or archaeological sites that could be affected by the proposed resort development project.

2.2.12 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 radius of at least fifteen 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 include:

- 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); and
- Negligent use or management of a fire which could result in damage to property (Section 13a).

2.2.13 Towards an Ocean and Coastal Zone Management Policy in Jamaica 2000

The Council on Ocean and Coastal Zone Management was established in 1998, with responsibility of defining a national policy for Ocean and Coastal Zone Management. The aim of this policy document is to develop a policy that will "enhance the contribution of economic sectors to the integrated management of coastal areas by developing awareness in sector line agencies and resource users." The document recognises the extensive use and resulting degradation of coastal and ocean resources in Jamaica, including coral reefs, mangroves and seagrass beds, as well as non-living resources such as sand.

2.3 PUBLIC HEALTH & WASTE MANAGEMENT

2.3.1 Water Quality Standards

The NRCA has primary responsibility for control of water pollution in Jamaica. National standards for ambient marine water and freshwater are shown in Table 2-4 and Table 2-5 respectively. For drinking water, World Health Organisation (WHO) standards are utilized and these are regulated by the National Water Commission (NWC).

Table 2-4 Draft national ambient marine water quality standards for Jamaica, 2009

Source: National Environment and Planning Agency (NEPA)

Parameter	Measured as	Standard Range	Unit
Phosphate,	P*	0.001-0.003	mg/L
Nitrate,	N**	0.007-0.014	mg/L
BOD_5	O	0.0-1.16	mg/L
pH		8.00-8.40	
Total Coliform		2-256	MPN/100mL
Faecal Coliform		<2-13	MPN/100mL

*Reactive phosphorus as P
**Nitrates as Nitrogen

Table 2-5 Draft national ambient freshwater water quality standards for Jamaica, 2009

Source: National Environment and Planning Agency (NEPA)

Parameter	Measured as	Standard Range	Unit
Calcium	**(Ca)**	**40.0-101.0**	**mg/L**
Chloride	**(Cl^-)**	**5.0- 20.0**	**mg/L**
Magnesium	**(Mg^{2+})**	**3.6- 27.0**	**mg/L**
Nitrate	**(NO_3^-)**	**0.1- 7.5**	**mg/L**
Phosphate	**(PO_4^{3-})**	**0.01 - 0.8**	**mg/L**
Potassium	**(K^+)**	**0.74- 5.0**	**mg/L**
Silica	**(SiO_2)**	**5.0- 39.0**	**mg/L**
Sodium	**(Na^+)**	**4.5- 12.0**	**mg/L**
Sulfate	**(SO_4^{2-})**	**3.0- 10.0**	**mg/L**
Hardness	**($CaCO_3$)**	**127.0-381.0**	**mg/L (as $CaCO_3$**
Biochemical Oxygen Demand	**(O)**	**0.8- 1.7**	**mg/L**
Total Dissolved Solids		**120.0-300**	**mg/L**
pH		**7.00- 8.40**	
Conductivity		**150.0-600**	**µS/cm**

Standards for industrial (trade effluent) and sewage discharge into rivers and streams are stipulated within the Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013 (Table 2-6, Table 2-7 and Table 2-8).

Table 2-6 Sewage Effluent Standards for new and existing plants

Table 1—*Sewage Effluent Standards for Existing Plants*

PARAMETER	EFFLUENT LIMIT
BOD_5	20 mg/L
TSS	30 mg/L
Nitrates (as Nitrogen)	30 mg/L
Phospates	10 mg/L
COD	100 mg/L
pH	6-9 pH units
Faecal Coliform	1000 MPN/100 ml.
Residual Chlorine	1.5 mg/L

Table 2—*Sewage Effluent Standards for Plants other than Existing Plants*

PARAMETER	EFFLUENT LIMIT
BOD_5	20 mg/L
TSS	30 mg/L
Total Nitrogen	10 mg/L
Phosphates (PO_4-P)	4 mg/L
COD	100 mg/L
pH	6-9 pH
Faecal Coliform	1000 MPN/100 ml.
Residual Chlorine	1.5 mg/L
Floatables	not visible

Table 2-7 Sewage Effluent Standards for use in Irrigation

Table 4—*Standards for Sewage Effluent to be used for Irrigation*

PARAMETER	STANDARD LIMIT
Oil and Grease	10 mg/L
Total Suspended Solids (TSS)	1.5 mg/L
Residual Chlorine	0.5 mg/L
Biochemical Oxygen Demand (BOD_5)	15 mg/L
Chemical Oxygen Demand (COD)	<100 mg/L
Faecal Coliform	12 MPN/100ml.

Table 2-8 Industrial Trade Effluent Standards

Table 3—*Trade Effluent Standards*

PARAMETER	TRADE EFFLUENT LIMIT
Ammonia/ammonium measured as NH_4	1.0 mg/L
Barium	5.0 mg/L
Beryllium	0.5 mg/L
Biological oxygen demand (BOD)	<30 mg/L
Boron	5.0 mg/L
Calcium	No standard
Chemical Oxygen Demand (COD)	<100mg/L or <0.01 kg/1000 kg product
Chloride	300 mg/L
Colour	100 TCU
Cyanide (free)	0.1 mg/L
Cyanide (Total as CN)	0.2 mg/L
Detergent	15 mg/L
Dissolved oxygen (DO)	>4mg/L
Faecal Coliform	<100 MPN/100 ml
Fluoride	3.0 mg/L
Iron	3.0 mg/L
Magnesium	No standard
Manganese	1.0 mg/L
Nitrate as NO_3	10 mg/L
Oil and Grease	10 mg/L or < 0.01 kg/1000 kg product
PH	6.5 - 8.5
Phenols	0.1 mg/L
Phosphate as PO_4	5 mg/L
Sodium	100 mg/L
Sulphate	250 mg/L
Sulphide	0.2 mg/L
Temperature	±2° of ambient
Total Coliform	<500 MPN/100 ml
Total Dissolved Solids (TDS)	1000 mg/L
Total Organic Carbon (TOC)	100 mg/L
Total Suspended Solids (TSS) (maximum monthly average)	50 mg/L
Total Suspended Solids (TSS) maximum daily average	<150mg/L

PARAMETER	TRADE EFFLUENT LIMIT
Trace Metals:	
Zinc	1.5 mg/L
Lead	0.1 mg/L
Cadmium	0.1 mg/L
Arsenic	0.5 mg/L
Chromium	1.0 mg/L
Copper	0.1 mg/L
Mercury	0.02 mg/L
Nickel	1.0 mg/L
Selenium	0.5 mg/L
Silver	0.1 mg/L
Tin	No standard
Total Heavy Metals	2.0 mg/L

2.3.2 Noise Abatement Act 1997

The Noise Abatement Act of 1997 was created in order to regulate noise caused by amplified sound and other specified equipment. This act has been said to address "some concerns but is too narrow in scope and relies on a subjective criterion" (McTavish). Given this, McTavish conducted a study to recommend wider and more objective criteria in accordance with international trends and standards, but tailored to Jamaica's conditions and culture.

National guidelines (NEPA) used for noise levels are shown in Table 2-9; values for commercial, industrial and residential areas are specified.

Table 2-9 NEPA guidelines for daytime and night time noise in various zones

ZONE	NEPA Daytime Guideline (dBA)	NEPA Night Time Guideline (dBA)
Commercial	65	60
Industrial	75	70
Residential	55	50

2.3.3 The Natural Resources Conservation Authority (Air Quality) Regulations 2006

Under section 38 of the NRCA Act, regulations pertaining to air quality in Jamaica are stipulated. The National standards, known as the National Ambient Air Quality Standards (NAAQS) are categorized into two groups. Part I of the NRCA Air Quality Regulations (2002) instructs on license requirements and indicates that every owner of a major or significant facility shall apply for an air pollutant discharge license. Part II makes reference to the stack emission targets, standards and guidelines.

According to the Natural Resources Conservation Authority (Air Quality) Regulations, 2006, a "significant air quality impact", means:

(a) the increment in the predicted average concentration of sulphur dioxide (SO_2), total suspended particulates (TSP), particulate matter less than ten microns (PM_{10}) or nitrogen dioxide (NO_2) is greater than an annual average of 20 µg/m^3 or a 24-hour average concentration of 80 µg/m^3; or
(b) the increment in the predicted average concentration of CO is greater than 500 µg/m^3 as an 8-hour average or 2000 µg/m^3 as a 1-hour average.

Table 2-10 summarizes the Significant Impact Concentrations and the Jamaican National Ambient Air Quality Standards (JNAAQS) and Guideline Concentrations (GC).

Table 2-10 Significant Impact Concentrations and the Jamaican National Ambient Air Quality Standards (JNAAQS) and Guideline Concentrations (GC) for air quality

Pollutant	Avg. Period	Significant Impact Concentration (µg/m^3)	Jamaican NAAQS or GC (µg/m^3)
PM_{10}	24-hr	80	150
	Annual	20	60
NO_2	1-hr	N/A	400
	24-hr	80	N/A
	Annual	20	100

Pollutant	Avg. Period	Significant Impact Concentration (µg/m^3)	Jamaican NAAQS or GC (µg/m^3)
SO_2	1-hr	N/A	700
	24-hr	80	280
	Annual	20	60
CO	1-hr	2000	40000
	8-hr	500	10000
1,3 Butadiene	1-hr	N/A	0.04
Acetaldehyde	1-hr	N/A	1250
	24-hr	N/A	500
Acrolein	1-hr	N/A	58.75
	24-hr	N/A	23.5
Benzene	Annual	N/A	1
Benzo (a) pyrene	1-hr	N/A	0.00275
	24-hr	N/A	0.0011
Carbon Tetrachloride	1-hr	N/A	6
	24-hr	N/A	2.4
Chloroform	1-hr	N/A	1250
	24-hr	N/A	500
Ethylene Dibromide	1-hr	N/A	7.5
	24-hr	N/A	3
Formaldehyde	1-hr	N/A	162.5
	24-hr	N/A	65
Methylene Chloride	1-hr	N/A	550
	24-hr	N/A	220
Styrene	1-hr	N/A	2500
	24-hr	N/A	1000
Xylenes	1-hr	N/A	5750
	24-hr	N/A	2300
Vinyl Chloride	24-hr	N/A	1
	Annual	N/A	0.2
Arsenic	1-hr	N/A	0.75
	24-hr	N/A	0.3
Beryllium	Annual	N/A	0.0013
Cadmium	1-hr	N/A	5
	24-hr	N/A	2
Chromium	1-hr	N/A	3.75
	24-hr	N/A	1.5
Cobalt	24-hr	N/A	0.12
Copper	1-hr	N/A	125
	24-hr	N/A	50
Lead	1-month	N/A	N/A
	3-month	N/A	2
Manganese	Annual	N/A	119
Mercury	1-hr	N/A	5
	24-hr	N/A	2
Nickel	1-hr	N/A	5
	24-hr	N/A	2
Selenium	24-hr	N/A	25
	Annual	N/A	10
Zinc	24-hr	N/A	12

In 1987, U.S. Environmental Protection Agency replaced TSP with PM_{10} as the indicator for both the annual and 24-hour health-related standards. The reason for this is because exposure to PM_{10}

particles may cause serious health/respiratory related issues as these particles are retained deep in the lungs. The 24-hour NEPA standards for PM_{10} are shown in Table 1 4. However, the 24-hour US EPA standards are used for $PM_{2.5}$ and TSP:

- TSP = 150 µg/m³
- $PM_{2.5}$ = 35 µg/m³

2.3.4 The Clean Air Act 1964

The Clean Air Act (1964) 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, fumes, gases or dust in the air. An inspector may enter any affected premises to examine, make enquiries, conduct tests and take samples of any substance, smoke, fumes, gas or dust that may be considered necessary or proper for the performance of his/her duties.

2.3.5 Public Health Act 1985

The Public Health Act is administered by the Ministry of Health through Local Boards, namely the Municipal Corporations. *The Public Health (Nuisance) Regulations 1995* aims to, control reduce or prevent air, soil and water pollution in all forms. Under the regulations:

- No individual or organisation is allowed to emit, deposit, issue or discharge into the environment from any source;
- Whoever is responsible for the accidental presence in the environment of any contaminant must advise the Environmental Control Division of the Ministry of Health and Environmental Control, without delay;
- Any person or organisation 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; and
- No industrial waste should be discharged into any water body, which will result in the deterioration of the quality of the water.

2.3.6 Public Health Act (Air, Soil and Water Pollution) Regulations 1976

Under the ambit of this act, the Environmental Health Unit, Ministry of Health, is required to review the design and plans for sewage treatment.

2.3.7 The National Solid Waste Management Authority Act 2001

The National Solid Waste Management Authority Act of 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 National Solid Waste Management Authority (NSWMA) was established in April 2002 as a result of this Act to effectively manage and regulate the collection and disposal 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. Under the Act, solid waste can only be placed at an approved or designated site. The designated site for the western Jamaica is at Retirement, St James.

3.0 PROJECT DESCRIPTION

3.1 PROJECT FEATURES

3.1.1 Proposed Zones

The Peninsula in Reading, Montego Bay seeks to offer luxury residential living with supreme amenities to promote a lifestyle of wellbeing. The 7-hectare (17.5 acre) waterfront property entails 5 zones:

- Zone 1: The Villas at The Peninsula
- Zone 2: The Peninsula Bay
- Zone 3: The Towers at the Peninsula
- Zone 4: The Commercial spaces
- Zone 5: The General Ground Amenities and Project Management and Back of house buildings

3.1.1.1 Zone 1: The Villas at The Peninsula

Zone 1 encompasses 15 3000 sq. ft. modern 3-bedroom villas along the waterfront with large glazing and open-concept space to allow light from the morning sunrise. Garage space, staff quarters, pool and deck with pergola and 2 levels are included.

Plate 3-1 View of road with seaside villas

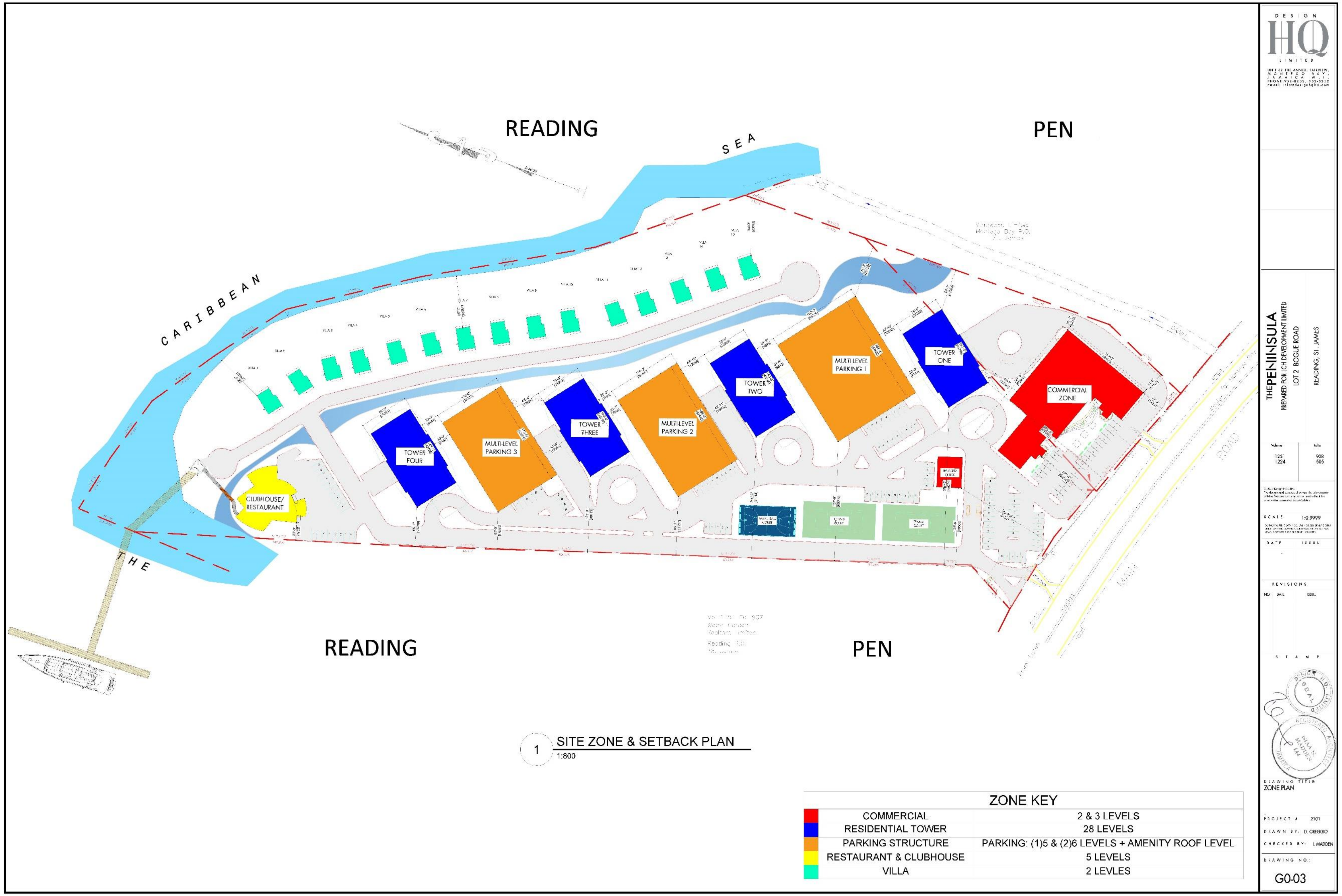


Figure 3-1 Proposed site zone and setback plan

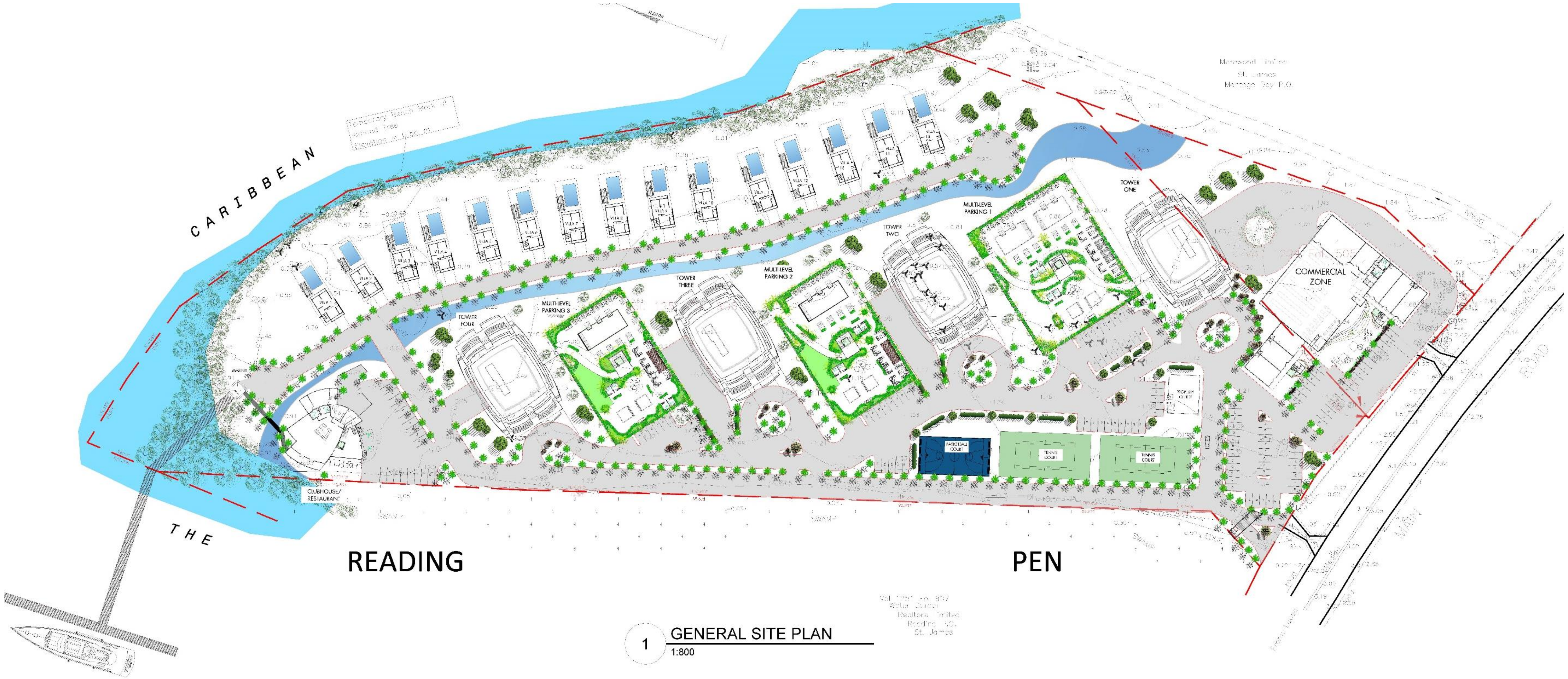


Figure 3-2 General site plan

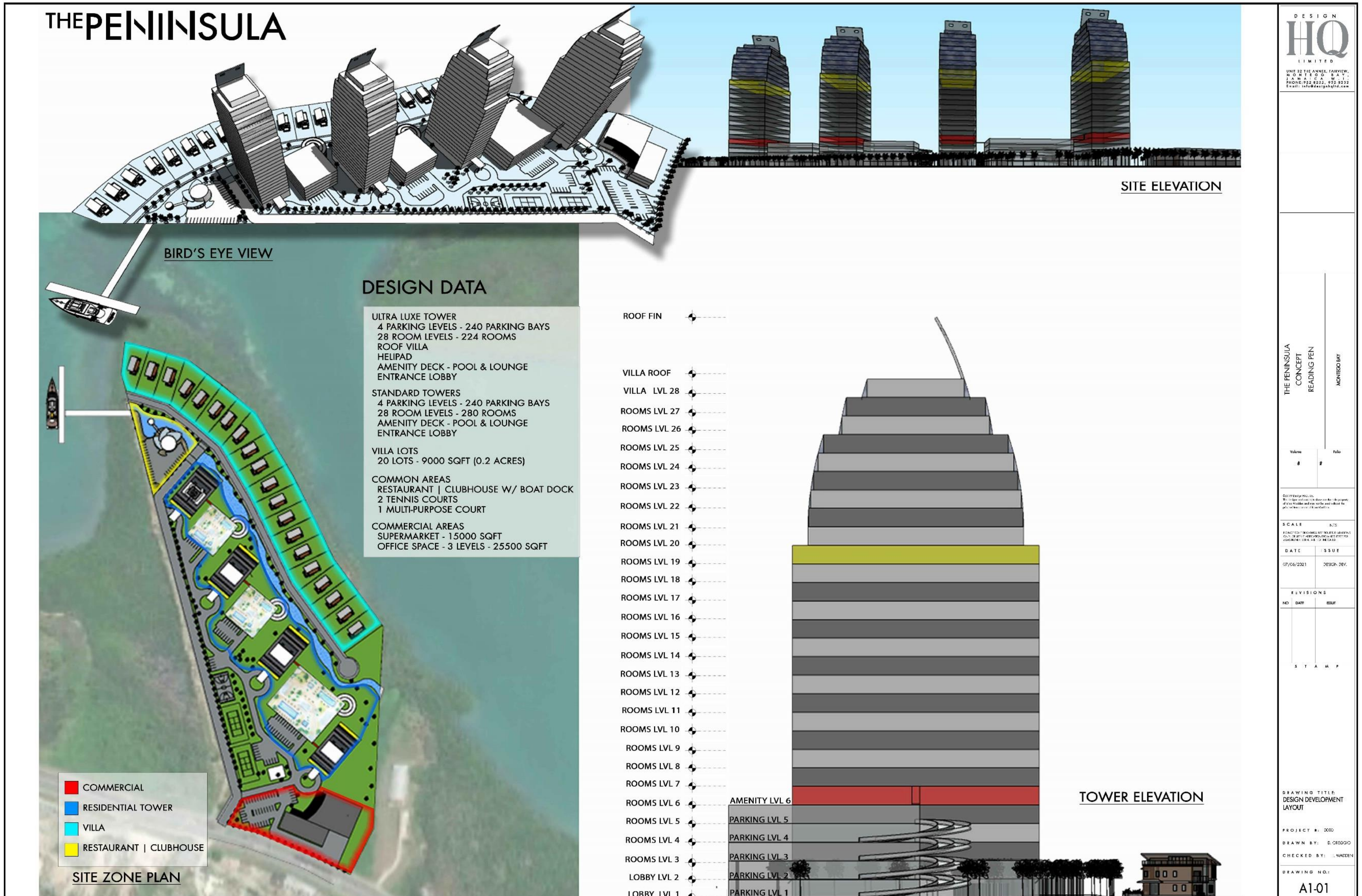


Figure 3-3 Design data, zone plan, bird's eye view and elevations

3.1.1.2 Zone 2: The Peninsula Bay

Located at the tip of the peninsula overlooking the Caribbean Sea facing northwest. The design of this contemporary building focuses on creating stunning views of the sea. The ground level which houses the restaurant has inside and outside dining. The outside dining has pathway access to the marina, which crosses over the site's main water feature. The clubhouse is on the 2nd level for members only to host events. This area also has an outside deck and bar overlooking the sea. The 3rd level hosts a karaoke lounge for mostly night-time fun. The fourth and fifth levels have guest units for residents who will host their guests in these units whenever they come to visit.

Other features include:

- 7000 sq. ft. fine dining restaurant with panoramic views of the sea.
- 5000 sq. ft. clubhouse and lounge
- 3400 sq. ft. karaoke lounge
- 6 guest apartments
- Mini marina that has at least 8 berths for residents that own boats. Also, for the docking of restaurant patrons.

Plate 3-2 East elevation of clubhouse and restaurant

3.1.1.3 Zone 3: The Towers at the Peninsula

Four high rise towers approx. 336 ft./102 m tall are proposed within Zone 3. The design is also modern, using the elements of a concrete structure wrapped in tinted glass to reflect the surrounding sea. The curved balconies create movement in the structures with a structure on top that mimics the waves in the sea. The towers are strategically placed on the site to accommodate the north trade winds that will flow between the towers and not to obstruct the view to the sea from the surrounding hillside.

The towers themselves offer panoramic views of the sea for the proposed residents. Each building is designed to suit the residents' needs. One can enter each tower via the entrance roundabout covered by a porte-cochere into a double-height lobby adjourned with sleek minimalist contemporary furniture or via the bridge on the 7th floor leading from the parking and roof amenities building.

Plate 3-3 Bird's eye view of towers and parking structures

Towers 1 and 2 are geared to support the working sector and their families that would like to work remotely. In addition to the usual amenities such as the pool deck and bar, fitness centre, kids lounge and adult entertainment lounges, there will also be office lounges and meeting rooms available to suit their needs. Tower 3 is geared towards the young at heart that have retired and wants to relax in the sun, sand and sea at their leisure. In addition to the pool deck, outdoor/ indoor lounges, the amenities in this tower include special fitness activities and areas of leisure to support a mature clientele. Tower 4 is the ultra-lux high-rise residence topped with a sky villa. Additional square footage in each unit creates a boutique setting with fewer units with a large variety of top-class amenities. A mini theatre, a trendsetting games room, bar and lounges with catering services and a full-service spa, to name a few, will be available in this tower.

Modern clad multi-storey parking garages will support the towers with sufficient parking spaces and storage spaces for each unit with the amenities on the roof. This will include large swimming pools adorned with cabanas, kid's swimming pools, restrooms, BBQ pergolas and outdoor activity decks.

Plate 3-4 East view of parking structure

Plate 3-5 View of rooftop amenities

Figure 3-4 Parking and Tower Layout and Cross Sections

3.1.1.4 Zone 4: The Commercial Spaces

Zone 4 comprises a Supermarket/Deli with a mini food court in a 15,000 sq. ft. building. The entrance area to this building has a covered courtyard with a large canopy for patrons to enjoy outdoor seating set around planter boxes and landscaping with vending kiosks. Shops and offices in a three-storey building on either side of the supermarket are planned, to support the residences in the complex and the surrounding areas. These spaces are intended to be a doctor's office, pharmacy, high-end retail and executive offices.

Plate 3-6 View of Supermarket and Offices

3.1.1.5 Zone 5: The General Ground Amenities, Project Management and Back of House Buildings

The amenities on the ground will include two tennis courts and one basketball court. The property will also have recreational parks with jogging/walking trails and gazebos.

Towards the east of the towers, there will be a meandering water feature with outdoor landscaped lounges and gazebos. The ponds are excavated spaces lined with heavy-duty pond liners to be filtered with fountain and pump systems.

The development will also have backup generator systems.

Plate 3-7 View of Amenities Area

3.1.2 Habitable Rooms and Density

3.1.2.1 Habitable Rooms

17.5 Acres- 100 habitable rooms/ acre **1750 habitable rooms total**

Zone 1

- **Villas**
  - 15 3000 sq. ft. Waterfront Villas- 4 habitable rooms/Villa

80 habitable rooms

Zone 2

- **Restaurant/Club House**
  - 5000 sq. ft. fine dining restaurant
  - 3000 sq. ft. clubhouse and lounge
  - Karaoke Lounge
  - Mini marina
- **30 Parking Spaces**

Zone 3

- **Towers**
  - 1 bedroom- 2 habitable rooms 800 sq. ft.
  - 2 bedroom- 3 habitable rooms 1100-1800 sq. ft.
  - 3 bedroom - 4 habitable rooms 2000-2200 sq. ft.
  - 4 bedroom- 5 habitable rooms 2400-2800 sq. ft.
  - 5 bedrooms- 6 habitable rooms 3000 - 3200 sq. ft.
- **Tower 1,2 & 3**
  - Working sector/ Families
  - Indoor Amenities- resident lounge, kids lounge, games room

- Outdoor Amenities- pool with deck, outdoor bar and lounge, BBQ area, private storage areas-above garage
- Multi-level Garage parking
- Lobby/BOH 1 Level
- Level 2- Indoor Amenities
- Levels 3-18 7 Units/ floor
  - 1 1bedroom/ floor
  - 5 2 bedroom/floor
  - 1 3 bedroom/floor
  - 16 Levels 112 Units total
- Levels 19-24 4 Units/ floor
  - 2 2 bedroom deluxe
  - 2 3 bedroom deluxe
  - 6 Levels 24 Units total
- Level 25-26- Penthouse Level 2 Units
- 2 Level 2 4 bedroom

  4 Units total
- Level 27-28- Villa in the Sky 1 Unit
  - 2 5 bedroom
- **Total 142 Units/Tower**

- **Tower 1, 2 & 3 - 426 Units 1,356 habitable rooms**
- **Parking Building 1- 427 spaces**
- **Parking Building 2- 204 spaces**
- **Tower 4**
  - Ultra Lux
  - Private elevators, concierge services, valet parking, private mini marina, helipad
  - Indoor Amenities - Multimedia theatre, exclusive membership lounge with bar fully staffed, fitness centre, yoga, spa with sauna, steam, hydro spa pools, private meeting/function room.-3rd level
  - Outdoor Amenities- Pool deck, private cabanas, outdoor lounge and bar with turf games - Above Garage
  - Private sky pool deck with landscaped lounge, members-only lounge- 20th level
  - Multi-level Garage Parking
  - Lobby 1 levels
  - Level 2 - Amenities
  - Level 3-14 6 Units
    - 2 2 bedroom deluxe/floor
    - 2 2 bedroom/floor
    - 1 3 bedroom /floor
    - 1 1 bedroom deluxe/floor
    - 12 Levels 84 Units
  - Level 15-18 Panoramic Residences
    - 2 4 bedroom/floor

    - 2 3 bedroom deluxe/floor
    - 4 levels 16 Units
  - Level 19 - Sky Amenities
  - Level 20-25-Penthouse levels 3 Units
    - 2 4 bedroom
    - 1 5 bedroom
    - 6 Levels 18 Units
  - Level 26-27- Upper Penthouse 2 Units/floor
    - 2 4 bedroom deluxe
    - 2 Levels 4 Units
  - Level 28- Sky Villa 1 5 Bedroom deluxe
    - 1 Level 1 Unit
  - **Total Units 123 338 habitable rooms**
- **Parking Spaces 159**

Zone 4

- **Commercial**
  - 15,000 sq ft. Supermarket/Mini food court
  - 18,000 sq ft. Office/Shops
- **50 parking spaces**

Zone 5

- **General Ground Amenities**
  - 2 tennis courts, 1 basketball court, recreational parks, gazebos, outdoor landscaped lounges, water ponds, running/walking trails
- **Amenity Space Requirements**
  - 1 bedroom- 30 sq m/ 300 sq ft.
  - 2-5 bedrooms- 60 sq m/ 600 sq ft.
  - Tower 1,2 & 3 -
    - 88,800 sq ft. amenity space needed for each tower
    - 266,400 sq ft. total for 3 towers- approximately 6 acres
  - Tower 4-
    - 67,200 sq ft. amenity space needed- approximately 1.5 acres
  - **Total 7.5 acres**

3.1.2.2 Square Area Data

Towers 1,2,3 & 4

- Ground floor - 18 11,402 sq ft. / 1060 sq m
- Level 19 9867 sq ft. / 917 sq m
- Level 20 9636 sq ft. / 895 sq m
- Level 21 9406 sq ft. / 874 sq m
- Level 22 9176 sq ft. / 853 sq m

• Level 23	8946 sq ft. / 831 sq m
• Level 24	8715 sq ft. / 810 sq m
• Level 25-26	7161 sq ft. / 665 sq m
• Level 27-28	5006 sq ft. / 465 sq m
Total per Tower	**285,316 sq ft. / 26,516 sq m**
Total 4 Towers	**1,141,264 sq ft./106,064 sq m**

Parking Building 1

• Level 1-5	28,755 sq ft. / 2671 sq m per Level
• Level 6	10,246 sq ft. / 952 sq m
• Outdoor Amenities	28,755 sq ft. / 671 sq m
Total	**182,776 sq ft. / 16,980 sq m**

Parking Building 2

• Level 1-5	21,952 sq ft. / 2,039 sq m per Level
• Level 6	18,326 sq ft. / 1702 sq m
• Outdoor Amenities	21,952 sq ft. / 2,039 sq m
Total	**106,134 sq ft. / 9,860 sq m**

Parking Building 3

• Level 1-4	19,978 sq ft. / 1,856 sq m per Level
• Level 5	16,977 sq ft. / 1,577 sq m
• Outdoor Amenities	19,978 sq ft. / 1,856 sq m
Total	**96,889 sq ft. / 9,001 sq m**

Restaurant

• Level 1	7,060 sq ft. / 655 sq m
• Level 2	5,260 sq ft. / 488 sq m
• Level 3-5	3,400 sq ft. / 315 sq m per Level
Total	**22,520 sq ft. / 2,092 sq m**

Other

• Supermarket/ Mini Food Court	15,000 sq ft. / 1394 sq m
• Offices/Retail	18,000 sq ft. / 1673 sq m
• Property Management/ Maintenance	2000 sq ft. / 185 sq m

3.1.3 Construction Methodology

The construction method for the proposed development which consists of four 28 storey towers, three multi-level parking garages, supermarket and offices, fine dining restaurant, mini marina, seaside villas and property management office with outdoor amenities will be done on a phased basis.

1. Phase 1- Towers 1 and 2 with parking garage, supermarket, offices and amenities
2. Phase 2- Towers 3 and 4, with parking garage, restaurant and marina
3. Phase 3- Seaside villas

3.1.3.1 Geotechnical Work

In order to determine the bearing depths and subsoil conditions, a Soil Mechanics study will be conducted. Exploratory probes will be advanced using hollow shank augers (H.S.A) coupled to CME 55 drilling rigs. The depth of the water table at the end of the drilling will be recorded in each drilling hole and additional readings will be taken 24 hours after completion. An Electrical Resistivity Geophysical Survey will also be conducted to create profiles of subsoil conditions. A minimum of 10 to 25 profiles will be created, depending on the condition of the terrain.

3.1.3.2 Foundation

The structural engineer will review the Soil Mechanics Study and the Geotechnical Report to determine the most appropriate foundation systems which are likely to be a deep pile-based foundation, based on the condition of the terrain in the area. This process involves drilling guide holes of the necessary size for the placement of the piles. The piles are prefabricated reinforced concrete, made on-site. The exact dimensions will be specified by the structural engineer based on the Soil Mechanics Study. Once the drilling is completed the "ramming" of the piles is done by means of a mechanical "hammer". After ramming, the piles are "beheaded" in order to integrate them into the Superficial Foundation. The Superficial Foundation may be stripped and/or isolated footing.

3.1.3.3 Masonry

A cement-sand mortar in a 1:5 ratio will be applied to flatten both the walls and the ceilings with an average thickness of 1.5 cm. The procedure will be as follows; Repelling and masking the walls and ceilings using sifted cement-sand putty to give the final texture. In the bathroom areas, only repelling will be done. Firm levellers will be made prior to the laying of the floors using cement-sand mortar.

3.1.3.4 Covering and Finishes

The floor coverings will be Porcelain tiles, with ceramic floors in certain areas, as will the bathroom coverings. After flattening, a vinyl paint will be applied. The pool area will be lined with tile affixed with a cement-based tile adhesive and grouted with white-coloured cement.

3.1.3.5 Carpentry

The access doors to the rooms, bathrooms and closets will be made of wood, appropriately selected based on typical conditions and treated to repel moisture and pests.

3.1.3.6 Windows and Glasses

All windows will be made from aluminium profiles. The glass will be tempered and/or laminated. Glass will be no less than 6mm thick, however, their final thickness will depend on their intended purpose.

3.1.3.7 Drywall and Paint

The false ceilings for indoor areas and the space partition walls will be made of standard drywall while the kitchen areas will be fitted with fire-resistant, inflammable panels. For outdoor and wet-prone areas, moisture resistant drywall and/or Durock will be used. The drywall will be caulked with joint reinforcement tape and joint compound and then sanded and primed before being painted.

3.1.3.8 Exterior Works

Pedestrian and vehicular pathways will be built using reinforced and/or stamped concrete, on a 30 cm double-layer base, compacted at 90% Proctor. The same will apply for all paved areas such as plazas, multipurpose courts and playgrounds.

3.1.3.9 Equipment and Materials

The following equipment and materials will be used for construction:

Equipment:

- CME 55 drilling rigs
- Pile driver
- Benders
- Rod cutters
- Welding Plants
- Platforms for transporting prefabricated parts
- Hydraulic cranes
- Four (4) 110-tonne tucks
- Four (4) 60-tonne trucks

Materials:

- Piles, concrete columns and beams
- Concrete walls and steel, drywall and concrete board partitions
- Drywall ceilings
- Porcelain tiles
- Tinted Glass windows and doors
- Aluminium framing
- Glass railings
- Aluminium decorative panels on exterior in certain areas

3.1.3.10 Raw Material and Solid Waste

The aggregate and concrete blocks for the project will be sourced. The excavated material will be stored on site and covered with tarpaulin to minimise dust pollution and bermed to prevent runoff. The construction waste will be collected onsite by a waste disposal company and will be transported to the Retirement Disposal Site in St. James.

3.1.4 Employment

The work force for the site will at peak time be approximately 1,000 trade men and labourers during the construction phase.

3.2 AUXILIARY PROJECT ACTIVITIES

3.2.1 Water Supply, Sewage Treatment and Disposal

Water for the development will be supplied by the National Water Commission (NWC) (Appendix 2). Wastewater from apartments and villas in the surrounding area is collected through a pipe network, treated by septic tanks, and discharged into the NWC municipal sewerage network on the south side of the municipal road (South China Construction and Engineering Ltd., 2022).

Wastewater for the proposed development will be collected via septic tanks, and then piped to the NWC municipal sewerage network where it will be treated at the Bogue Wastewater Treatment Facility (Appendix 2).

Calculation of outdoor sewage system: the displacement per person per day is 380L (according to the domestic water consumption of 400L/ person/day; 95% of days are calculated), the number of water hours is 24 hours, and the time change coefficient is 2 5. The maximum daily discharge of outdoor sewage is 380 * (2450 + 105) = 970900 L / d; the maximum displacement is 970900/24*2.5=101135 42 L/h=28. 10 L/s; and therefore, the diameter of the outdoor sewage drainage system is DN400, and the flow rate is 0 961m/s (South China Construction and Engineering Ltd., 2022).

Water consumption per day: 400 Litres (0.4 m^3) per person
Sewage discharge per day: 380 Litres (0.38 m^3) per person
Max water consumption per day: 1,022,000 Litres (1,022 m^3)
Max sewage discharge per day: 970,900 Litres (970.9 m^3)

The effective volume of the septic tank shall be the sum of the volume of the sewage part and the sludge part, and should be calculated according to the following formula:

$$V = V_w + V_n \qquad (4.10.15\text{-}1)$$

$$V_w = \frac{m_f \cdot b_f \cdot q_w \cdot t_w}{24 \times 1000} \qquad (4.10.15\text{-}2)$$

$$V_n = \frac{m_f \cdot b_f \cdot q_n \cdot t_n (1 - b_x) \cdot M_s \times 1.2}{(1 - b_n) \times 1000} \qquad (4.10.15\text{-}3)$$

Wherein:

Vw - septic tank sewage part volume (m3);
Vn - partial volume of septic tank sludge (m3);
qw - calculate the amount of sewage per person per day [L/(person ·d)];
tw - the time for the sewage to stay in the pool (h), which should be determined according to the amount of sewage, and should be used for 12h to 24h;
qn - calculate the amount of sludge per person per day [L/(person·d)];
tn - the sludge removal cycle should be determined according to the temperature of sewage and local climatic conditions, and should be used (3 to 12) months;
bx - fresh sludge moisture content can be calculated as 95%;
bn - the moisture content of the sludge after fermentation and concentration can be calculated at 90%;
Ms - the volume reduction coefficient after sludge fermentation, it is advisable to take 0. 8;
2- 20% volume coefficient left behind after cleaning;
mf – the total number of people served by septic tanks;
bf - the percentage of the total number of people actually using septic tanks,

The setting of the septic tank shall comply with the following regulations:

1. The septic tank should be set up at the downstream end of the household pipe, which is convenient for motor vehicles to clear;
2. The outer wall of the septic tank should not be less than 5m from the external wall of the building, and shall not affect the foundation of the building;
3. Septic tank should be equipped with a snorkel, and the outlet of the ventilation pipe should be set to meet the requirements of safety and environmental protection.

The structure of the septic tank shall comply with the following regulations:

1. The ratio of the length of the septic tank to the depth and width shall be determined by hydraulic calculation according to the settlement conditions and accumulation quantity of suspended solids in the sewage; the depth (water surface to the bottom of the pool) shall not be less than 1.30m, width shall not be less than 0. 75m, the length shall not be less than 1. 00m, circular septic tank diameter shall not be less than 1.00m ;
2. The capacity of the first compartment of the double-compartment septic tank should be 75% of the calculated total capacity; the capacity of the first compartment of the three-compartment septic tank should be 60% of the total capacity, and the second and third compartments should each be 20% of the total capacity;
3. Septic tank grid and lattice, pool and connection well should be set up ventilation holes;
4. Septic tank inlet and outlet should be set up to connect wells with inlet pipes and outlet pipes;
5. 5 Septic tank inlet pipe nozzles should be equipped with a diversion device, and between the water outlet and the grid should be equipped with a facility to intercept sludge scum;

6. Septic tank walls and bottoms should be prevented from leakage;
7. The top plate of the septic tank should be equipped with manholes and covers.

Figure 3-5 to Figure 3-7 below shows the calculation and details on septic tank design.

1. Calclation formula

1) When fecal sewage and domestic waste water confluence

$$W=W_1+W_2=\frac{N_z \alpha q t}{24X1000}+1.2\ (0.00028 N_z \alpha T) \qquad W_1=\frac{N_z \alpha q t}{24X1000}$$

$$N_z=\frac{W}{\alpha 10^{-5}\ (4.17qt+33.6T)} \qquad W_2=1.2\ (0.00028 N_z \alpha T)$$

2) When the excrement sewage and domestic wastewater are separated

$$W=W_1+W_2=\frac{N_z \alpha q t}{24X1000}+1.2\ (0.00016 N_z \alpha T) \qquad W_1=\frac{N_z \alpha q t}{24X1000}$$

$$N_z=\frac{W}{\alpha 10^{-5}\ (4.17qt+19.2T)} \qquad W_2=1.2\ (0.00016 N_z \alpha T)$$

W——Effective volume of septic tank, m^3

W_1——The sewage portion of the septic tank, m^3。

W_2——Partial Volume of Sludge in Septic Tank, m^3。

N_z——Septic tank design for total number of people

q——Per capita daily sewage /per person (same as thed maximum water consumption quota)

t——The retention time of sewage in the septic tank , 12h, 24h

T——Septic tank emptying cycle, 90d, 180d, 360d。

α——Percentage of persons actually using sanitary wares to the total number of persons designed according to building usage

Figure 3-5 Calculation and Explanation of Total Number of People in Septic Tank Design

SEPTIC TANK G13-100SF (NO:13)
SEPTIC TANK G7-20SF (NO:7)

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Septic No:	Effective Volume (m^3)	The following sewage volumes and the actual number of persons can use at the same time: 20 L person/per day, Cleaning 4 times per year	20 L person/per day, Cleaning 2 times per year	5 L person/per day, Cleaning 4 times per year	5 L person/per day, Cleaning 2 times per year	Length: L	Length: ℓ_1	Length: ℓ_2	Length: ℓ_3	Width: B, No Overhead crane	Width: B, Overhead crane	Width: b	High: H	High: h_1	High: h_2	Divider: h_3	Divider: Steel 1	Divider: Steel 2	S_1 Steel 1: No Overhead crane	S_1 Steel 1: Overhead crane	S_1 Steel 2: No Overhead crane	S_1 Steel 2: Overhead crane	$S_2(S_3)$ Steel 1: No Overhead crane	$S_2(S_3)$ Steel 1: Overhead crane	$S_2(S_3)$ Steel 2: No Overhead crane	$S_2(S_3)$ Steel 2: Overhead crane		
1	0.476	9	6	12	6	1600	640		480	1000	1200	640	1100	800	400	600	5ø10	4ø10	3ø10	4ø12	5ø4	5ø6	2 3ø10	2x2ø16	2x2ø4	2x2ø8	S_2、S_1	2x2ø10
2	0.708	13	8	18	10	2100	960		660	1000	1200	640	1100	800	400	600			3ø10	4ø12	5ø4	5ø6	2 3ø10	2x2ø16	2x2ø4	2x2ø8	$2S_2$	
3	1.228	22	14	31	16	2600	1000	440	440	1250	1250	770	1300	1000	500	700	5ø10	4ø10	3ø10	5ø12	2x3ø4	2x3ø6	2 3ø10	2x2ø16 2x1ø12	2x3ø4	2x3ø8	$2S_2$、S_1	S_2 2ø16 1ø12
4	1.579	29	18	40	21	3100	1080	650	650	1250	1250	770	1300	1000	500	700	5ø10	4ø10	3ø10	5ø12	2x3ø4	2x3ø6	2 3ø10	2 3ø16	2x3ø4	2x3ø8	$3S_2$	
5	2.113	39	24	53	28	3100	1080	650	650	1500	1760	1020	1300	1000	500	700	5ø10	4ø10	3ø10	3ø16	7ø4	7ø6	2 3ø10	2x3ø16	2x4ø4	2x5ø8	$3S_2$	
6	2.860	51	32	71	38	3600	1380	750	750	1500	1760	1020	1400	1100	550	750	5ø10	4ø10	3ø10	3ø16	7ø4	7ø6	2 3ø10	2x3ø16	2x4ø4	2x5ø8	S_2、S_1、$2S_2$	
7	3.582	66	40	91	48	3600	1380	750	750	1750	2010	1270	1400	1100	550	750	5ø10	4ø10	3ø10	4ø16	9ø4	9ø6	2x3ø10	2x3ø20	2x5ø4	2x5ø8	S_2、S_1、$2S_2$	
8	4.643	85	52	111	63	4100	1680	850	850	1750	2010	1270	1500	1200	600	800	5ø10	4ø10	3ø10	4ø16	9ø4	9ø6	2x3ø10	2x3ø20	2x5ø4	2x5ø8	S_1,S_2, S_1, $2S_2$	
9	5.388	99	60	136	73	4600	1880	1000	850	1750	2010	1270	1500	1200	600	800	5ø10	4ø10	3ø10	4ø16	9ø4	9ø6	2x3ø10	2x3ø20	2x5ø4	2x5ø8	S_1,S_2, S_1,S_2, S_1,S_2	
10	6.082	111	68	154	82	5100	2180	1100	1100	1750	2010	1270	1500	1200	600	800	5ø10	4ø10	3ø10	4ø16	9ø4	9ø6	2x3ø10	2x3ø20	2x5ø4	2x5ø8	S_1,S_2,$2S_1$, S_2, S_1,S_2	
11	7.384	135	83	187	99	5600	2380	1250	1250	1750	2010	1270	1600	1300	650	850	5ø10	4ø10	3ø10	4ø16	9ø4	9ø6	2x3ø10	2x3ø20	2x5ø4	2x5ø8	$2S_1$, S_2, $2S_1$,S_2, S_1,S_2	
12	8.882	163	100	225	120	5600	2380	1250	1250	2000	2260	1520	1600	1300	650	850	5ø10	4ø10	4ø10	5ø16	10ø4	10ø@200	6ø12	2x3ø22	8ø4	ø8@170	$2S_1$, S_2, $2S_1$,S_2, S_1,S_2	
13	9.809	180	110	248	132	6100	2580	1400	1400	2000	2260	1520	1600	1300	650	850	5ø10	4ø10	4ø10	5ø16	10ø4	10ø@200	6ø12	2x3ø22	8ø4	ø8@170	$2S_1$,S_2,$2S_1$,S_2, $2S_1$,S_2	
14	11.687	214	131	296	158	7100	3080	1650	1650	2000	2260	1520	1600	1300	650	850	5ø10	4ø10	4ø10	5ø16	10ø4	10ø@200	6ø12	2x3ø22	8ø4	ø8@170	$3S_1$,S_2,$2S_1$,S_2, $3S_1$,S_2	
15	13.565	248	154	343	183	8100	3580	1900	1900	2000	2260	1520	1600	1300	650	850	5ø10	4ø10	4ø10	5ø16	10ø4	10ø@200	6ø12	2x3ø22	8ø4	ø8@170	$3S_1$,S_2,$3S_1$,S_2, $4S_1$,S_2	

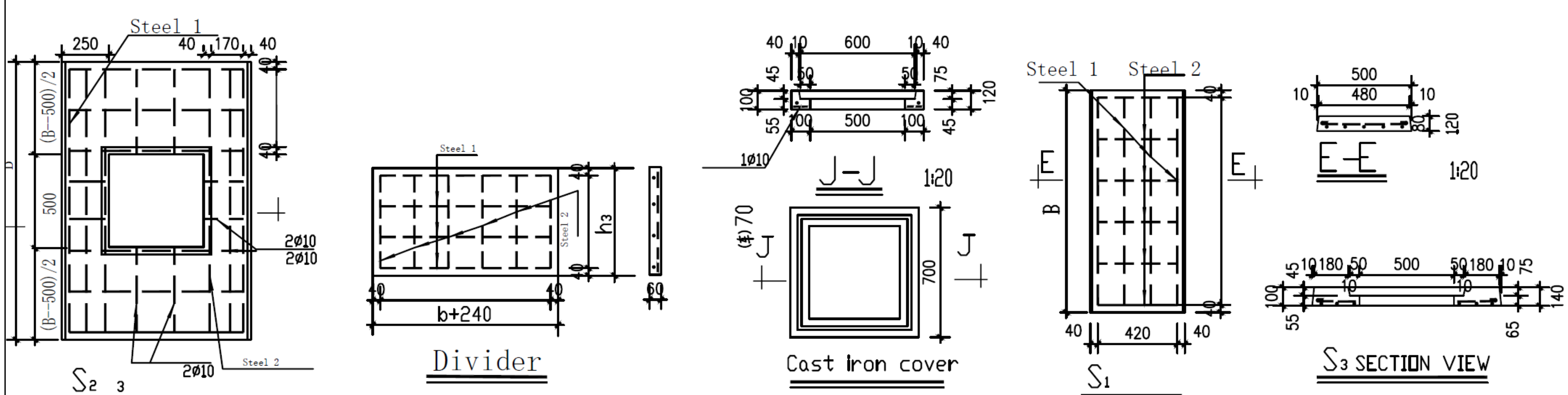

Figure 3-6 Septic Tank Design Calculations

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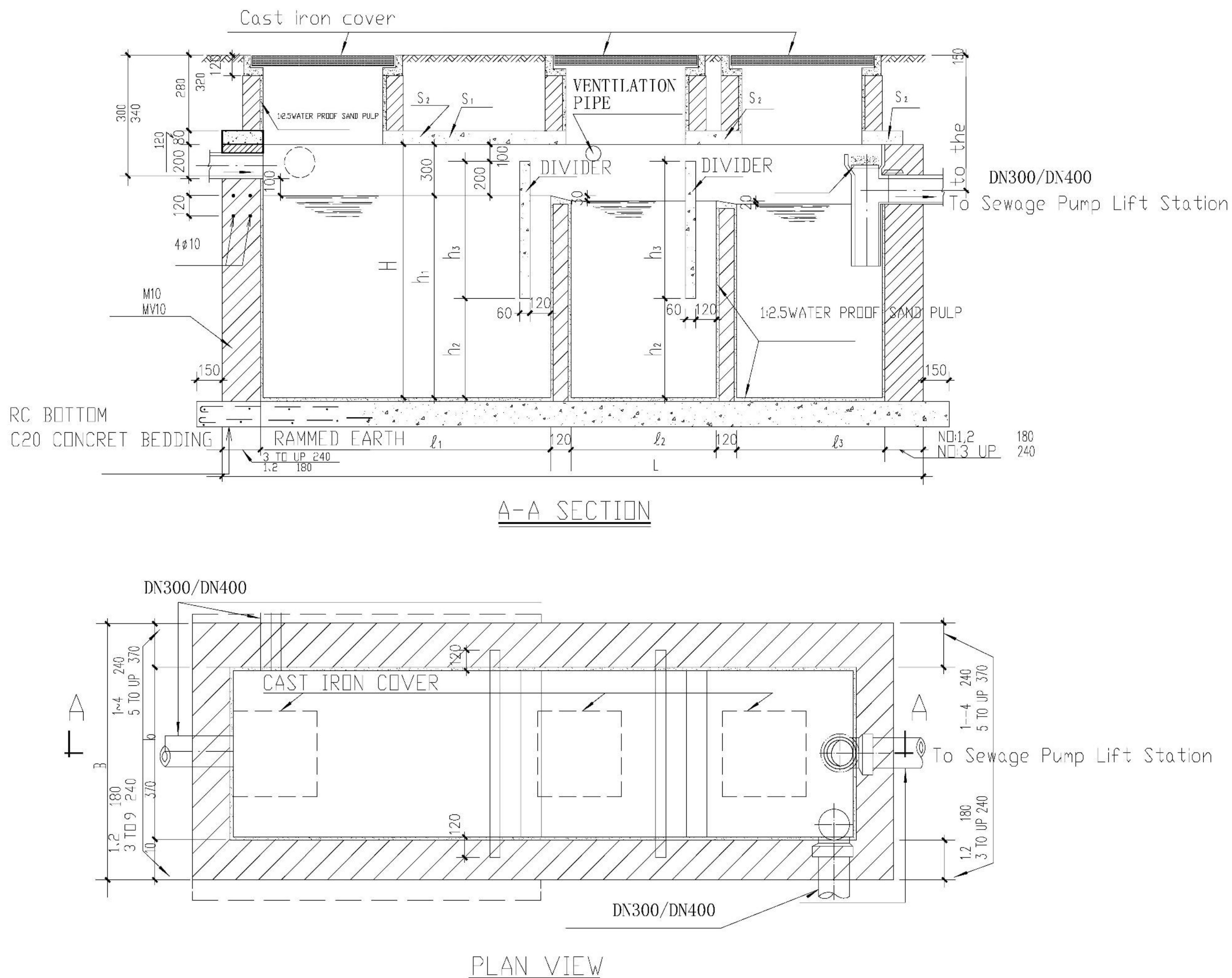


Figure 3-7 Schematic of Septic Tank

The layout of pipelines and the layout of domestic drainage pipes for the development will comply with the following provisions:

- It will be arranged in parallel with the perimeter of roads and buildings, and under sidewalks or grass;
- The distance of the pipe centreline according to the external wall of the building will not be less than 3m, and the pipeline will not be arranged under the tree;
- When the pipeline intersects with the road, it will be perpendicular to the centreline of the road;
- The main pipe will be close to the main drainage building and arranged on the side of the road with more connecting branch pipes.

The minimum buried depth of the living drainage pipe in the community will be determined by calculation according to the driving grade of the road, the compressive strength of the pipe, the bearing capacity of the foundation and other factors, and should meet the following provisions: The living drainage pipe under the main road of the community and the road of the community group, the covering depth should not be less than 0.70m.

The following locations of outdoor domestic drainage pipes will be equipped with inspection wells: at pipe turns and connections; and in the pipe diameter, slope change, drop. The connection of the domestic drainage pipe of the inspection well shall comply with the following regulations:

1. The water flow angle at the connection shall not be less than 90°; when the diameter of the drainage pipe is less than or equal to 300mm and the drop difference is greater than 0. At 3m, it can be not limited by the angle;
2. In addition to the outdoor drainage pipe, the top of the pipe should be flattened;
3. The ceiling height of the discharge pipe shall not be lower than the ceiling height of the outdoor pipe;
4. At the junction of the discharge pipe and the municipal pipe and canal in the community, the design water level of the discharge pipe should not be lower than the design water level of the municipal pipe and canal.

The inner diameter of the inspection well shall be determined according to the diameter, quantity and burial depth of the connected pipes. When the inner diameter of the well is greater than or equal to 600mm, anti-fall measures should be taken. The inspection well of the domestic drainage pipe should have a diversion trough or a downstream structure. Less than or equal to 150mm of drainage pipes, when laid in the outdoor basement roof cladding layer, you can use the cleaning port instead of the inspection well, the cleaning port should be located in the well room.

3.2.2 Stormwater Drainage Design

3.2.2.1 Existing Drainage Conditions

The land for this project is currently undeveloped, the terrain is relatively flat, and the site is sloped from south to north and from west to east. Rainwater from the site is collected through infiltration or surface rainwater, collected through the pipe network, and discharged into the Caribbean Sea.

3.2.2.2 Stormwater Management

The stormwater management for the site is based on the National Works Agency's 'Guidelines for Preparing Hydrologic and Hydraulic Design Reports for Drainage Systems and Proposed Development'. The drainage system is considered to be a minor drainage system and as such, the rainfall intensity used will be based on a return period of up to 1 in 10 yrs and peak discharge will be based on the Rational Method.

Drainage Design

The criteria used for drainage design were determined by the GOJ Development and investment manual, the Jamaica Institution of Engineers guidelines, the newly developed "NWA drainage Guideline" and best practices of the industry. The storm runoff from the property will be directed toward the necessary features of the drainage system such as storm sewer and open drains that fall toward the outlets identified.

Catchment Areas

The catchment areas contributing to the drainage system include roof areas and paved areas and roadways. For the purpose of run off coefficients, roof areas, and parking areas are assumed to be similar. Other soft landscaped areas are assumed to undergo natural runoff and not contribute to the stormwater management system.

Design Storm Event

The Jamaica Institution of Engineers recommended "Guidelines for the design and Construction of Housing Infrastructure" Vol 1: 1984 Storm Water Drainage recommends that the design storm frequency of storm sewers be 2 years and for culverts, bridges and flood control projects a minimum of 10 years. Surface drainage systems are primarily concerned with convenience in relatively minor storms and providing access to property. The criteria for the designs of drains are as follows:

1. Roof rainfall to the main buildings will be collected in down pipes and runoff from pavements and other impermeable surfaces will be collected in open concrete channel drain inlets.
2. Local streets will accommodate storm flows for 2 years return period to the crown of the road and storm flows for 5 years return period to kerb height.
3. Main stormwater drainage pipes will be designed to accommodate storms to 1:10 year return period with a freeboard provision of 25% depth of flow.

Where additional guidance is required, the following manuals were used. The FHWA documents referenced are:

1. Hydraulic Engineering Circular No. 12 - Drainage of Highway Pavements
2. Hydraulic Engineering Circular No. 14, Hydraulic Design of Energy Dissipaters

Method of Determining Design Peak Flows

Storm runoff generated within the development is intercepted at various locations from several sub-catchments, particularly from the roof and parking areas. The size of the drainage structures is determined by the peak flow generated from the sub-catchment. The Rational Method was used for determining the peak flow throughout. These peak flows were compared with the rainfall intensity analysis formulas developed by the World Meteorological Organization for "Seminar for the Transfer of Technology, Flood Plain Mapping Project." IDF curves are developed using this method based on the 24hr Rainfall Isohyetal Maps.

The major factors affecting the rational method runoff coefficient value for a watershed are the land use, the soil type and the slope of the watershed. The physical interpretation of the runoff coefficient for a watershed is the fraction of rainfall on that watershed that becomes storm water runoff. Thus, the runoff coefficient must have a value between zero and one.

Storm Sewers

The storm sewer system being the buried drainage conveyance system below the pavement is designed to convey a 1:10 year storm without surcharging. The discharge of storm sewers will be to the existing adjacent concrete drains. The storm sewer pipes or channels will have a minimum gradient of 0.35% for HDPE drain pipes; however, the more important factor will be the minimum and maximum velocities which will be between 1-3.5m/s. Storm inlets will be placed appropriately in order to minimize the pipe runs and allow for maximum collection. As stipulated by NWA the maximum spacing between inlet manholes will be 80m for pipes ≥ 600mm diameter and for pipes less that 600mm diameter the maximum distance will be 50m.

Intensity

Rain data was taken from the National Meteorological Service's estimates of maximum 24 hour rainfall for selected return periods. This was converted to rainfall intensity developed from the Kingston Isohyetal maps recording rain gauge based on the proximity of the site to this station. The NWA has requested that an additional MONTEGO BAY MIXED USE DISTRICT consideration be given to the rainfall intensities based on the increasing trend in global warming. It is predicted that rainfall intensities will be higher in the future than they are now. For this reason, a factor of 10% was added to the calculated intensities to satisfy future expected increase in precipitation.

3.2.2.3 Rainwater System

This project refers to the amount of local rainwater and rainfall in the project and determines the design rainstorm intensity q=3 7 L/s. 100 m^2. Formula for calculating the amount of rain:

$Q = q \cdot \Psi \cdot F$

Where:

Q is designed for rainwater flow
q is the design rainstorm intensity (L/s· 100 m^2)
Ψ is the runoff coefficient
F is the catchment area (100 m^2)

Basic Parameters: Design rainstorm intensity q=3 7 L/s. 100 m^2, runoff coefficient Ψ = 0 55, villa area catchment area F = 27673 m^2, apartment area catchment area F = 43074 m^2.

Calculation of rainwater discharge

Design flow of rainwater in the villa area Q=3.7*0.55*27673/100=563. 15 L/S, design rainwater pipe diameter to take DN700, flow rate of 1 318 m/s.

The design flow of rainwater in the apartment area is Q=3.7*0.55*43074/100=876 56 L/S, design rainwater pipe diameter to DN1000, flow rate of 1 365 m/s.

Community rainwater

The discharge of rainwater in the community should follow the principle of source emission reduction, and it is advisable to use the terrain elevation to adopt an organized surface drainage method. The rainwater drainage outlet of the community should be set at the end of the rainwater control and utilization facility and discharged in the form of overflow; the rainfall overflow that exceeds the requirements of the rainwater runoff control enters the municipal rainwater pipe canal. When a rainwater pipe network must be set up in the community, the layout of the rainwater outlet should be set according to the terrain, soil characteristics, and building location. The following parts should be arranged with rainwater inlets:

1. Road intersection and road surface bottom;
2. Underground ramp entrance.

Drainage ditches should be set up in the following places:

1. Outdoor square, parking lot, sunken square;
2. Where the slope of the road changes;
3. Around the water feature pool and super high-rise buildings;
4. Areas where the depth of the cover cannot meet the requirements when the pipeline is laid;
5. When conditions permit, the finished linear drainage ditch should be used;
6. When the soil has infiltration conditions, it is advisable to use seepage ditches.

The layout of rainwater pipes in the community should comply with the following regulations:

1. It is advisable to arrange it in parallel along the perimeter of roads and buildings, and under sidewalks, driveways or green belts;

2. The minimum net distance between rainwater pipes and other pipes and trees shall comply with the provisions of Appendix E to this standard;
3. When the pipeline intersects with the road, it should be perpendicular to the centreline of the road;
4. The main pipe should be close to the main drainage building and should be arranged on the side of the road with more connected branch pipes.

The minimum buried depth of the rainwater pipe in the community should be calculated and determined according to the driving grade of the road, the compressive strength of the pipe, the bearing capacity of the foundation and other factors, and should comply with the following regulations:

1. The cover depth of the pipe under the main road of the community and the group road of the community should not be less than 0.70m；
2. When there is no water stored in the pipe in winter, the rainwater pipe can be buried in the frozen layer.

The rainwater inspection well should be set up in accordance with the following regulations:

1. When the diameter, slope and flow direction of rainwater pipes and rainwater ditch pipes change, rainwater inspection wells should be connected;
2. The rainwater pipe is connected in the inspection well, in addition to the water flow drop difference, it is advisable to take the pipe top flat connection;
3. The water flow angle at the connection shall not be less than 90°; when the diameter of the rainwater pipe is less than or equal to 300mm and the drop difference is greater than 0. At 3m, it can be not limited by the angle;
4. When the discharge pipe of the community is connected with the municipal pipeline, the ceiling height of the discharge pipe of the community shall not be lower than the ceiling height of the municipal pipeline;
5. When the rainwater pipe drains water to the landscape water body and the river channel, the water level in the pipe should not be lower than the design water level of the water body.

3.2.2.4 Conclusion

The drainage system has been designed in accordance with best practices. The roadways and storm drainage network will convey the 10-year event and all storm sewers will empty into the adjoining stormwater mains drainage. Stormwater velocities are within the limit of 1-3.5m/s in order to ensure clearance of any blockages as well as limit the forces in the pipe network.

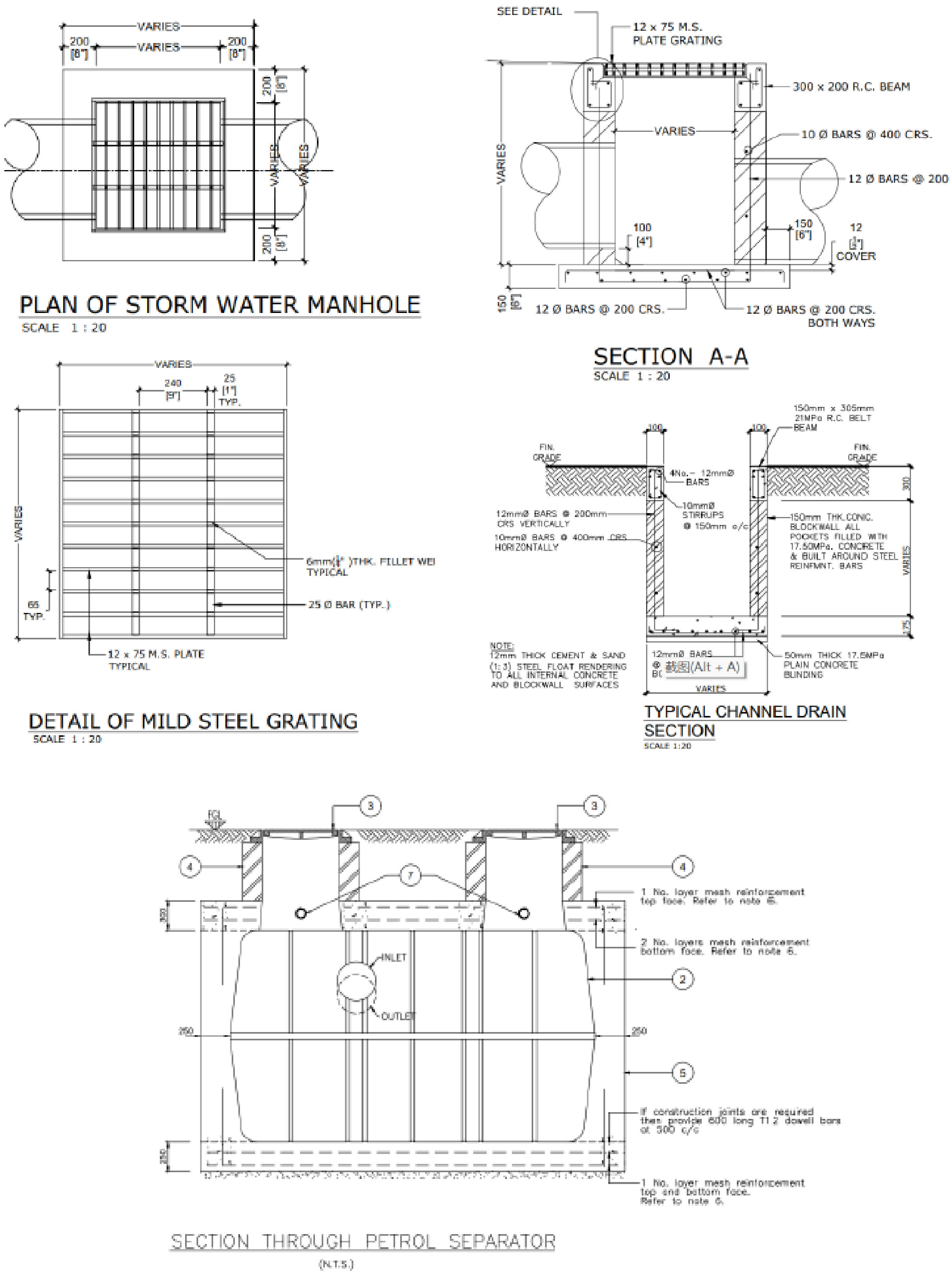


Figure 3-8 Details of stormwater drainage design sample approach

Figure 3-9 Proposed sewage and storm water drainage system

3.3 JETTY DESIGN

3.3.1 Scope and Approach

The client requires a Marina to be designed to accommodate ten (10) forty-five foot (45 ft) (13.7 metre) vessels. To complete this design, data collection and analysis (bathymetric, topographic, geotechnical, current tracking surveys and wave climate) and hazard assessment investigations were incorporated in the design. Specifically, the scope of works for the jetty design undertaken by CEAC Solutions Co. Ltd. included (CEAC Solutions Co. Ltd., 2022):

1. Assessment of field data and hazard modelling:
    a. Bathymetric survey from nearshore to 20 metres depth offshore (see Section)
    b. Current measurements (drogue tracking) (see Section 4.1.8)
    c. Topographic survey and aerial survey from the back of beach (see Section 4.1.5)
    d. Storm surge modelling for 10-to-100-year (yr.) return period (RP) (see Section 4.3.3)
    e. Wind assessments from hurricane models and regional wind models to give 10 to 100yr RP (see Section 4.3.1)
2. Marina design
    a. Decking elevation
    b. Decking and mooring pile materials, reinforcement, and embedment depth
    c. Marina and berthing layout
3. Construction Methodology
    a. Method of construction including stockpile location and access road.

3.3.2 Design Basis

3.3.2.1 Regulations, Standards and Codes

The designs were prepared in accordance with industry standards and codes of practice listed below, as well as those in Table 3-1 (CEAC Solutions Co. Ltd., 2022):

1. American Concrete Institute (ACI)
    - ACI 318-08, Building Code Requirements for Structural Concrete
2. American Society of Testing and Materials (ASTM) - Standards, Specifications, and Recommended Practices
3. American Society of Civil Engineers (ASCE):
    - ASCE 7-10, Minimum Design Loads for Buildings and Other Structures
    - Manual 50: Planning and Design Guidelines for Small Craft Harbours
4. Standard Specifications for Anchor Bolts ASTM F1554-07
5. ASTM C114-69 Standard method of chemical Analysis of Hydraulic cement.
6. Unified Facilities Criteria
    - Design: Small Craft Berthing Facilities
7. British Standard:
    - Structural timber – strength classes

Table 3-1 Summary of the governing codes

Source: (CEAC Solutions Co. Ltd., 2022)

Code	Code Description	Application
British Standard: 6349-1:2000, Maritime structures — Part 1: Code of practice for general criteria	BS 6349-1:2000 provides guidance on the criteria relevant to the planning, design, construction, and maintenance of structures in a maritime environment and located at or close to the shore.	1. Berthing loads; 2. Mooring loads.
British Standard: 6349-2: 2019, Maritime structures — Part 2: Code of practice for the design of quay walls, jetties and dolphins	BS 6349-2 Includes guidance on the design of quay walls, jetties and dolphins, roll-on/roll-off terminal ramps and pedestrian access.	1. Marina layout 2. Decking pile design
British Standard: 6349-4: 1994, Maritime structures — Part 4: Code of practice for design of fendering and mooring systems	BS 6349-4: 1994 sets out guidance on the criteria relevant to the planning, design, construction and maintenance of structures in a maritime environment and located at or close to the shore.	1. Mooring pile design 2. Fender design 3. Bollard and cleat design
Natural Resources Conservation Authority Guidelines for the Planning, Construction and Maintenance of Facilities for Enhancement and Protection of Shorelines	This document outlines all the requirements for the design and construction of Jetties.	1. Data collection 2. Foundation design considerations
British Standard: Structural timber – strength classes	This standard establishes a system of strength classes of timber for general use.	1. Decking deign 2. Bolt and screw designs
American Society of Civil Engineers (ASCE 7-16), 2017	ASCE provides the minimum load requirements for building and structural design to meet building code specifications.	1. Wind Load; 2. Dead loads; 3. Live loads;
Eurocode 5: Structural Timber Design	This code provides information on timber characteristics and design considerations.	Decking design

3.3.2.2 Conditions and Loads

For the purposes of the marina design, the specifications of the Ocean Alexander 45 Divergence boat were used as the design vessel.

Table 3-2 Design vessel, climatic conditions and loads criterion

Source: (CEAC Solutions Co. Ltd., 2022)

Basis	Criterion
Design vessel	1. Number of vessels: 10 2. Overall length: 44’8” (13.61m) 3. Waterline length: 39’8” (11.18m) 4. Maximum draft: 4’ (1.2 m) 5. Loaded displacement 40,100 lbs (18,190 kg) 6. Maximum Beam: 13’9” (4.19 m)
Oceanographic and Metrological	1. Operational Wind Speeds and directions: up to 30 m/s from the NW direction (58.3 knots), mooring permitted 2. Operational and Swell moored wave heights: 0.12m and 0.15m 3. Hurricane wave heights: 100 year RP, up to 1.8m, no mooring permitted 4. Bathymetry: CATZOC A1 survey

Basis	Criterion
Loads	1. Live loads 2. Dead loads: decking, joists, beams, piles 3. Mooring loads: a. Docking impact load - 127kN based on 1ft/s (0.3m/s) approach speed b. Windage loads – 42kN during winds up to 31m/s

3.3.3 Jetty Layout and Structural Design

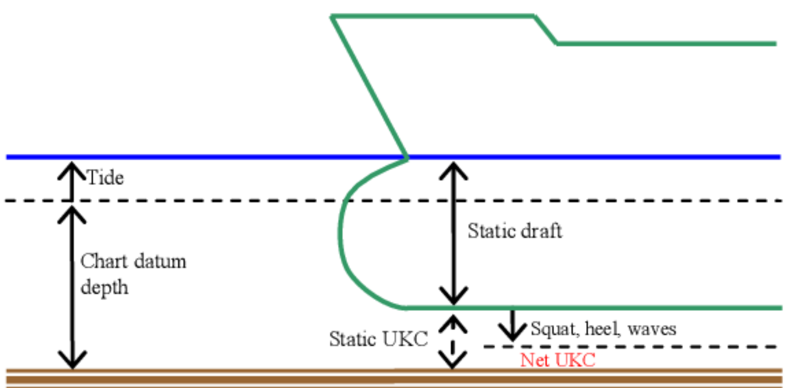
The jetty was designed for a 50-year return period and took into consideration the design of the decking, decking piles and mooring piles. The key loads considered were (CEAC Solutions Co. Ltd., 2022):

6. Boat impact
7. Wind
8. Waves
9. Dead load of deck, beams and stringers
10. Anticipated live loads on decking

3.3.3.1 Design and Materials

Under Keel Clearance

The Under-keel clearance (UKC) is the distance between the lowest point on the ship's keel (or hull) and the highest point in the channel beneath the ship. UKC is equal to the minimum total water depth at the location of the ship minus the maximum dynamic draft of the ship. The dynamic draft is the distance from the water's surface to the lowest point on the ship's keel while the ship is in motion. This value was calculated using the Permanent International Association of Navigation Congresses (PIANC) guidelines.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-10 Diagram depicting UKC considerations.

Two (2) approach scenarios and three (3) moored scenario was calculated. It was determined that the minimum required UKC for the proposed boat would be 0.61m. This clearance is achievable in water depths ≥ 3m. This depth is what influenced the placement of the berthing spaces for the marina in 3-4m of water, which is approximately 60m from the shoreline. This location will facilitate the safe boat approach and mooring at the jetty in both operational and swell wave conditions for the design 45ft vessel. Mooring, however, is not advisable during hurricane conditions.

Mooring Piles

MOORING LOADS

The design of the Mooring piles took into consideration the lateral forces on these piles, i.e., windage, wave impact & boat load. These calculations took into consideration hurricane conditions for a 100 yr Return Period storm. Hence, the correlated design values were used for the wind and wave calculations. To determine the wind energy, the effects of oncoming winds, wind conditions that were both aligned with and perpendicular to the vessel were assessed. The relationship between the exposed area, shape factor and wind pressure produced the wind impact. The maximum force from wave energy was determine from considering the wave characteristics (including breaking height), pile dimensions, drag coefficient and density of water. Morrison's Formula was used to determine the horizontal force per unit length of piles subject to waves.

Additionally, the docking impact load took into consideration the specifications of the design vessel and approach velocity limited by the coefficient of restitution. This allowed the computation of the impact energy to be absorbed by the pile.

Table 3-3 Mooring Load Values

Source: (CEAC Solutions Co. Ltd., 2022)

Mooring Loads	kN
Wind Impact	1.63
Wave Impact	2.6
Berthing Load	126.9
Total Load	131.1

REINFORCED CONCRETE PILE DESIGN

These piles were designed as square precast concrete piles with a compressive strength of 30MPa, diameter of 305mm and length of up to 7.8m. The design calls for 4-32mm ϕ and 12-13mm ϕ reinforcement bars (Figure 3-12). This steel will require a minimum cover of 75mm. The soil conditions from Borehole No. 101 provided in the Geotechnical Report advised the embedment depth of the mooring piles.

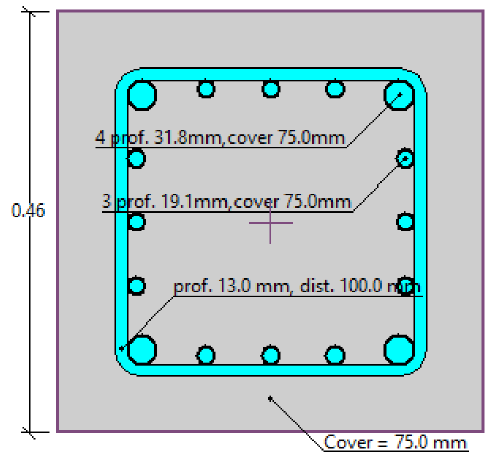
Table 3-4 Soil properties use for Reinforced Concrete Pile design

Source: (CEAC Solutions Co. Ltd., 2022)

Parameters	Peat	Sand
Unit Weight (kN/m3)	16	20
Poisson's Ratio	0.3	0.3
Deformation Modulus (MPa)	7	100
Saturated Unit Weight (kN/m3)	16	20
Elastic Modulus (MPa)	30	15
Angle of internal friction	--	32.5
Cohesion of soil (kPa)	21	--

Parameters	Peat	Sand
Adhesion factor	0.8	--
Coefficient of lateral stress	1	--

Based on the properties of the soils assumed at the project site, the design embedment depth of the mooring piles was 6.57m for all piles.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-11 Mooring Pile cross section

FENDER DESIGN

The impact energy from berthing is 127kN. To protect the vessel, Rubber D Fenders were attached to the mooring piles in the direction of the mooring forces. The design used a blend of natural and synthetic rubber to absorb the berthing energy and protect the vessel against damage. The 1.5m long strips were 150mm wide and 50mm thick.

MOORING RINGS

Marine grade stainless steel mooring rings with square plates of 65 mm and height of 3 mm was designed to be attached to the mooring piles 0.5m down from the top. The rings had an external diameter of 70 mm and thickness of 8 mm.

CLEATS

Based on UFC-4-152-07, the recommendation is 3 evenly spaced cleats along the main pier and 1 in the centre at the end of finger piers. The cleat size recommended for 45ft boats is 15" (38cm). Cleats to be attached with a minimum of two through bolts into the structural frame of the pier or dock.

Decking Piles

DECKING LOADS

This design took into consideration the lateral forces on these piles, i.e. wave impact, dead loads and other live loads. The maximum force from Wave energy was determine from considering the wave characteristics (including breaking height), pile dimensions, drag coefficient and density of water.

Morrison's Formula to determine the horizontal force per unit length of piles subject to waves. These calculations took into consideration hurricane conditions for a 100 yr Return Period storm. Hence, the correlated design values were used for the wind and wave calculations.

Based on the positions of the mooring piles little to no boat impact on the decking and finger piles are expected. Therefore, the boat impact load was not considered.

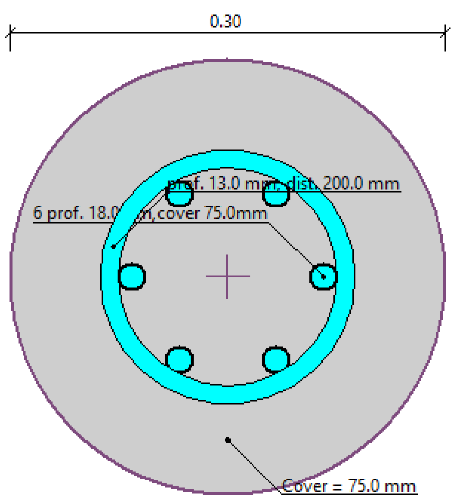
Table 3-5 Decking Load Values

Source: (CEAC Solutions Co. Ltd., 2022)

Decking Loads	kN
Wave Impact	2.6
Dead Loads	0.51
Live Loads	5.17
Total Load	8.3

REINFORCED CONCRETE DESIGN

These circular piles were designed with a compressive strength of 30MPa, diameter of 305mm and length of up to 7.8m. The design calls for 6-18mm ϕ rebars formed the reinforcement within the piles along with 13mm ϕ bars @200mm c/c for the stirrups as seen in Figure 3-122. This steel will require a minimum cover of 75mm.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-12 Decking Pile cross section.

Decking

The 220 sq. ft. main decking was designed to facilitate a live load of 5.17kN in accordance with platform loading which is standard per m^2. Materials chosen were guided by the British standards, Euro 5 code and the AISC manual. The decking consists of a network of beams 2x4, joists 2x4 and decking 2x12 made from Marine pitch pine. Marine pitch pine was chosen as this is durable and more accessible than hardwoods. The joists are connected to piles using M24 hexagonal stainless-steel bolts with a length of 500mm. The deck of the Jetty was designed to accommodate anticipated live loads of 5.17kN/m^2 on top of the deck and dead load of the deck (0.51kN/m^2). The anticipated area load for the deck is 5.7 kN/m^2. The allowable moments, deflection and stress calls for the geometry outlined in Table 3-7. The decking level was set at 1m above MSL.

Table 3-6 Decking elevation calculations

Source: (CEAC Solutions Co. Ltd., 2022)

Minimum floor level	Amount	Units	Input to Elevation	Units
Tide amplitude	0.25	m	0.25	m
Wave height at jetty - Annual swell	0.15	m	0.15	m
Depth of floor beam and bents	0.25	m	0.25	m
Sea Level Rise	0.5	m	0.5	m
Proposed elevation (to LLWL)			1.15	m
Proposed elevation (to MSL)			**1.025**	**m**

Table 3-7 Geometry of the proposed deck

Source: (CEAC Solutions Co. Ltd., 2022)

Decking		
Width	2.744	m
Width of plank	0.305	m
Thickness of decking	0.051	m
Beam/bent		
Depth	0.102	m
Width	0.102	m
Length-inside of bents/columns	2.439	m
Cantilevered ends	0.152	m
Joists/stringer		
Depth	0.102	m
Width	0.051	m
Length	1.524	m
Spacing	0.152	m

3.3.3.2 Planning

Layout Consideration

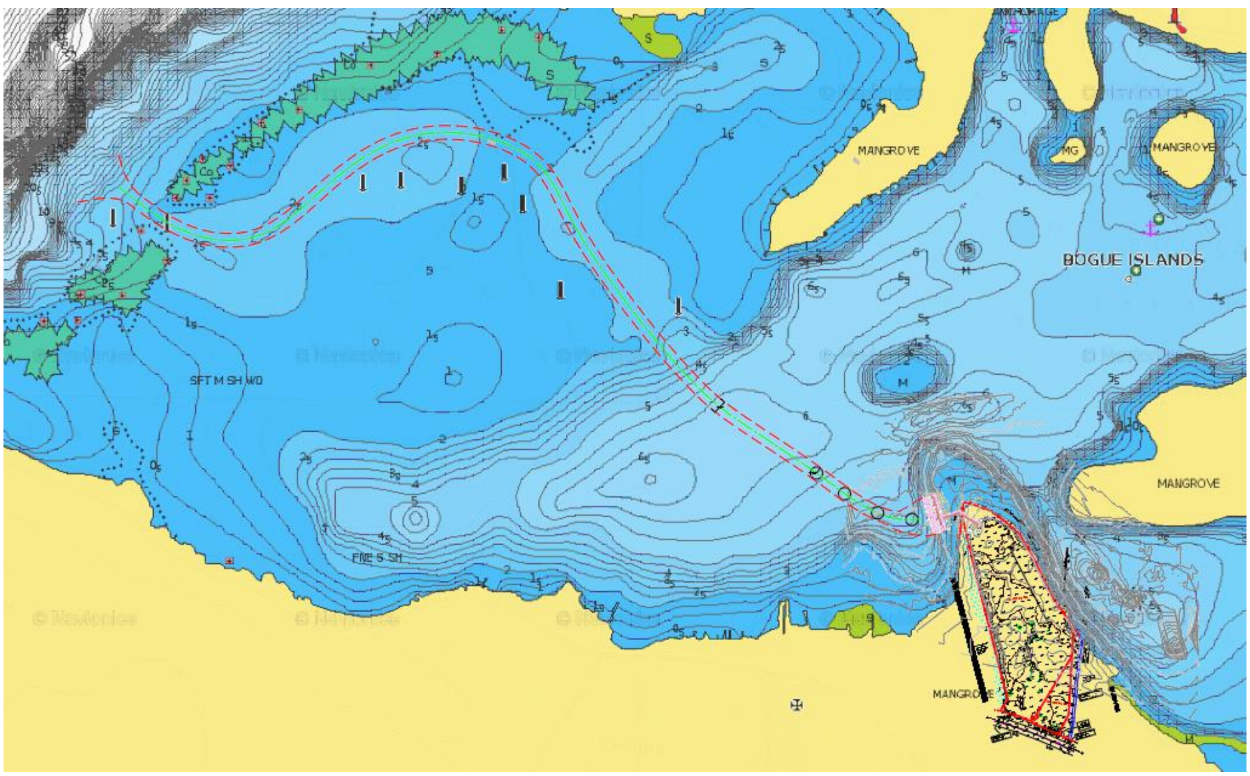
The layout was completed taking into consideration the bathymetry, land boundary, wind, waves and architectural drawings (CEAC Solutions Co. Ltd., 2022). This also facilitates the preservation of the seascape characterised by densely populated mangroves. Figure 3-14 shows the jetty positioned where the sea water depth exceeds 3m. The feature is located within a bay which offers a degree of natural protection.

PROPOSED ACCESS CHANNEL

Channel width is defined as the clear width at the design depth. The required channel width is dependent on the expected vessel type and volume of traffic. Based on our design vessel of beam 13’9” (4.2m), the required channel width for 2-way traffic should be at least 100ft (30m). As such the proposed channel has a width of 100ft which allows for travel through the reef system located at the entrance to the bay as shown in Figure 3-13.

When planning the route of the access channel, the UKC requirement based on the draft of the design vessel is one of the most important considerations. The maximum draft of the design vessel is 3’11” (1.2m). As such the minimum UKC is 0.8m with the dynamic UKC being 0.62m and 1m for Swell and operational conditions respectively. This means that the lowest charted depth along the route, at 2m will allow the passage of 45ft vessels during operational conditions. During swell conditions however, at low tide, the boats will not have the minimum clearance to traverse through the reefs. If dredging were to take place at this section to a depth of 3m, the design vessels will be able to traverse during both operational and swell conditions.

Smaller vessels were also assessed to determine manoeuvrability through the most feasible access to the bay. When 40ft vessels and 35ft vessels with a draft of 1.02m and 0.9m respectively, were analysed, it was determined that they would be able to pass through the access channel at the entrance of the bay during both operational and swell conditions. All vessels were assessed with an assumed speed of 3 knots and a list angle of 2 degrees.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-13 Proposed access channel showing path through the reef

TURNING BASIN

Since the minimum interior channel widths in the typical small craft harbour are based on vessel length, turning the vessel within, or at the end of the channel is accommodated without the need for an enlarged turning basin. However, if a situation arises in which a substandard channel width exists, a turning basin should be provided at an appropriate point in the channel; the basin should provide a clear turning circle whose minimum diameter is 1.5 L, where L is as defined above. Where channel currents or winds make turning difficult, this minimum should be increased to 2.0 L. Therefore, for this project, 2 L was chosen as the diameter of the turning basin. For a vessel length of 45ft (13.7m), a turning basin of 90ft (27.4m) was required. This space is available along the entire length of the proposed channel and therefore no turning basin is required.

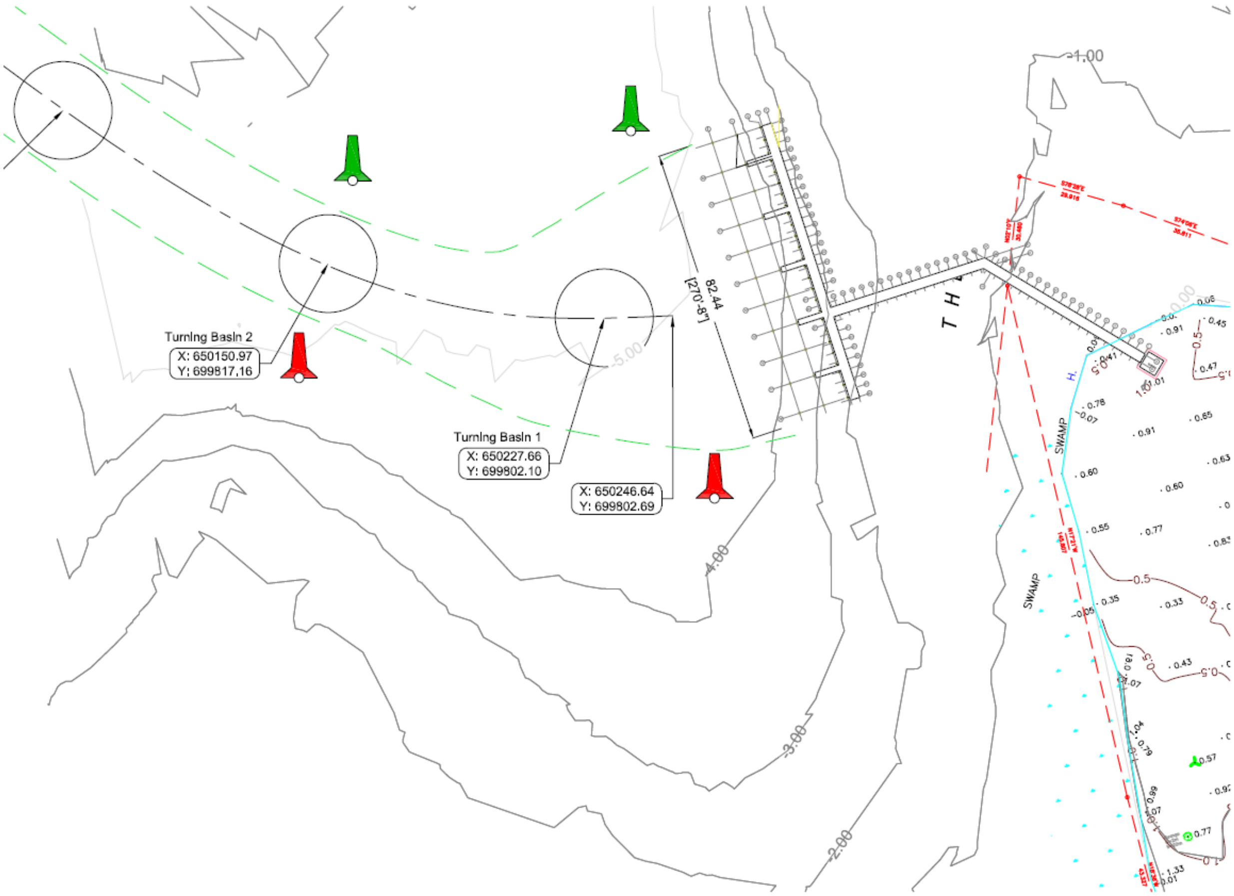


Figure 3-14 Turning basins (diameter 90ft) fall within the channel (100ft)

ORIENTATION OF BERTHS

The layout was developed taking into consideration the bathymetry, land boundary, operational wind directions, waves and architectural drawings. This also facilitates the preservation of the seascape characterized by densely populated mangroves. Figure 3-14 shows the berths of the jetty positioned where the sea water depth exceeds 3m. The feature is located within a bay which offers a degree of natural protection.

The operational wind direction is predominantly from 60 - 80 degrees (relative to north) and the berths were oriented at 69 degrees. This means that berthing operations should be easily manoeuvrable during operational wind conditions.

Tranquillity Criterion

Wave protection and tranquillity is one of the key requirements in the planning and design of berthing area. Common practice is that the significant wave height is less than 0.3m (1ft). Other factors were considered to establish the tranquillity value of the basin, based on ASCE (2012) using wave height, return period and direction of the approaching waves to derive a qualities value (excellent, good, or moderate condition) of tranquillity. The assessment is based on both locally generated waves (with shorter periods) and extreme wave (longer periods) and is applicable to all sizes and types of vessels.

Table 3-8 Tranquillity rating based on Future Climate Conditions.

	Location	Wave Heights (m)	Comment on Tranquillity and operation	
			Head on	Beam on
Operational	Channel	0.08	Excellent	Excellent
	Berthing	0.04	Excellent	Excellent
Swell	Channel	0.26	Good	Moderate
	Berthing	0.14	Excellent	Moderate
50-year RP hurricane	Channel	3.8	<Moderate	<Moderate
	Berthing	2.8	<Moderate	<Moderate

Note: < Moderate - Boat operation not recommended.

Berth Dimensions

Berth widths are based on the particulars of the vessels to be berthed, in this case 45ft vessels with a 13'9" (4.19m) beam. The minimum width of a berth should be:

1. Double berth: 2 x Beam of the wider vessels served + clearance for environmental conditions, boater experience, and fendering system
2. Single Berth: Beam of the widest vessel served + clearance for environmental conditions, user experience, and fendering system

From the foregone the total berth width used was 28ft (8.6m) for single berths and 50'6" (15.4m) for double berths which exceeds the minimum allowance requirements of 7ft for the safe berthing of the design vessel. The length of each berth is 45'11" (14m).

Walkways

The minimum clear width of walkways should be 6 ft. to 8ft (1.8 m to 2.4m). Depending on the need for dock carts passing each other and emergency access and egress, additional width may be necessary. The width defined above is clear width between obstructions on the pier or dock such as cleats, piles, etc. The width chosen for the walkway was 9ft.

Finger Piers

The finger piers were designed to support safe pedestrian use. The minimum clear width of the finger should be the greater of:

i. L, where L is the length of the slip served by the finger or
ii. 3 ft

The design width chosen to enhance the stability of the finger is 5 ft. The length of the finger piers is generally 0.5L. This recommended length was used for the length of the finger piers in this design.

Navigation Aids

Four navigations were placed at the outer edges of the pier and narrow as they lead to the design approach channel. These aids are necessary as the entire lagoon/bay does not accommodate the required under keel clearance of the design 45ft vessels. To prevent marine accidents and vessels shoring at shallow areas, navigational aids will be necessary in guiding these boats toward the design channel.

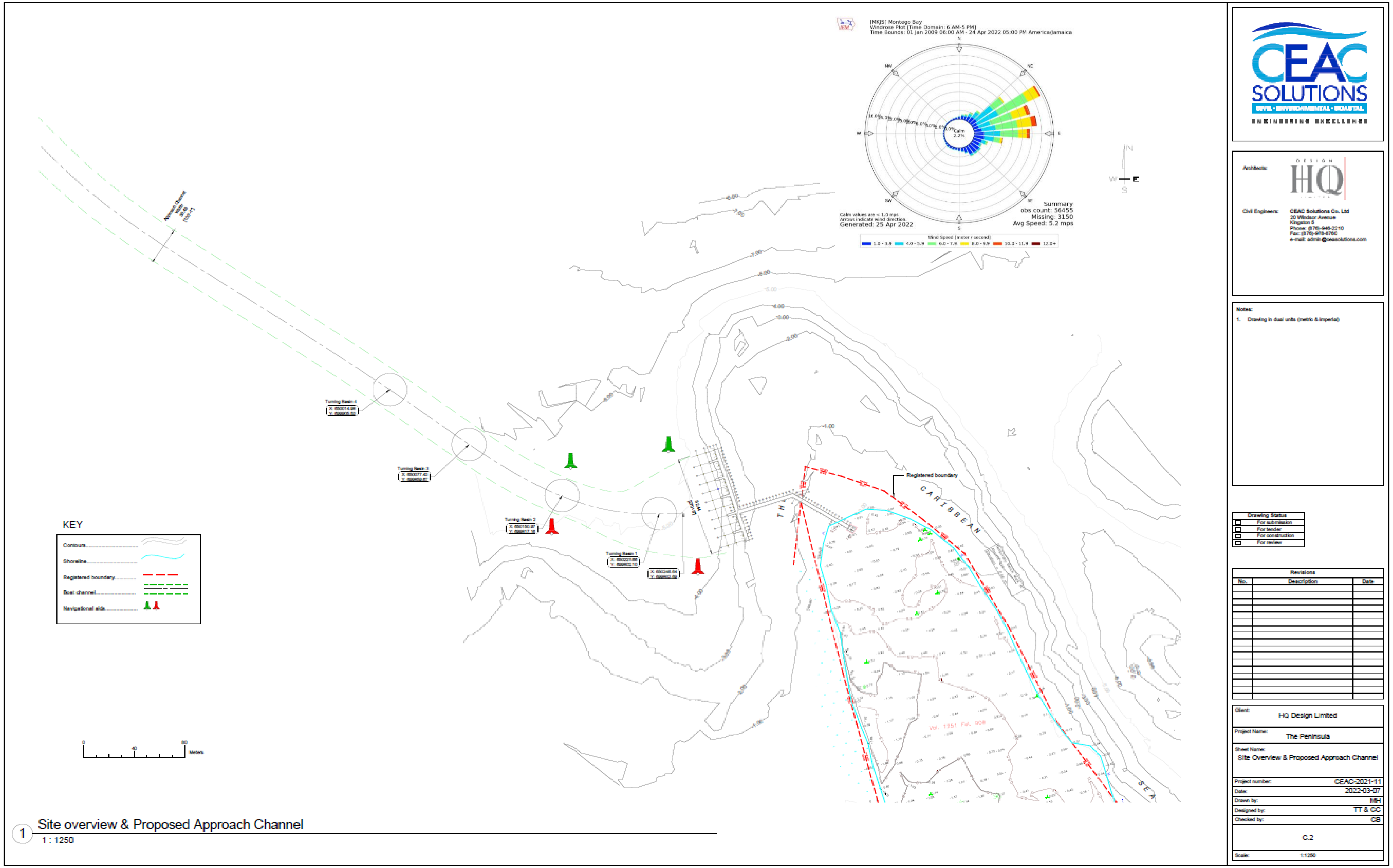
3.3.3.3 Summary

The jetty was aligned between the 3 and 4m bathymetric lines exceeding the minimum required depth of 3m determined from the minimum required UKC for the proposed boat which would be 0.61m (CEAC Solutions Co. Ltd., 2022). Additionally, this created an angle towards the west-south-west. The presence of the lagoon allowed ease of manoeuvring and omitted the need for a turning basin. Notably, the design vessel was 45 ft long with a width of 14 ft and a draft of 3.9ft. A total of 10 berths will be constructed.

The mooring piles were designed as square precast concrete piles with a compressive strength of 30MPa, 0.46m cross sectional dimensions and length of up to 7.8m. The design called for 4-32mm ϕ and 12-13mm ϕ reinforcement bars. This steel will require a minimum cover of 75mm. This was built to resist a lateral loading of 131kN. While the decking piles were circular with a diameter of 305mm and length of up to 7.8m. The design called for 6-18mm ϕ rebars formed the reinforcement within the piles along with 13mm ϕ bars @200mm c/c for the stirrups. This steel will require a minimum cover of 75mm. These were built to withstand a vertical load of 5.7kN and horizontal load of 2.6kN.

Area of decking as designed is 220sqft. It was fabricated from 12x1 planks resting on 2x4 joists with 2x12 beams which allowed the distribution of the decking load of 5.7kN/m2 to the decking piles beneath.

The design considerations of the jetty took into consideration the conditions of the wind and waves of future climate during a storm with a 100 years Return Period.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-15 Proposed layout of Jetty

3.3.4 Construction Methodology

The sequence of steps outlined below pertain to the construction of the proposed groyne along the shoreline (CEAC Solutions Co. Ltd., 2022).

3.3.4.1 Construction Access Road

The existing road that leads into the property will be used by construction and haulage vehicles to access the site from the Reading Pen main road. The road will be cleared of trees, widened to a minimum width of three (3) meters to accommodate trucks that have an average capacity of 25 cubic yards. The proposed access roads will come off the eastbound lanes of the Reading Pen main road. This will allow heavy vehicles to enter and exit the site without having to engage in excessive reversing manoeuvres or obstructing traffic to the main road.

3.3.4.2 Site Preparation

Stockpile Areas and Construction Platforms

The construction materials including hot rolled steel bars, 12ft diameter PVC pipes will be stockpiled close to the shoreline, so they can be more conveniently accessed during jetting. A suitable granular fill material should be used to establish temporary construction platforms that will allow heavy equipment to traverse the beach and nearshore more easily during the jetting of the piles.

Placement of turbidity barriers around work area

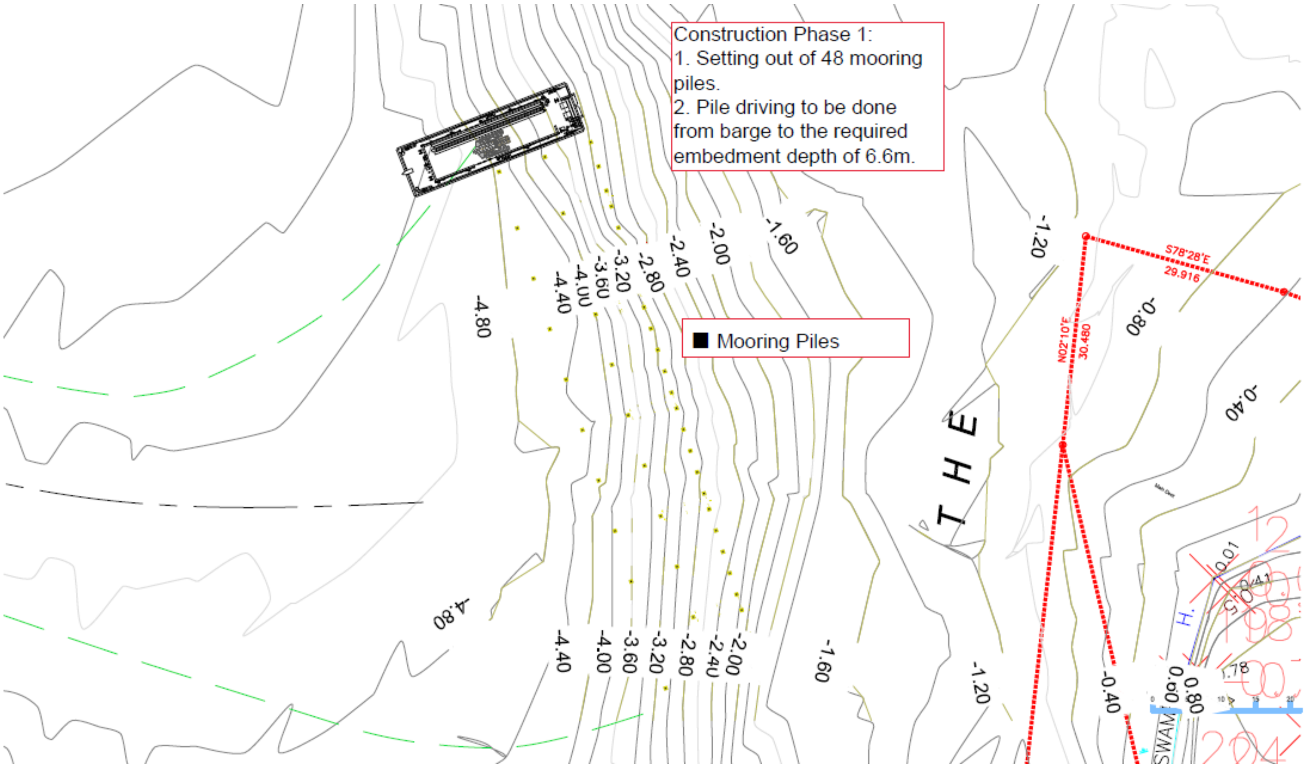
Turbidity curtains that can extend to depths between 3m and 4m should be set around the work area, suitably anchored and should be free from breaks or tears. Any section of the barrier that is damaged should be replaced at once to ensure that the quality of the surrounding water is not significantly affected.

3.3.4.3 Construction Sequence

The mooring piles shall be driven first, followed by the decking piles and decking. The construction process is as follows (CEAC Solutions Co. Ltd., 2022):

1. Setting out and driving the mooring piles via a barge,
2. Turbidity barrier to be placed to reduce impact on surrounding marine life,
3. Decking piles to be set out by a surveyor,
4. Pile foundations to be jetted to the design depth while driving pvc pipe with reinforcement,
5. Cement to be poured into pvc/formwork,

Beam, stringer, and decking construction to take place after all piles have been placed to required embedment depth and design elevations.

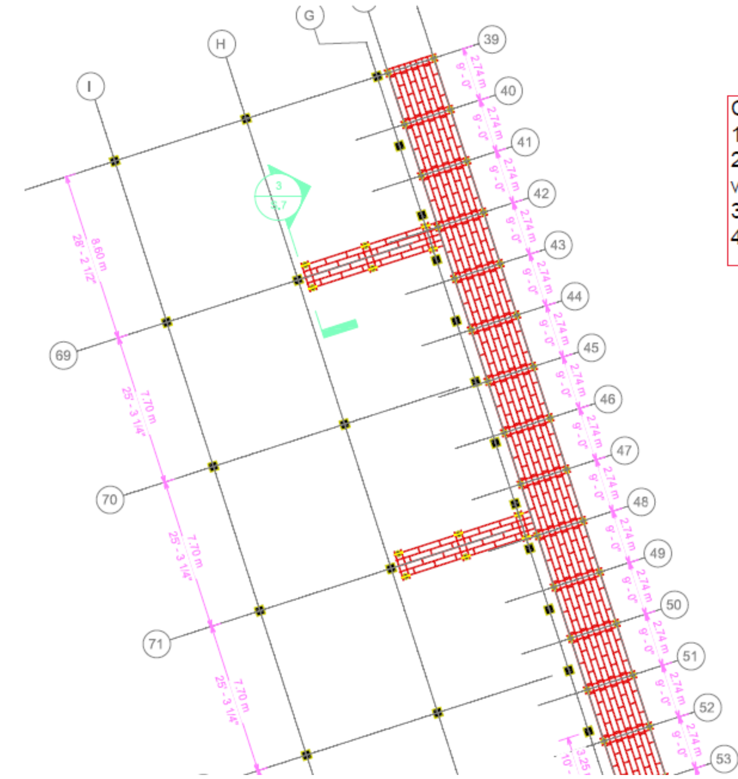


Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-16 Construction Phase 1

Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-17 Construction Phase 2



Construction Phase 3:
1. Bents to be attached to piles with bolts
2. Stringers will then be attached to the beams with straps.
3. Spacers will be placed intermittently
4. Decking will then be installed atop the frame.

Source: (CEAC Solutions Co. Ltd., 2022)

Figure 3-18 Construction Phase 3

4.0 DESCRIPTION OF THE ENVIRONMENT

4.1 PHYSICAL ENVIRONMENT

4.1.1 Climate

4.1.1.1 Weather Station Data (2022)

Temperature, relative humidity, rainfall and wind speed and direction were recorded over forty-eight (48) hours (February 9th – 11th, 2022) setup on the proposed project site, by using a Davis Instruments wireless Vantage Pro2 weather system with a data logger and a complete system shelter erected on a tripod. Data were collected every fifteen minutes and stored on the data logger. This information was downloaded using the WeatherLink 6.0 software. The following were the summarized results of the assessment:

- Average temperature recorded was 24.77°C and ranged from a low of 20.38°C to a high of 30.4°C.
- Average relative humidity was 86.2% and ranged from a low of 65% to a high of 97%.
- There was no rainfall recorded during this period.
- Average wind speed was 0.48 m/s and ranged from a low of 0 m/s to a high of 3.13 m/s.
- Dominant wind direction during this period was from the southeast.

4.1.1.2 Historical Data

Historical Data

The following climate data was taken from the Technical Report for the NFE North Holdings Ltd. Montego Bay Micro-LNG Receiving Terminal, 2016 (C.L. Environmental Co. Ltd., 2016).

TEMPERATURE

Montego Bay has a subtropical to tropical climate, with yearly minimum temperatures averaging 22.3 °C and maximum temperatures averaging 29.8 °C (Table 3-1). Mean monthly temperatures are lowest in January and February and highest between June and October.

HUMIDITY

The mean monthly relative humidity ranges between 71 and 84 percent. Relative humidity is low in the afternoon and high in the evenings. Mean monthly values of daily sunshine hours range between 7.0 and 8.5 (Table 4-1).

Table 4-1 Monthly Averages of Climatological Data for Montego Bay (Sangster International Airport)

Month	Maximum Temperature (°C)	Minimum Temperature (°C)	Rainfall (mm)	Number of Rain days	Relative Humidity - 7am (%)	Relative Humidity - 1pm (%)	Sunshine (hrs)
January	27.9	20.7	85.0	9	85	71	7.3
February	28.2	20.4	69.0	8	85	71	7.5

Month	Maximum Temperature (ºC)	Minimum Temperature (ºC)	Rainfall (mm)	Number of Rain days	Relative Humidity - 7am (%)	Relative Humidity - 1pm (%)	Sunshine (hrs)
March	28.8	20.9	27.0	5	83	68	8.5
April	29.5	21.9	53.0	7	82	68	7.5
May	30.2	22.6	100.0	12	83	71	8.2
June	30.9	23.1	122.0	10	84	72	7.5
July	31.3	23.5	53.0	7	82	70	8.3
August	31.4	23.6	95.0	10	82	70	7.8
September	31.1	23.1	127.0	12	84	72	7.0
October	30.4	23.1	166.0	13	86	75	7.5
November	29.7	22.8	110.0	11	84	73	7.0
December	28.4	21.9	103.0	9	89	72	7.5
Maximum	**31.4**	**23.6**	**166.0**	**13**	**89**	**75**	**8.5**
Minimum	**27.9**	**20.4**	**27.0**	**5**	**82**	**68**	**7.0**
Mean	**29.8**	**22.3**	**92.5**	**9**	**84**	**71**	**7.6**

RAINFALL

The Average Climatological data based on a 50-year return period monthly mean rainfall for Montego Bay ranges from a low of 27 mm in March to a high of 166 mm in October (Figure 4-1). The rainy season is from August to December and the dry season from January to July.

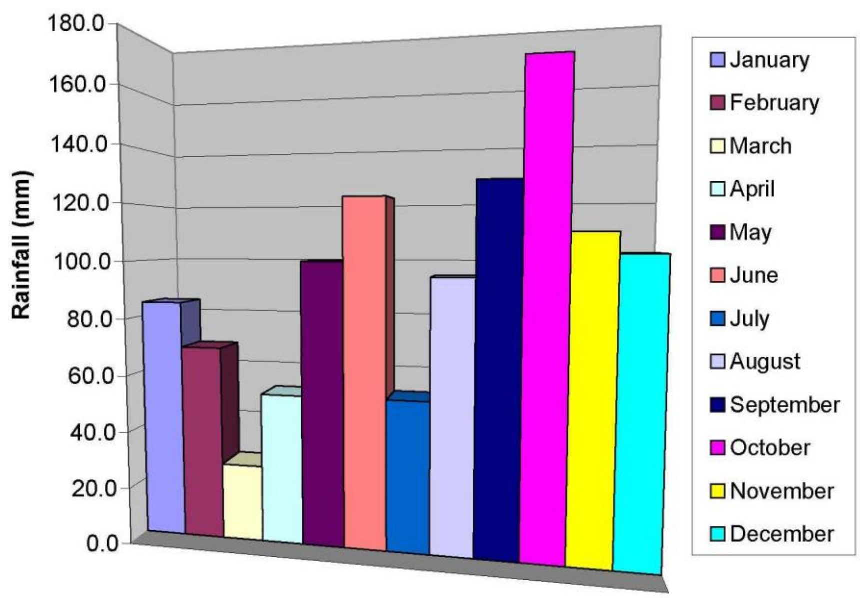


Figure 4-1 Monthly Rainfall Distribution (Sangster International Airport, Montego Bay)

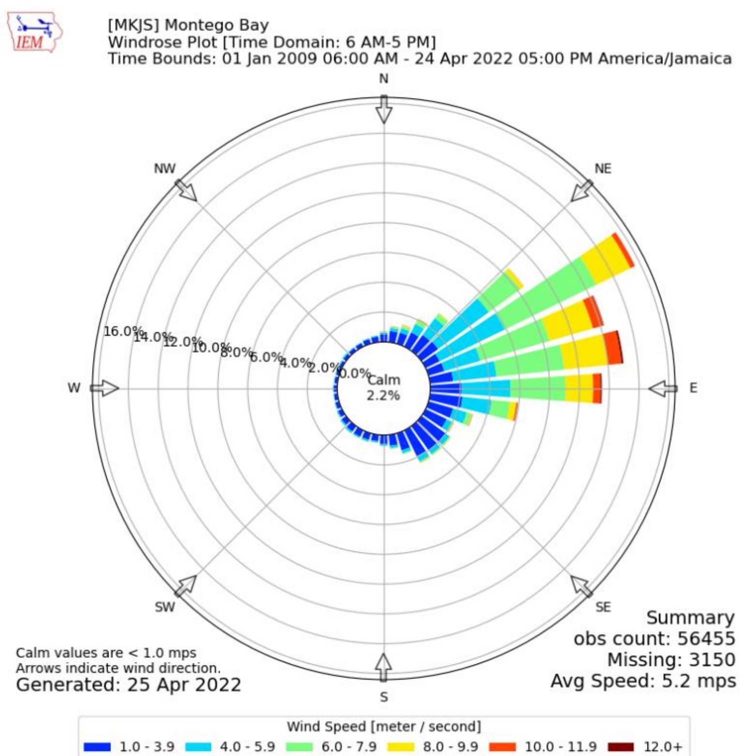
WIND

Winds impacting Montego Bay blow predominantly from the E and ENE throughout the greater part of the year. However, seasonal changes occur in the annual wind regime and may be described as follows:

- December to February: winds are primarily from the NE to ENE.
- March to May: winds are mainly from the East.
- June to August: winds are primarily from the E to ESE.
- September to November: winds are mainly from the E to SE.

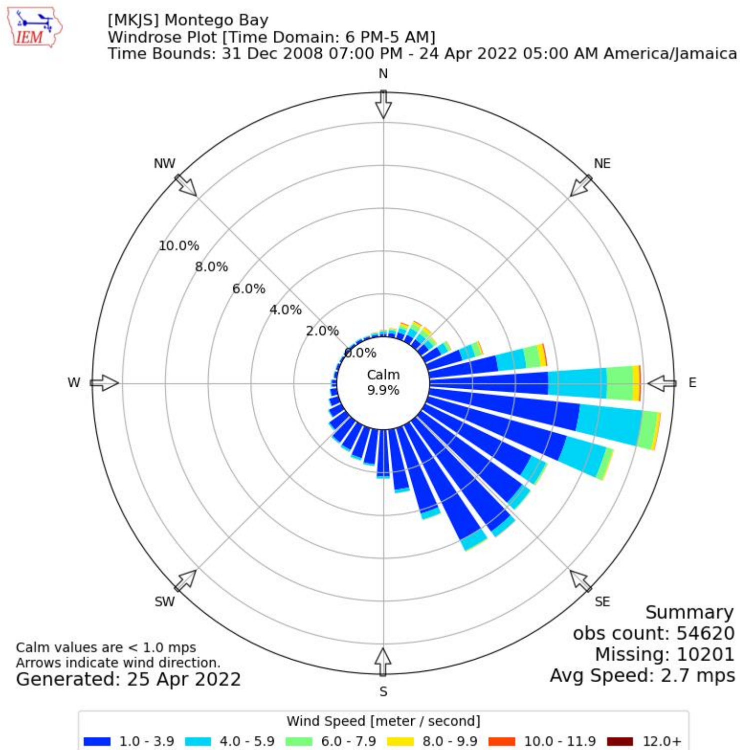
Mean wind speed at Sangster International Airport is typically 9 m/s (17 knots) and maximum sustained winds speeds are generally between 5 m/s (10 knots) and 12 m/s (25 knots).

Historical wind data was obtained from the Montego Bay Jamaica station (MKJS) by CEAC Solutions for the period January 1, 2009, to April 14, 2022 (CEAC Solutions Co. Ltd., 2022). The data was analysed, and wind roses generated to determine daytime and night time operational wind conditions. From this data it was determined that during the daytime, the East-North-Easterly (ENE) direction was the dominant wind direction with wind speed averaging 5.2m/s; dominant speeds, however, range from 6 – 7.9m/s. The night-time operational winds were blowing from an easterly direction with speeds averaging 2.7m/s with dominant speeds ranging from 1 – 3.9m/s.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-2 Historical wind data showing daytime operational wind speeds and direction for Montego Bay between January 2009 and April 2022



Source: (CEAC Solutions Co. Ltd., 2022)

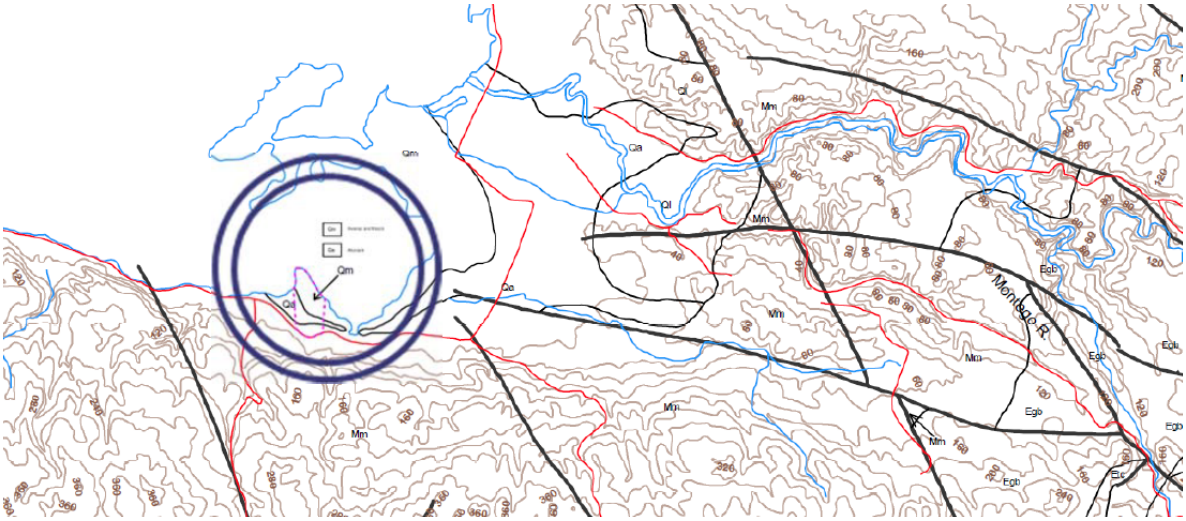
Figure 4-3 Historical wind data showing night-time operational wind speeds and direction for Montego Bay between January 2009 and April 2022

4.1.2 Geology and Soils

4.1.2.1 Geological Setting

Jamaica is the third largest island in the Caribbean with approximately 11,000 km^2.The island is located in the north-eastern part of the Caribbean, with Cuba to the north and the Hispaniola Island to the northeast, bordering the North American Plate. The island can be divided into three different parts based on the morphology of the soil: the central mountain range that occupies most of the central area of island, formed by igneous and metamorphic rocks; the hills of karstic limestone and finally the coastal planes (Horizon Construction-Jamaica Limited, 2022).

Based on the Montego Bay Geological Sheet 02 of the 1:50,000 Geological Series (Figure 4-4), the site is located on unconsolidated deposits of Alluvium (Qa) and Swamp (Qm) (Horizon Construction-Jamaica Limited, 2022). The alluvial deposits are dominantly calcareous sands and gravels. Swamp and marsh are found surrounding the shallow bay south of Montego Bay.



Source: Horizon Construction-Jamaica Limited T/A HC Geotechnical, 2022

Figure 4-4 Geological Map Montego Bay 1:50,000 Geological Series. Montego Bay Sheet 02

4.1.2.2 Soils and Seismicity

The soil profile encountered in the area consists of an upper layer (up to 4 meters of depth) of soft clay and peat followed by a loose, susceptible to liquefaction, layer of silty sand up to 11 meters of depth. The Seismic Site Class was determined using the Standard Penetration Test blowcount (SPT-N) for all the boreholes drilled. For the calculation of the Site Class following this method, the value of SPT-N was limited to 100 blows/foot. Based on the calculations and local geology the site has been classified as SITE CLASS E: Soft Soils (Horizon Construction-Jamaica Limited, 2022).

4.1.2.3 Site Investigation and Generalized Stratigraphy

Horizon Construction Jamaica Ltd. executed a soil boring campaign in January 2022. Twenty-six (26) soil borings were drilled for this project up to a depth of 36 meters below the ground surface (Table 4-2, Figure 4-5). The soils were sampled by the Standard Penetration Test (SPT) ASTM D-1586 with automatic 140-pound hammer falling from a height of 30 inches per blow. SPT tests were performed at intervals of 1.5 meters. The recovered samples descriptions are based on visual field and laboratory observations using classification methods of ASTM D2488. When laboratory data are available, classifications are in accordance with ASTM D2487. The depth of the water table was measured at the end-of-drilling (Horizon Construction-Jamaica Limited, 2022).

With the data obtained from the exploration, five noticeable layers were identified (Figure 4-6 through to Figure 4-9): fill, a layer of soft clay and peat, followed by a loose silty sand layer, a stiff clay layer follows, and finally a saprolite type layer, where some remains of a weathered rock are observed (Horizon Construction Jamaica Limited, 2022).

The fill layer is composed of medium compact **1) FILL** sampled as silty sand (marl) with gravel material at depth from the top of the surface up to 1 meter approximately.

Below this layer, a soft layer of **2) CLAY (CL) / PEAT (PT)** layer was identified. This layer has a thickness that ranges of 3-4 meters. The material in this zone has an organic odour (swamp and marsh) and has an average SPT-N values of around 6 blows per foot and values of around 0 - 0.5 kg/cm^2 to the pocket penetrometer.

At about 3-4 metres of depth, a **3) SILTY SAND (SM)** is found in all of the borings. This material belongs to alluvial sediments deposition, and it is mainly formed by a very loose silty sand with average SPT-N values of 3 blows per feet.

The silty sand is followed by a layer of **4) CLAY (CL).** This layer is found in consistencies ranging from firm to hard, with values of the pocket penetrometer ranging in values of about 1.5 to 4.0 kg/cm^2. This layer is found in all of the borings drilled in this campaign.

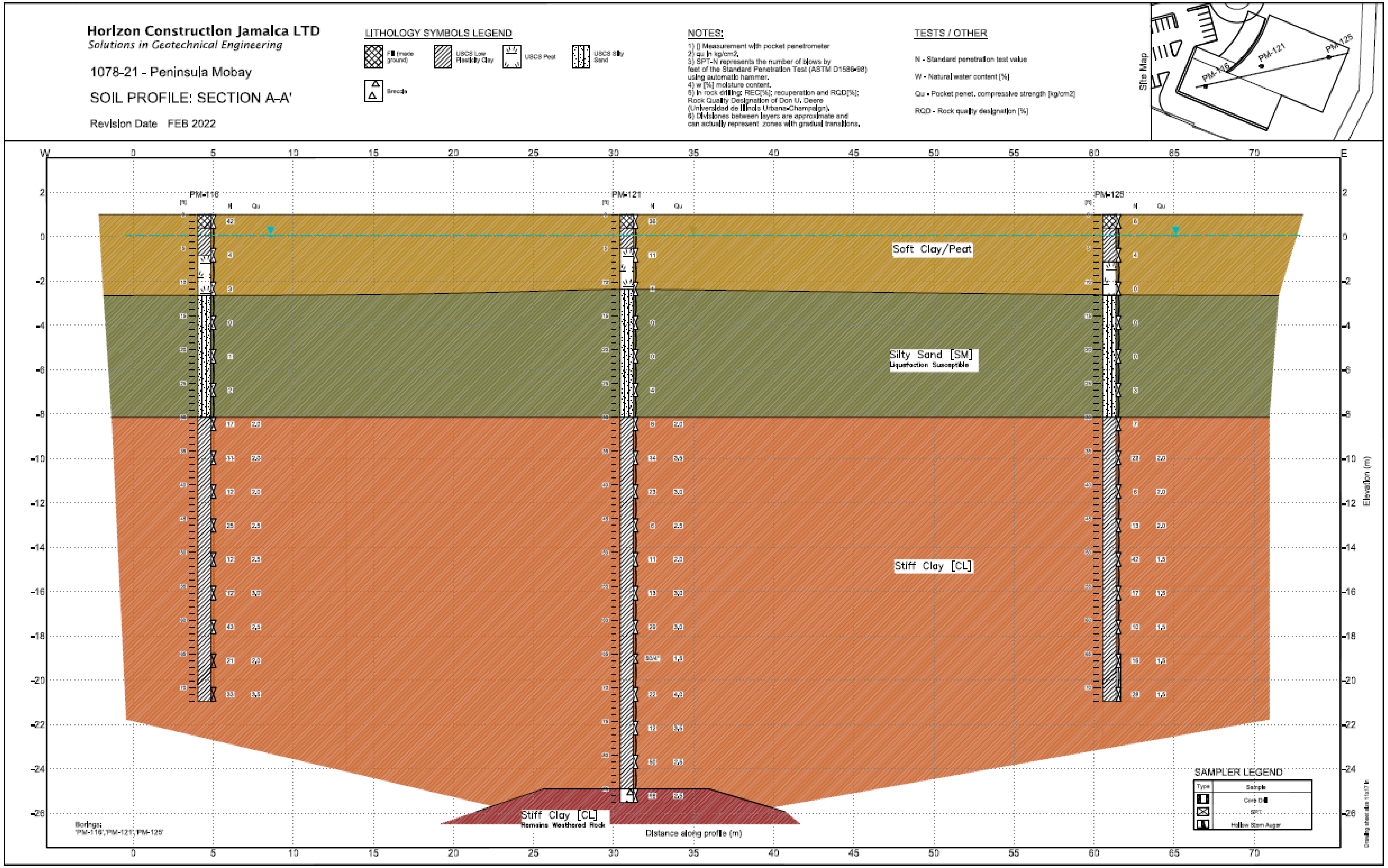
Some of the deeper borings detected a layer of a clay with remains of a weathered rock, resembling a saprolite type layer. This material was found at depths greater than 24 metres of depth and was found in a very firm condition.

Table 4-2 Summary of exploratory borings (coordinates are in Universal Transverse Mercator (UTM Projection WGS84 Datum)

Source: Horizon Construction-Jamaica Limited, 2022

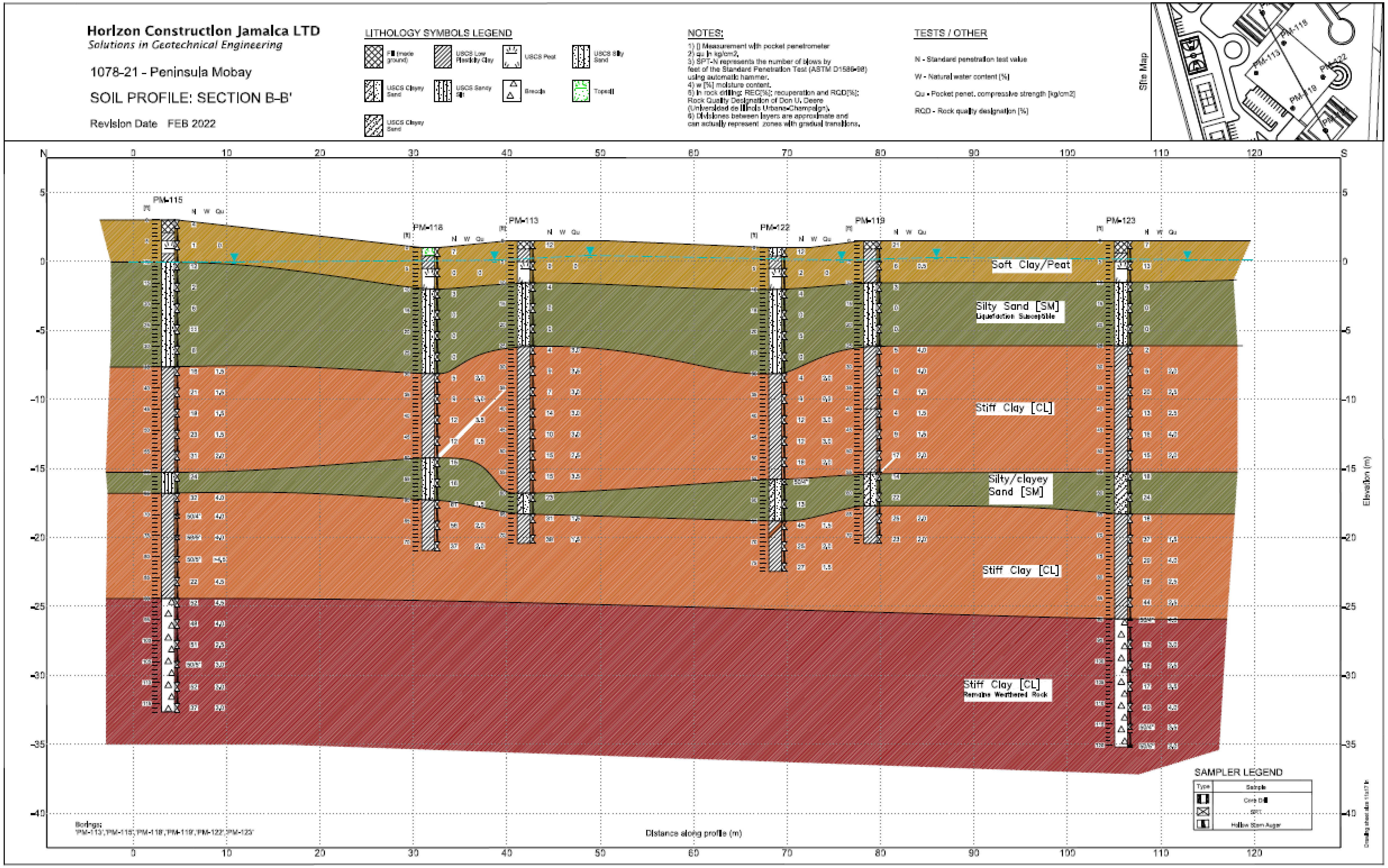
BORING	STRUCTURE	EAST [M]	NORTH [M]	DEPTH DRILLED [FT]	ELEVATION [M]	WATER LEVEL [FT]
PM101	Villas	189123	2042205	77	1.5	4
PM102	Restaurant	189138	2042137	77	1.5	5
PM103	Villas	189155	2042189	92	1.5	4
PM104	Parking C	189162	2042057	67	1.5	5
PM105	Tower 4	189162	2042095	117	2	7
PM106	Villas	189182	2042169	37	2	6
PM107	Parking C	189195	2042062	87	2	7
PM108	Parking B	189197	2041983	42	3.5	11
PM109	Tower 3	189198	2042019	117	3.5	11
PM110	Villas	189205	2042144	37	2	5
PM111	Villas	189222	2042116	37	2	5
PM112	Parking B	189230	2041988	77	1.5	4
PM113	Parking A	189237	2041902	72	1.5	3.5
PM114	Villas	189239	2042084	60.41	2	6
PM115	Tower 2	189242	2041948	117	3	10
PM116	Offices	189252	2041790	72	1	3
PM117	Villas	189252	2042052	42	1.5	4
PM118	Parking A	189258	2041925	72	1	3
PM119	Parking A	189265	2041875	72	1.5	4
PM120	Villas	189266	2042020	42	2	5
PM121	Supermarket	189277	2041799	87	1	3
PM122	Parking A	189288	2041899	77	1	3
PM123	Tower 1	189290	2041858	120.41	1.5	4.5
PM124	Villas	189291	2041995	42	1.5	4
PM125	Supermarket	189307	2041803	72	1	3
PM126	Villas	189312	2041967	42	1.5	5

Figure 4-5 Boring location plan



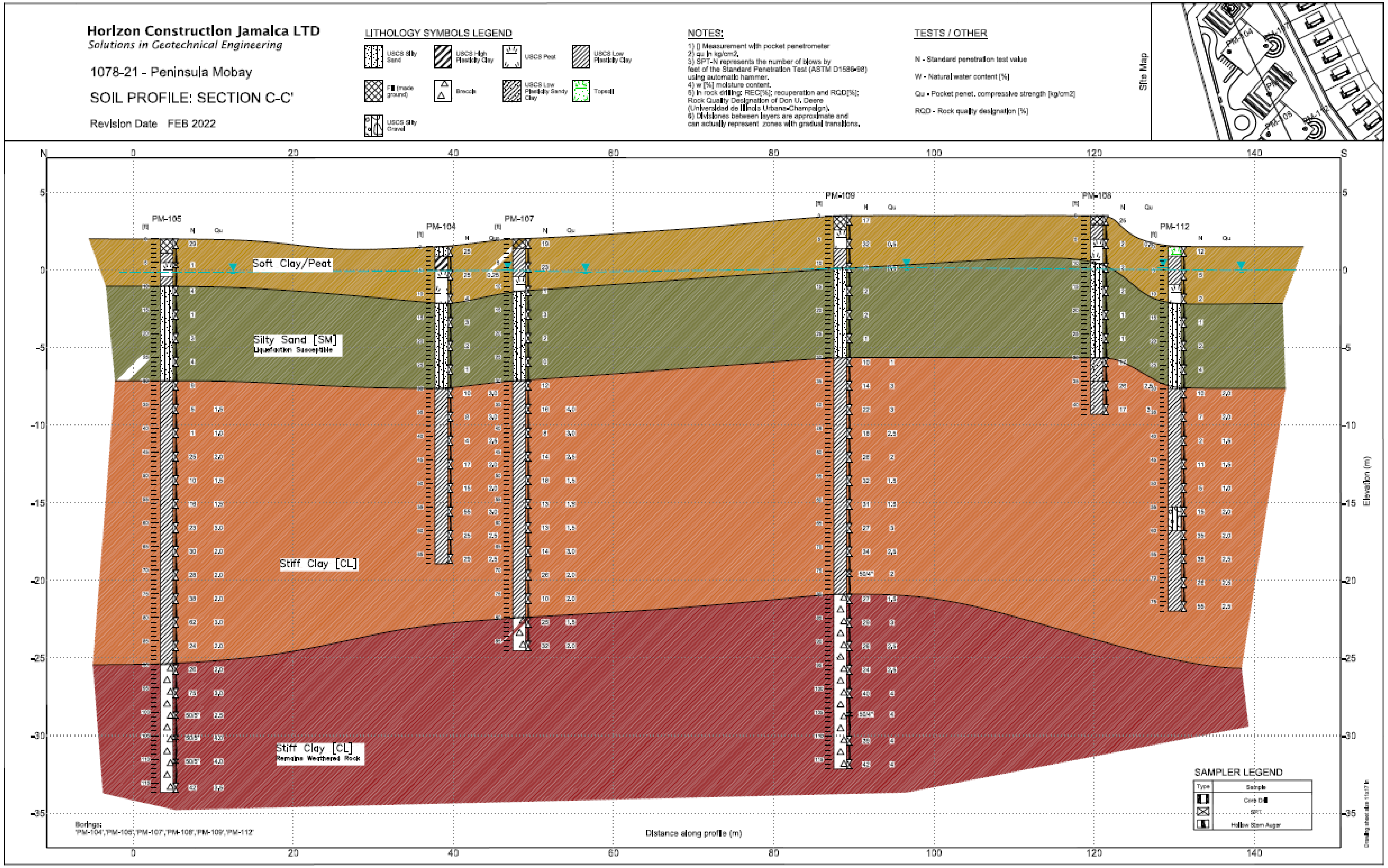
Source: (Horizon Construction-Jamaica Limited, 2022)

Figure 4-6 Soil profile, Section A-A'



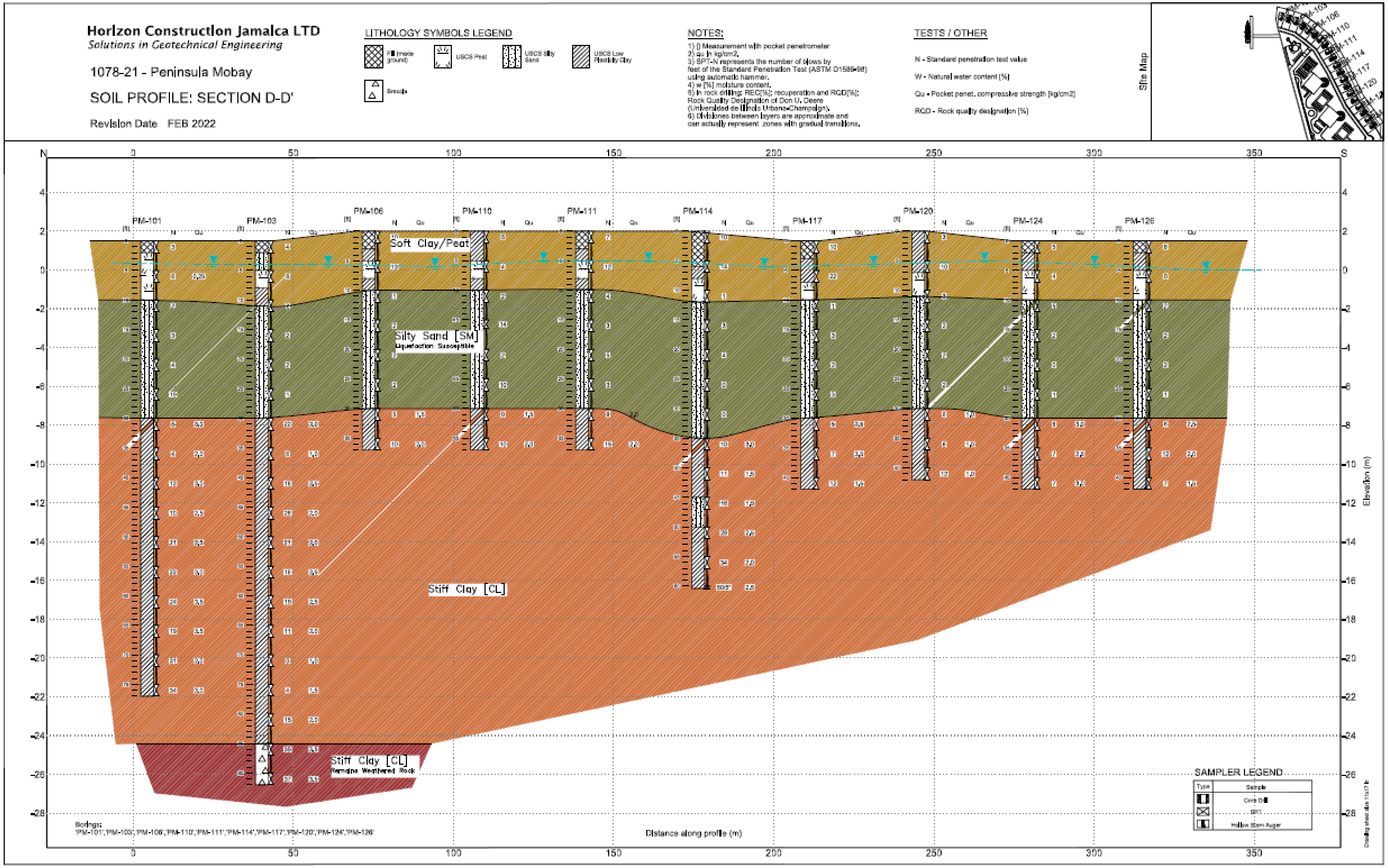
Source: (Horizon Construction-Jamaica Limited, 2022)

Figure 4-7 Soil profile, Section B-B'



Source: (Horizon Construction-Jamaica Limited, 2022)

Figure 4-8 Soil profile, Section C-C'



Source: (Horizon Construction-Jamaica Limited, 2022)

Figure 4-9 Soil profile, Section D-D'

4.1.3 Groundwater

Horizon Construction Jamaica Ltd. measured the depth of the water table at the end-of-the borehole drilling (Horizon Construction-Jamaica Limited, 2022); the results are presented in Figure 4-6 through to Figure 4-9. These depicted that groundwater was 0 metres AMSL.

4.1.4 Shoreline Classification

The project area can be classified as a "peninsula", a piece of land almost entirely surrounded by water but is connected to the mainland on one side. Peninsulas can be very small or very large. Several factors can lead to the formation of peninsulas, such as a rift formed as a result of a divergent boundary in plate tectonics. Peninsulas can also form due to sedimentation in rivers. When a river carrying sediment flows into an ocean, the sediment is deposited, forming a delta peninsula. This type of peninsula could also be identified as a sediment spit. Sea level rise from global warming may permanently reduce the size of peninsulas over time (CEAC Solutions Co. Ltd., 2022).

From the shape of the landform, it is evident that this type of peninsula is also a sand spit, which is a narrow coastal land formation tied to the coast at one end and are formed by the longshore movement of sediment at a location where the shoreline abruptly changes direction. The movement of the currents in a North-Westerly direction gives credibility to this assumption. The source of sediments appears to be from the East or South-East direction. Based on the current shoreline, it is evident that there is/was a source of sediment located to the south-east of the site. This is assumed to be the original source of sediment for the sand spit. Site visits conducted showed that this water channel is now dried up. This means that the land will stop growing and start eroding. This has been proved in the coastal evolution analysis where long-term erosion was evident. This erosion will be exacerbated during severe weather events which will likely damage the mangroves currently protecting the shoreline. This erosion is usually countered by the accretion of sediment brought by the water channel. With this water channel now dry, the accretion rates will significantly decrease or stop. This will cause the shoreline to continually recede at an accelerated pace (CEAC Solutions Co. Ltd., 2022).

4.1.5 Topography

The project area includes two parcels of land: Vol. 1251 Fol. 908, and Vol. 1244 Fol. 505. Both parcels are relatively flat, with the highest elevation being 2m, close to the road and drops to 0.17m seaward. Most of the seaward section is relatively flat, with elevations less than 1m above MSL. The mid-section, close to the eastern boundary is low-lying with elevations as low as 0.01 and 0.15m above MSL. The left section of the lands and the sections adjacent to the road have higher elevations of 1.2 to 2m. (CEAC Solutions Co. Ltd., 2022) (Figure 4-10).

4.1.6 Bathymetry

4.1.6.1 Existing Nautical Chart Data

Existing chart data for the bay shows the depths inside the bay ranging from 0.3m up to 7.3m (CEAC Solutions Co. Ltd., 2022). The western section of the bay is generally the shallowest section with depths of 0.3 – 3.7m. The eastern section has depts of 0.6m close to the Bogue mangrove islands and mainland and goes up to 4.9m Northward and 5.8m westward. The centre of the bay, to the northwest and southeast of the project site, the has the greatest depths reaching up to 7.3m. Two shoals were identified in this area with depths of 1.5m and 2.4m. The bathymetry directly surrounding "the Peninsula" is also relatively shallow, with depths of 0.9 – 1.5m up to 150m NW of the tip of the site. The entrance to the bay is located 1.75km NW of the project site. The entrance is characterized by a barrier reef that spans almost the entire width of the entrance with only two gaps in between the reefs and shallow areas adjacent to the mainland. The lowest charted depth at and around the reef system is 0.3m. An access channel has been identified by navigation aids for the safe passage of boats through the centre of the reefs where the depth increases to 2.1m.

4.1.6.2 CEAC Measured Bathymetry (2022)

Bathymetric data for the project area was obtained from a survey conducted by CEAC Solutions Co. Ltd. from the nearshore to 20 metres depth offshore, during December 2021. The bathymetric survey was done running parallel and perpendicular to the shoreline, along plan lines for the fine grid 20 metres with tie lines at 50 m spacing in nearshore while a coarse grid of 40 m with tie lines at 500 metres spacing for deep-water locations. A Garmin echo sounder connected to a GPS device was then used to measure and record the depth of the sea floor (CEAC Solutions Co. Ltd., 2022). The data was corrected for tides (obtained from NOAA Tide Prediction for December 5–10, 2021) and keel offset to ensure it was properly referenced to the mean sea level.

The nearshore areas to the site are relatively shallow, with depths averaging around 5m with bed slopes relatively flat (3%) (Figure 4-11). The entrance to the bay is relatively shallow, with a sand bar at a depth of 1.5m. Mangrove forests cover the shoreline around the project site with no apparent signs of erosion (CEAC Solutions Co. Ltd., 2022).

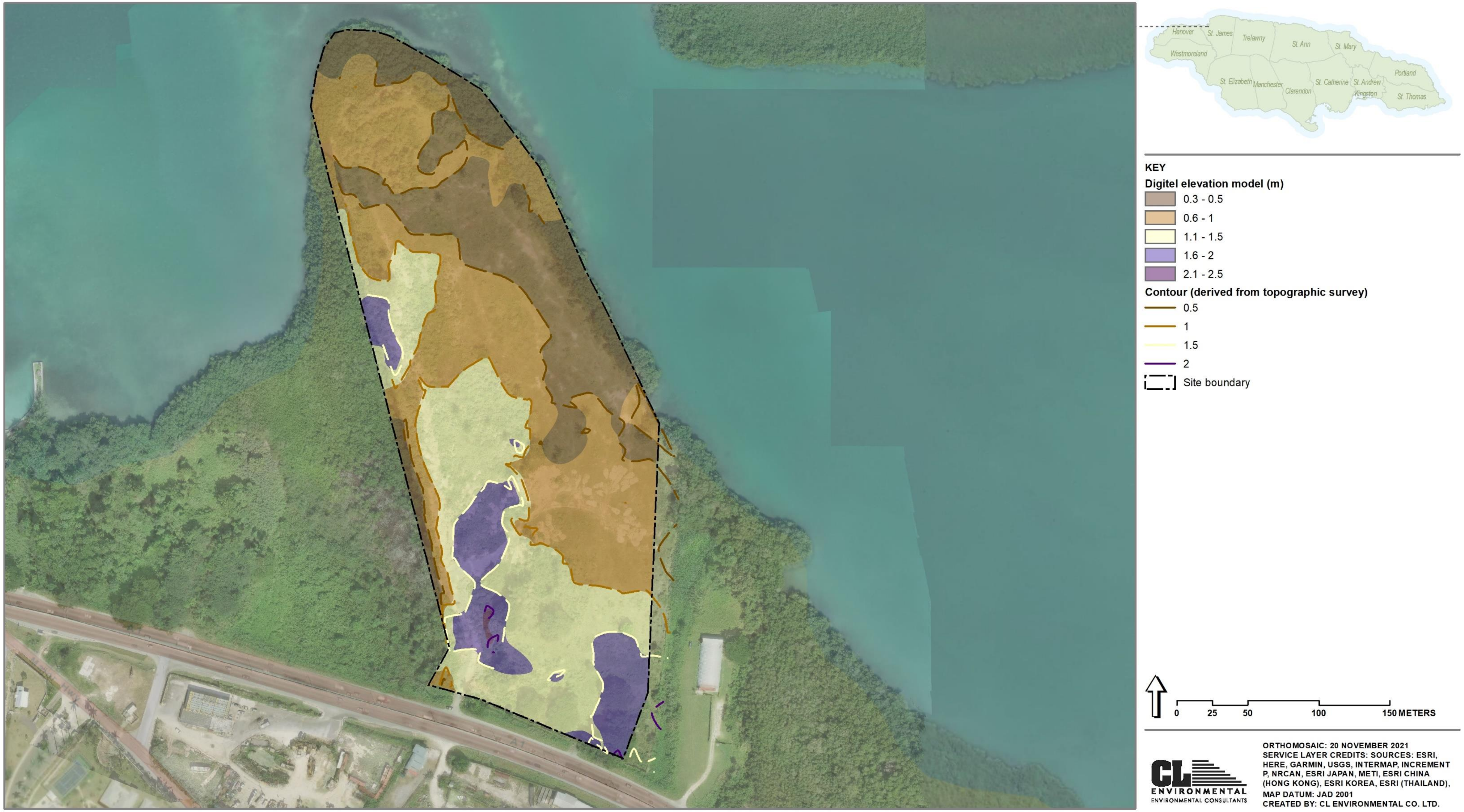
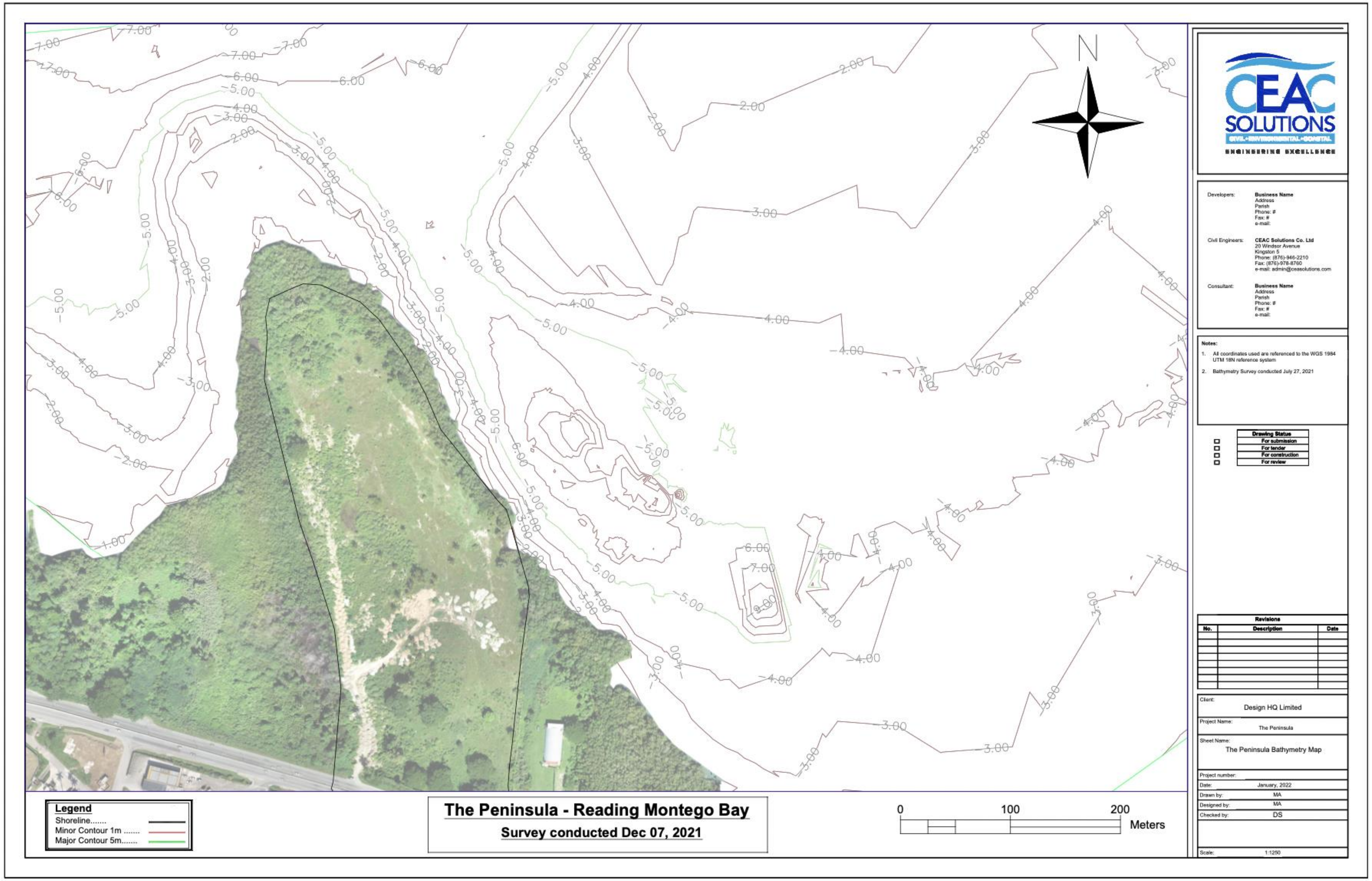


Figure 4-10 Digital elevation model produced using topographic survey-derived 0.5 interval contours



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-11 Bathymetric map of project area

4.1.7 Tides

4.1.7.1 Long-term Tidal Sea Levels

The average tidal range at the project location is 0.55m, during spring tides and 0.35m during neap tides (CEAC Solutions Co. Ltd., 2022).

Table 4-3 Water level variations at Montego Bay over the past two years

Source: NOAA Tide predictions

Tidal Datums	Description	Definition	Water Level
MHHW	Mean Higher-High Water	The arithmetic average of the elevations of the Higher High Waters of a Mixed Tide over a specific 19-year period.	0.45
MHW	Mean Higher-High Water	The average of the greater high-water height of each tidal day over a total epoch (19 years).	0.34
MLW	Mean Low Water		-0.05
MLLW	Mean Lower-Low Water		-0.23

4.1.7.2 Tide Predictions (December 2022)

Data was obtained from the NOAA Tide Prediction for December 5th – 10th, 2021. On December 6th, 2021, the rising tides occurred during the morning between 4:30 AM to 1:15 PM. During the afternoon, the falling tide occurred from 1:15 PM. On December 7th, 2021, the rising tide occurred during the morning period between 5:26 AM to 2:22 PM. In contrast, falling tides occurred in the afternoon period from 2:15 PM. Lastly, on the 8th of December 2021, the rising tide commenced at 6:45 AM while the falling tide commenced at 3:25 PM.

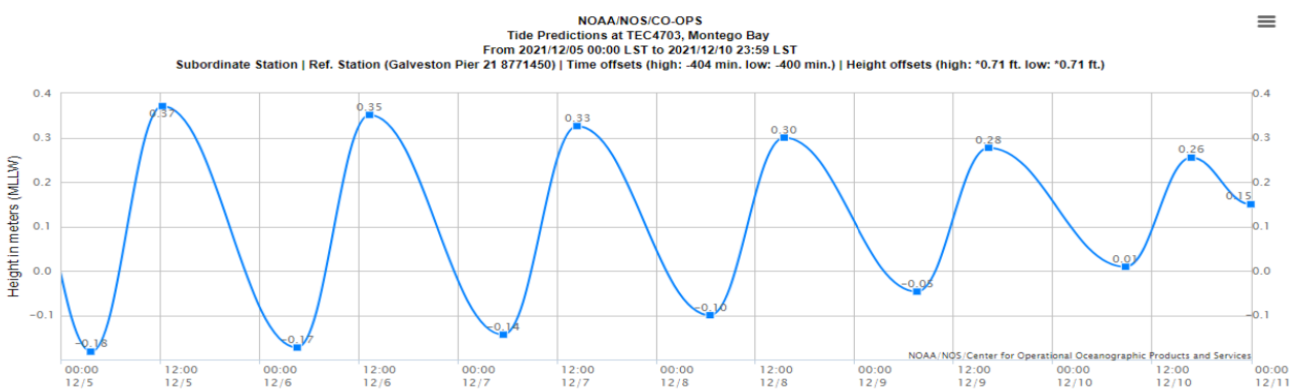


Figure 4-12 NOAA Tide Prediction (December 5 – 10 2021)

4.1.8 Currents

4.1.8.1 Methodology

Circulation patterns can be predicted by numerical or physical models or field studies. Numerical models are most often used as they are more flexible and easier to use. However, they require field data to verify and calibrate the model for use in a predictive mode. These models are also robust enough to include the prediction of suspended sediments in the bay (CEAC Solutions Co. Ltd., 2022).

The drogue tracking mission commenced on December 6th, 2021. Six (6) drogues were deployed; three (3) surface and three (3) sub-surface drogues with depths ranging from 1 to 8 meters. The drogues were deployed at three (3) offshore locations, two (2) within the nearshore and one (1) in deep water. At each location the drogues were tracked during two (2) separate sessions; the first session commenced in the morning and the other in the afternoon/evening to capture the rising and falling tides, respectively. The GPS data and drogue result log sheet from the drogue tracking missions were incorporated into a database. The data was then analysed to determine current speeds and directions, and current speed vectors were produced for the rising and falling tides (CEAC Solutions Co. Ltd., 2022).

4.1.8.2 Drogue Tracking Measurements

December 6th, 2021

RISING TIDE

In session 1, the drogues were deployed at 4 offshore locations, and it was observed that the surface and subsurface currents typically moved in a South Westerly (SW) direction, with the exception of those directly in front of the project area, which followed the shoreline. The current speeds were generally faster for the surface currents and varied from 0.038 m/s nearshore to 0.146 m/s deep-water, whereas subsurface currents varied from 0.006 m/s nearshore to 0.103m/s in deep-water (CEAC Solutions Co. Ltd., 2022).

FALLING TIDE

In session 2, the drogues were deployed at the same locations, and it was observed that the surface and subsurface current directions were similar to those observed in Session 1. The current speeds were generally faster for the surface currents and varied from 0.060 m/s nearshore to 0.093m/s in deep-water. Similarly, subsurface currents were observed to be faster in deeper waters varying from 0.035 m/s nearshore to 0.064 m/s and 0.069 m/s in deep-water and at the mouth of the bay.

December 7th, 2021

RISING TIDE

In session 3, the drogues were deployed at 4 offshore locations, and it was observed that the surface and subsurface currents moved in a South Westerly direction, with the exception of the deep-water currents which moved north easterly. The current speeds were slightly faster for the surface currents and varied from 0.030 m/s nearshore to 0.281 m/s in deep-water locations. Sub-surface currents varied from 0.026 m/s nearshore to 0.277 m/s deep-water (CEAC Solutions Co. Ltd., 2022).

FALLING TIDE

In session 4, the drogues were deployed at 4 offshore locations, and it was observed that the surface and subsurface currents moved in both north westerly and south westerly directions. The surface current speeds varied from 0.037 m/s nearshore to 0.094 m/s in deep-water. Sub-surface currents varied from 0.023m/s nearshore to 0.087 m/s in deeper locations, continuing the trend of greater surface current speeds in relation to sub-surface.

December 8th, 2021

RISING TIDE

In session 5, the drogues were deployed at 4 offshore locations, and it was observed that the surface and subsurface currents moved in a South Westerly direction, with the exception of the deep-water currents which moved north easterly. The current speeds were generally faster for the surface currents and varied from 0.026 m/s nearshore to 0.102 m/s. Sub-surface currents were slower and varied from 0.007m/s nearshore to 0.088 m/s deep-water.

FALLING TIDE

In session 6, the drogues were deployed in the same offshore locations as those recorded in session 5. The typical current directions observed were between a South Westerly and North Westerly compass direction. The surface current speeds varied from 0.032 m/s nearshore to 0.054 m/s in deep-water, while subsurface currents were slightly lower and varied from 0.036 m/s nearshore to 0.068 m/s in deeper areas.

4.1.8.3 Summary

The drogue tracking mission comprised of 6 sessions: one falling tide and rising tide session each day between December 6th and 8th 2021. The current speeds for the falling tides ranged from 0.030 and 0.094 m/s and 0.023 and 0.093 m/s for surface and sub-surface drogues respectively. The rising tide current speeds varied from 0.028 to 0.281 m/s and 0.023 to 0.277 m/s for the surface and sub-surface drogues respectively. The currents appear to be mostly circulation driven by longshore wave induced currents in a South-Westerly Direction (CEAC Solutions Co. Ltd., 2022).

Table 4-4 Average speed and direction of surface and sub-surface drogues

Source: (CEAC Solutions Co. Ltd., 2022)

	Average Speed (m/s)	Average Direction (Degrees)	Average Direction
Session 1 (Rising tide)			
Surface	0.067	244	South-West
Subsurface	0.066	271	South-West
Session 2 (Falling tide)			
Surface	0.067	265	West
Subsurface	0.069	272	West
Session 3 (Rising tide)			
Surface	0.092	182	South
Subsurface	0.090	184	South
Session 4 (Falling tide)			
Surface	0.067	268	West
Subsurface	0.064	286	West
Session 5 (Rising tide)			
Surface	0.045	169	South
Subsurface	0.037	157	South
Session 6 (Falling tide)			
Surface	0.04	218	Southwest
Subsurface	0.055	218	Southwest

4.1.9 Hydrology and Drainage

4.1.9.1 Flood Plain Modelling

A flood plain model was established illustrating the flood plain and rainfall intensities within the project area. The tool of choice when generating flood plains is the Hydrologic Engineering Centre's River Analysis System (HEC-RAS). The United States army corps of engineers created this software to perform one and two-dimensional hydraulic calculations for a complete network of natural and constructed channels. Due to the complex nature of the hydrodynamics within the project area, a 2-D model was used to generate flood depth and determine its impact on the surrounding infrastructure and land. To fully understand its extent, it was necessary to analyse the project area using a general approach, taking into account the dynamic nature of the environment and the existing drainage features. Key features used to do the assessment are as follows:

1. Topographic data (JAXA 30m Topographic Geo Tiff)
2. Site-Specific Topographical Data
3. Rainfall data (From rainfall stations provided by the Meteorological Office of Jamaica)
4. Rivers, streams, and storm water infrastructure.

The above data were utilised as model input, where the results were validated and calibrated with data from the anecdotal survey. For this assessment, scenarios for the 2-year, 10-year, 25-year, 50-year, and 100-year present and future rainfall events were modelled to determine the extent of the impact with varying intensity.

Model Input

The HEC-RAS hydrological data analysis was used to model how the water is conveyed over the flood plain to the downstream outflow points. The input parameters of this model were made up of 2 main components: (i) the geometry (terrain data) and (ii) the hydrological data. Present and future rainfall were used as the driving factor to model flooding in the project area within this project's scope.

TERRAIN DATA

The topography of the site and within the catchment generates terrain data, the crucial parameter to calculate flows and represent flooding within the catchment. The terrain data was created using topographic data (JAXA 30m Topographic Geo Tiff) and topographic surveys around the site. This data was then used to establish boundaries for the various catchments in and around the project area. The identified catchments A, B and C displayed the general areas ultimately drained into the bay/adjacent to the Peninsula project site.

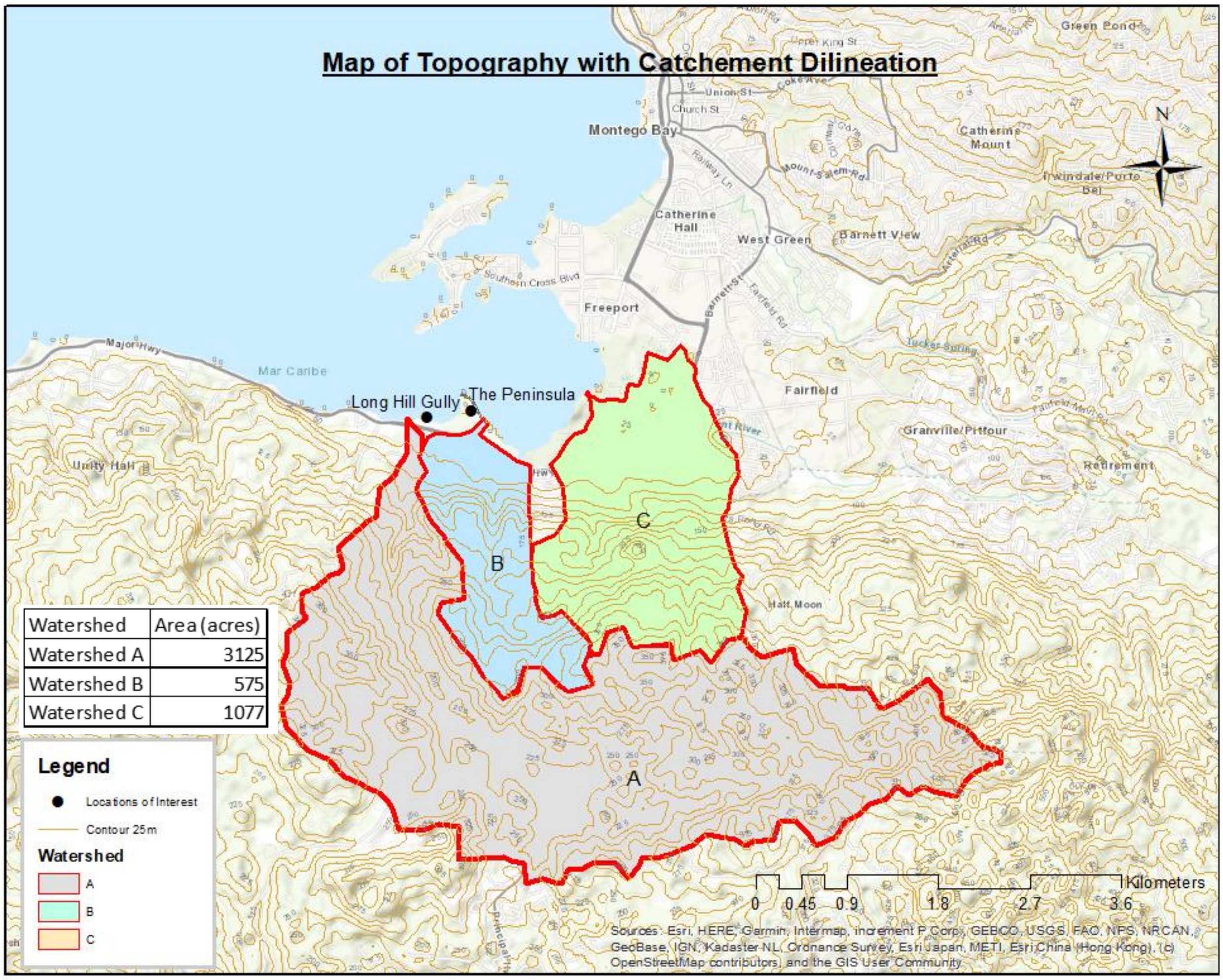


Figure 4-13 Map of delineated catchments associated with the project area.

LAND USE CHARACTERISTICS OF WATERSHED

The land use of the catchment was used as a basis for defining the various flow characteristics associated with having varying terrain within the model. The recorded land usage, associated manning's number and percentage impervious were assigned to each region within the HEC-RAS model.

Table 4-5 Classification of Land cover within the catchment

Land Cover Category	Area (m^2)	Manning's Coefficient	Percentage Impervious (%)
Disturbed broadleaved forest (Secondary Forest)	6163421	0.11	0
Buildings and other infrastructures	2633673	0.06	50
Mangrove Forest	725618	0.1	50
Fields and Secondary Forest	4178631	0.11	10
Open dry forest - Tall (Woodland/Savanna)	1056120	0.08	0
Secondary Forest and Fields	2005394	0.11	10
Fields: Herbaceous crops, fallow, cultivated vegetables	672174	0.07	10

Land Cover Category	Area (m^2)	Manning's Coefficient	Percentage Impervious (%)
Plantation: Tree crops, shrub crops, sugar cane, banana	132245	0.015	10
Road/Asphalt/Conc	37529	0.015	100
Open Water	370826	0.05	100
High Density Housing	630239	0.03	80
Rural Housing	887231	0.07	40
Suburb	298910	0.05	60
Industrial/Gas Station	35437	0.03	90
Barren/Dry	10981	0.03	0
Thick Grass/Bushy	12474	0.35	0

METEOROLOGICAL DATA

Depth of rainfall for various return periods was provided by the National Meteorological Service of Jamaica for the gauges across the island. Synthetic mass-curves (SCS type 3) were used for this study. The overall approach to defining the metrological conditions was as follows:

1. Evaluate the existing Meteorological Service data.
2. Define the present climate 24-hour rainfall depths for the 2-year, 25-year, 50-year and 100-year RP.

PRESENT RAINFALL CONDITIONS

The rainfall intensity for various return periods was provided by the National Meteorological Service of Jamaica for the rain gauges within the project area and processed using ArcMap shown in Figure 4-14 . In addition, rainfall intensity within the catchments affecting the site was determined using the inverse distance weighted (IDW) interpolation method. This allowed for a more representative rainfall intensity in regions with a low density of gauges.

Table 4-6 Present climate 24-Hour Rainfall Depths for the catchment affecting the Peninsula (source: Met. Service/NWA)

Return period (years)	Rainfall Depths (mm)		
	Watershed A	*Watershed B*	*Watershed C*
2-Year	99	100	99
10-Year	193	187	183
25-Year	248	237	231
50-Year	299	284	274
100-Year	342	323	311

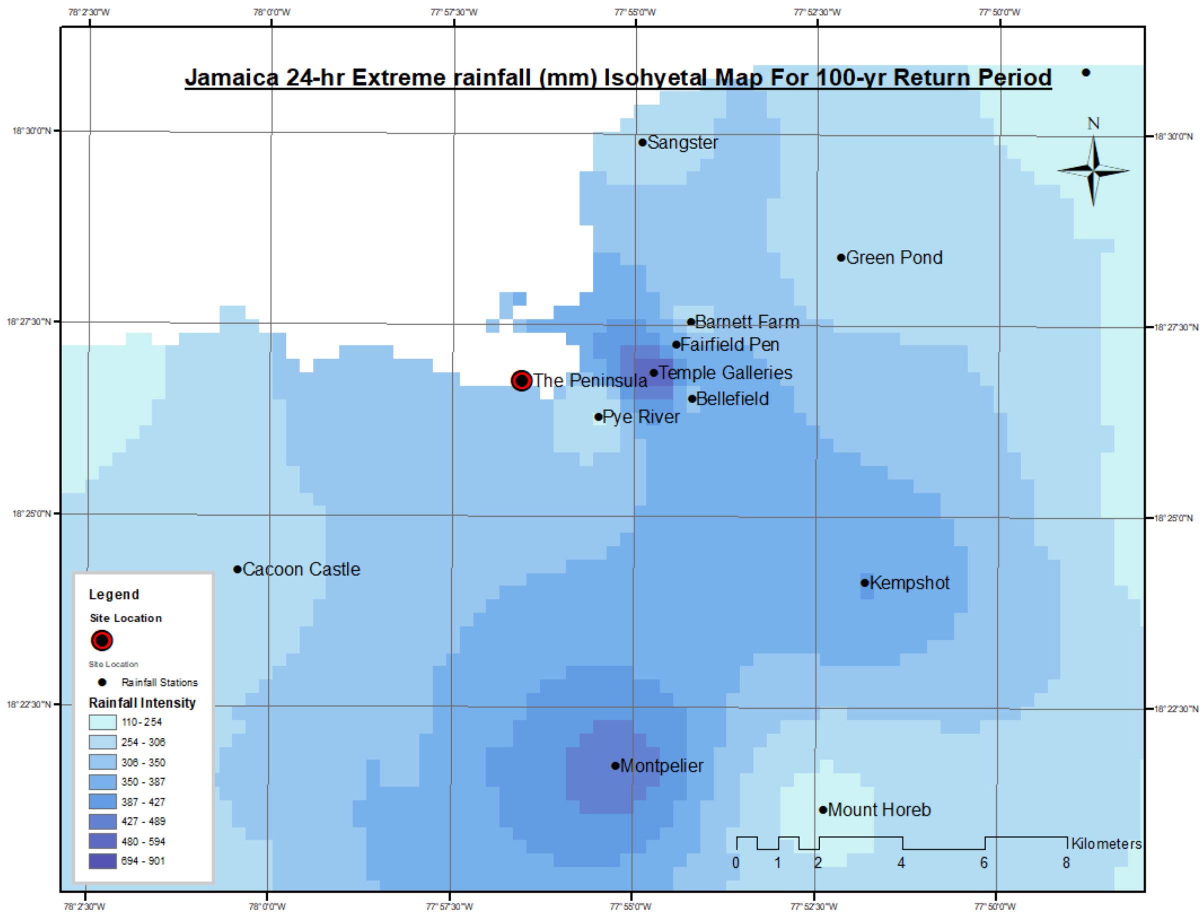


Figure 4-14 24-Hr Extreme rainfall Isohyetal Map for 100-yr Present climate showing locations of rainfall gauges in proximity to the Peninsula.

FUTURE CLIMATE CONSIDERATIONS

Future climate extreme rainfall was estimated based on the findings and recommendations of IPCC (2018) (Masson-Delmotte, 2018). This estimation is based on the probability ratio of heavy precipitation as a function of global warming and event probability (Figure 3). Climate change factors for the 2-yr, 25-yr, 50-yr and 100-yr were determined to be 1.2 to 1.45 for the 2°C above pre-industrial levels. Climate change factors (CCF) were applied to the present climate 24-hour rainfall depth extremes to determine the estimated future climate rainfall extremes as depicted in Table 4-7. Present climate (IPCC 2018) and estimated future climate 24-hour rainfall depths at 2°C.

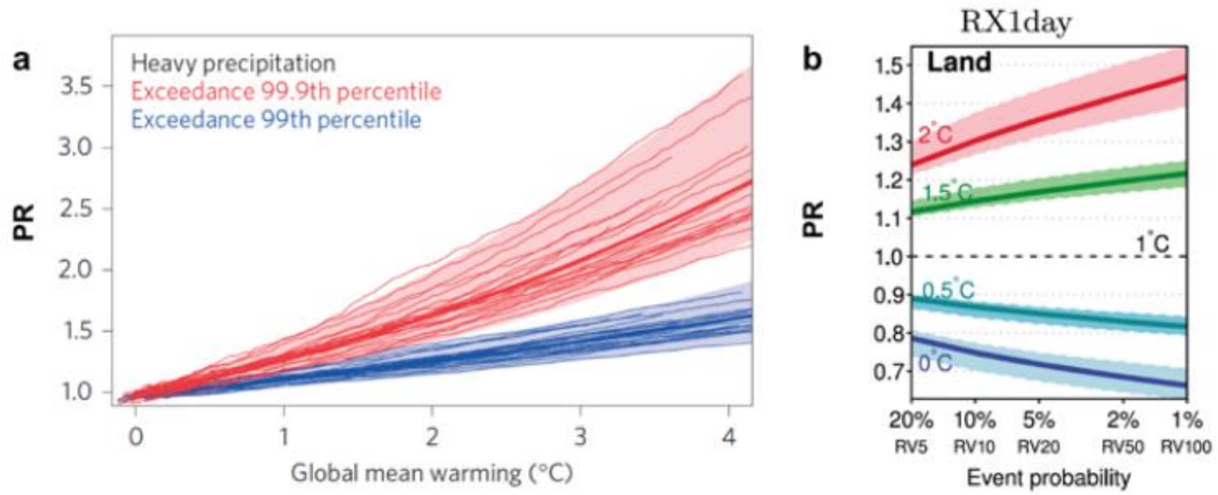


Figure 3.10 | Probability ratio (PR) of exceeding (heavy precipitation) thresholds. (a) PR of exceeding the 99th (blue) and 99.9th (red) percentile of pre-industrial daily precipitation at a given warming level, averaged across land (from Fischer and Knutti, 2015). (b) PR for precipitation extremes (RX1day) for different event probabilities (with RV indicating return values) in the current climate (1°C of global warming). Shading shows the interquartile (25–75%) range (from Kharin et al., 2018).

Figure 4-15 Probability ratio of heavy precipitation as a function of global warming and event probability (IPCC 2018)

Table 4-7 Estimated future climate (2050) 24-hour rainfall intensities and average percentage increase for 2°C global warming.

Return period (years)	Future Rainfall Depths (mm)			Average increase between present and future events
	Watershed A	Watershed B	Watershed C	
2-Year	107.76	108.33	107.60	9%
10-Year	213.09	204.99	199.44	10%
25-Year	273.05	260.02	251.73	10%
50-Year	318.41	301.65	291.29	6%
100-Year	363.77	343.28	330.84	6%

RAINFALL HYETOGRAPH

The Type III rainfall distribution curve was used for this assessment as it most accurately reflects the 24-hour rainfall distribution experienced by the island. Rainfall Hyetographs were generated using the present and future climate conditions extreme rainfall and used to model the respective return periods.

Model Calibration & Validation

ANECDOTAL EVIDENCE

Anecdotal surveys were conducted in December 2021 to understand the effects of floods in the bogue area. The data collected indicated minor flooding in the area, with flood depths ranging from 0.15 to 0.6m associated with heavy showers, summarized in Table 4-8.

Table 4-8 Summary of anecdotal flood interviews in the Bogue area

ID	Name	Age	Location	Time in area	Extreme weather event	Flood depth Experienced	Additional Comments
1	Glenrick	55	Bogues Hill& Bogue Road intersection	30	Matthew	0.3	
2	Pam	52	Boomerang Tyre Sales	40	Heavy Rain in November 2021	0.3	Drains are not regularly serviced causing the road to be impassable during flooding events
3	Benny	32	Boomerang Tyre Sales	29	Matthew, Heavy Rain in November 2021	0.3	The main road doesn't flood as it is higher than the surrounding area
4	Patrick	40	Thrifty Gas Station	4	Heavy Rain in November 2021	0	
5	Kim	35	Thrifty Gas Station	4	Heavy Rain in November 2021	0.3	
6	Simone	29	Tara estates	2	Heavy Rain in November 2021	0.15	
7	Bigga	31	Across from isratech	5	Heavy Rain in November 2021	0.3	
8	Denny	73	Thrifty Gas Station	73	Matthew/ Gilbert	0	
9	Campbell	42	D & G	2	Heavy Rain in November 2021	0.6	
10	Jef	52	Longhill (Reading Post Office)	52	Matthew, Heavy Rain in November 2021	0	
11	Cathy	32	Isratech	10	Heavy Rain in November 2021	0.3	Road Floods From D&G to Isratech

CALIBRATION

To evaluate the accuracy of the flood plain Model (Hec-Ras), a scenario was run using a known rainfall event in November 2021 and compared to anecdotal data collected in the field. The November 2021 event was common within the anecdotal survey, where 73 mm of rainfall was experienced, causing notable flooding in the area. The observed depth and extent of the flooding were compared to the flood plain rasters generated for a similar return period, which are shown in Table 4-9. Comparing the results, the average difference between the modelled and observed values fall within 11%, and the extent of the flooding matches the anecdotal survey. This indicates the model adequately predicted the flooding depths and extents in the study area, validating the model's results and thus can be extrapolated for higher return period events.

Table 4-9 Comparing observed and modelled flood depths for a 73mm rainfall event

Record ID	Observed Flood Depth (m)	Modelled Depth (m)	RMS
1	0.3	0.25	0
2	0.3	0.56	0.07
3	0.3	0.26	0
4	0	0	0
5	0.15	0	0.02
6	0.3	0.38	0.01
7	0.3	0.27	0

Record ID	Observed Flood Depth (m)	Modelled Depth (m)	RMS
8	0.6	0.64	0
9	0.3	0.38	0.01
Correlation			**0.861176432**

Flood Plain Model Results

FLOWS GENERATED UPSTREAM OF THE PROJECT AREA

The catchment is south of Bogue Road and consists of numerous industrial premises and a gated community at the foot of a hill. Catchment B poses the most significant impact on the Peninsula. In order to convey runoff generated to the bay, various culverts are used to bypass the elevated level of the Bogue main road. Field surveys highlighted at least 2 culverts channelled beneath the Bogue Main Road to earthen channels on either side of The Peninsula. Observation of the flows crossing these culverts and the Bogue Main Road is imperative as poorly channelised flow and inadequately sized channels can lead to unwanted inundation levels within the project area. This also provides a basis for designing the requisite means of stormwater management.

Figure 4-16 Layout of visible drainage infrastructure from the field survey

Figure 4-17 4.5x2m culvert from Gas Station to the channel west of The Peninsula

Modelling catchment B in HEC-RAS generated peak flows expected in various rainfall events. Based on the results, the culverts observed are expected to experience the following flow demand:

Table 4-10 Flows generated to be conveyed from catchment B to the bay

Return Period	Culvert A (Gas Station)	Culvert B
2-Year	5.046	5.076
10-Year	9.769	10.807
25-Year	13.054	13.442
50-Year	17.049	17.331
100-Year	17.84	20.384

Flood levels observed revealed that most occurrences were attributable to ponding within low points on-site and the exceedance of the eastern channel. Through approximate dimensioning of the earthen channel to the east of the Peninsula and contributing culvert, it was determined that its carrying capacity would be exceeded in a 25 Year return period and as such would result in an increase in flood depths seen in the surrounding area.

Flood levels observed to the west of the site, revealed flows conveyed from channel A, would lead to flooding in the mangrove area, but not necessarily The Peninsula site. However, the impact of flows may be exacerbated to impact the site when the effects of increased water levels are accounted for. In occurrences such as storm surge, the carrying capacity of the channel and mangrove area will be diminished by the additional volume of water from the bay. This will result in the backing up flows and overtopping of the channel banks.

SITE-SPECIFIC FLOODING

Flooding on the proposed Peninsula site was analysed using outputs from HEC-RAS to plot varying flood levels for the respective return periods of rainfall. Analysing the flood plain model, the flooding affected the site is mainly caused by ponding in depressions on the site and flows conveyed from catchment B. This mainly affects the south-eastern extent of the site.

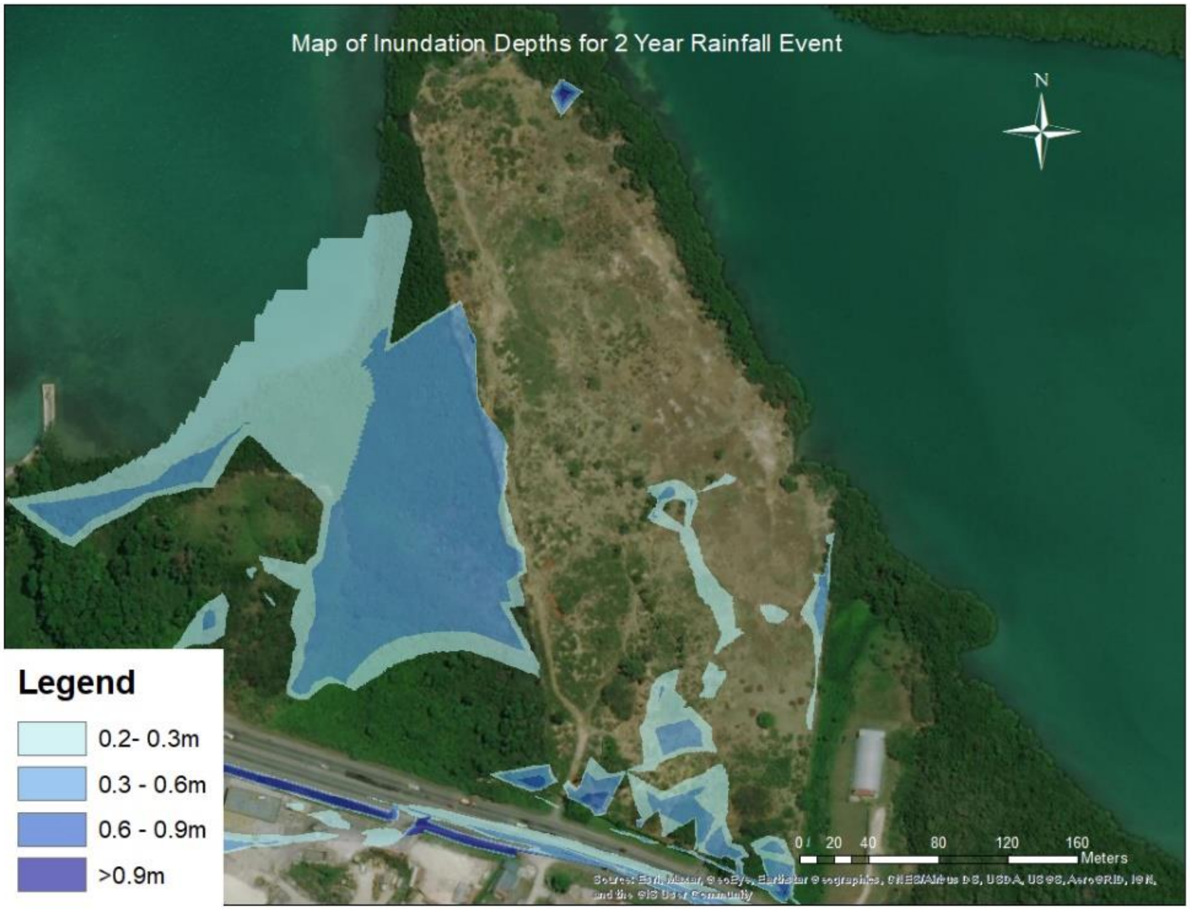


Figure 4-18 Site-specific flood level raster for 2Yr Future Rainfall Event (Source HEC-RAS 6.0)

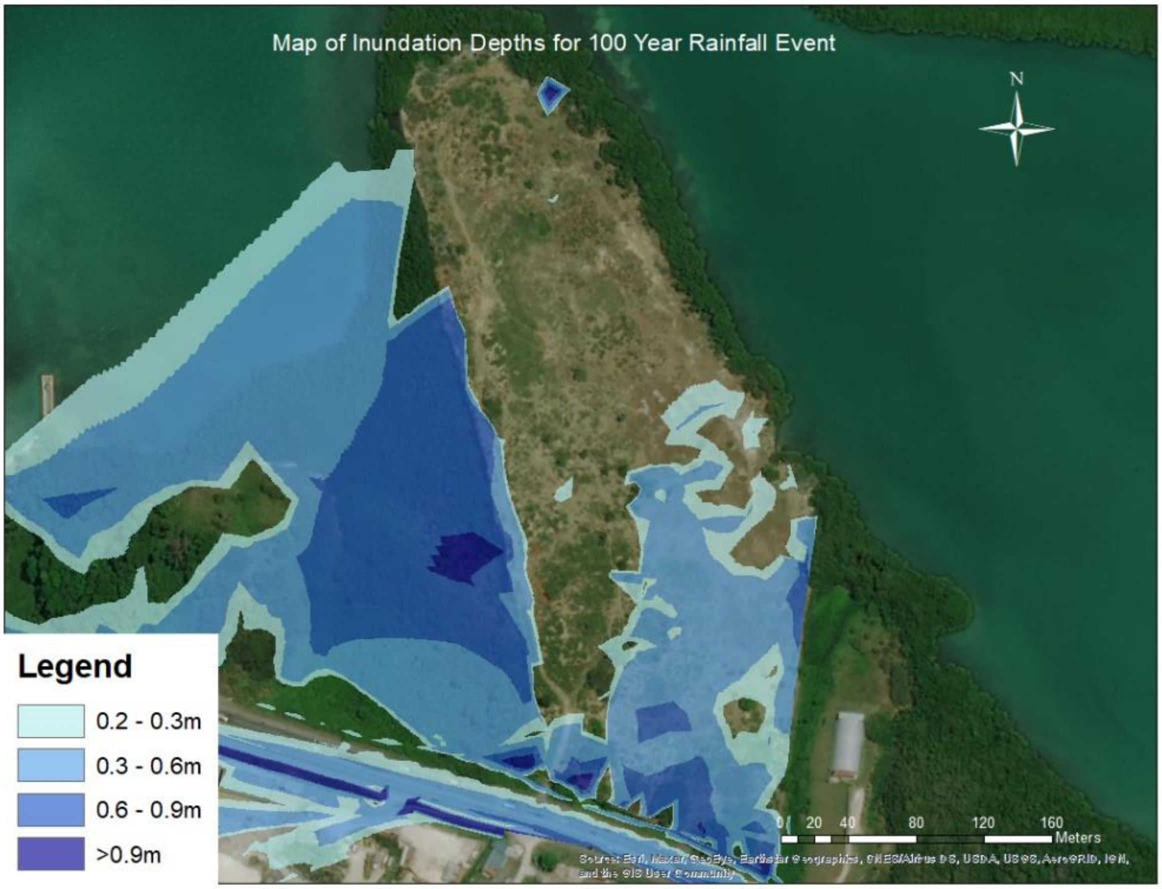


Figure 4-19 Site-specific flood level raster for 100Yr Future Rainfall Event (Source HEC-RAS 6.0)

Analysis of results highlighted that there were no significant increases in the flood depths, based on the precipitation generated by each return period. However, a relatively large increase in the percentage/extent of land area would experience flood depths above 0.2m. For the 2-Year return period, the average flood depths predicted on the site was 0.32m, with some isolated regions, associated with depressed areas on site, experiencing depths of up to 0.75m. During the 100-Year event based on future climate predictions, the average depth for inundated areas was 0.53m, with depressed, isolated zones recording depths of up to 1.16m. Throughout a comparison of 2- to 100-yr return periods under present and future scenarios, a maximum increase in flood depths of 0.11m can be expected.

Table 4-11 Inundation depths as a result of Rainfall Event RP

RP	Present (metres)	Future (metres)
2-Year	0.32	0.36
10-Year	0.36	0.44
25-Year	0.39	0.46
50-Year	0.42	0.50
100-Year	0.42	0.53

The model indicated that flows generated in the southern area of the site would accumulate in the depressions in regions between the roadway and the Peninsula. It is expected that the filling of said depressions will reduce the extent of inundation experienced within site. At location P1, experiencing the highest flood depths, a site ground level of 2.4m would be required to protect assets from inundation safely.

Table 4-12 Elevations required in select locations to mitigate flooded zones (based on 100 Future Return Period)

Location	Topography	Flood Depth	Flood Elevation	Recommended Floor level
P1	1.70	0.70	+2.40	+2.80
P2	0.66	0.44	+1.10	+1.50
P3	0.44	0.00	+0.44	+0.84

4.1.9.2 Stormwater Discharge Modelling

The primary objective of this evaluation was to determine the impacts on water quality in the bay and project area based on site-specific runoff and stormwater discharge from adjacent drainage features. The evaluation considers the dispersion of total suspended solids and heavy metal concentration from the existing drainage features and likely site-specific outfalls. The discharge evaluation was conducted for short term 24-hour rainfall events to determine the immediate effects and the runoff. The storm water pollutant plume was observed until the plume returned to acceptable or to ambient levels.

The MIKE 21 hydrodynamic and transport (mud & transport) modules were used to determine the extent of dispersion and flushing time of the TSS and heavy metal concentration in the bay. The MIKE 21 Mud Transport Module (MT) described erosion, transport and deposition of mud or sand/mud mixtures under the action of currents and waves and was used to analyse TSS.

Definition of Pollutant Concentration

TSS

Total suspended solids (TSS), refer to suspended solids larger than 2 microns. A high concentration of TSS can create an unsuitable environment for biological inhabitants by increasing water temperatures, reducing dissolved oxygen, light infiltration and physical impedances such as the blockage of fish gills. A high TSS can also lead to a cloudy appearance of the water body, making the water surrounding the proposed high rise unsightly for its guests.

TSS concentrations were determined using both TSS samples collected in the bay and empirical studies (for example Minnesota Stormwater Manual, Event mean concentrations of total suspended solids in stormwater runoff, 2021), which captured sediment concentration in stormwater discharge. As such, a representative range of 50mg/l – 500mg/l was determined. The lower end of the spectrum represented precipitation, soil, and surface conditions conducive to low sediment suspension and hydraulic transport. Further review of the data also revealed that a representative concentration of sediment generated from a construction site was within the realm of 1000mg/l.

Based on marine environment construction standards from NEPA, a limit of 15 nephelometric turbidity units (NTU) was provided. The relationship between NTU and Suspended Solid Concentration can be expressed in a 1:1.3 (NTU: SSC) relationship. As such, the acceptable limit for SSC was determined to be 20mg/l. National trade effluent standards from NEPA depicted a limit of 2mg/l and 10mg/l for Total Heavy metal and Oil and Grease concentrations, respectively. The model used these limits to determine whether the pollutants' dispersion was within acceptable quantity spatially and with respect to time.

HEAVY METALS

Heavy metals are metallic chemical elements with a relatively high density. They are known to bioaccumulate and do not degrade. Although, some heavy metals, such as zinc and iron are necessary for normal metabolic function (in low concentration), heavy metals can be toxic. As such, with entrance into a water body, they can contaminate the food supply for both wildlife and humans, leading to a host of acute and chronic illnesses.

Heavy metal concentrations were observed based on the impact of site-specific developments. It is expected that the construction of the Peninsula and the resultant change in land use would result in trace heavy metals being deposited and having a cumulative effect. Ranges for heavy metals, such as zinc, copper, lead, and cadmium generated by streets, parking lots, roofs, and other sources during a range of rainfall intensities (Table 4-13).

A combined total of the concentrations of approximately 1.5mg/l for each discharge point was determined for the expected operational land use of The Peninsula (based on upper limits).

Table 4-13 Ranges of heavy metal concentrations(micrograms) extracted from Sakson, Brzezinska, & Zawilski (2018)

Sampling Site	Zn (µg/l)	Cu (µg/l)	Pb (µg/l)	Cd (µg/l)
Roofs without metal elements	50–1060	< 0.5–133	1–108	< 0.1–2.1
Roofs with metal elements	520–31,300	7–6993	1–60	0.1–2.5
Roofs with metal elements—after the passing through vegetated soil	30–2280	< 0.5–850	2–29	0.1 < – 1.9
Streets and parking lots	80–4180	28–297	< 1–130	< 0.1–35.7

OIL AND GREASE

Oil and Grease concentrations measure constituents such as fuels, automotive oils, cooking oils, and fats within a volume of discharged water. The concentrations pose a similar risk to heavy metals, introducing toxic substances to the marine ecosystem. The increased viscosity of the substances also results in a film, which may inhibit the organism's movement and, in some cases, impact photosynthetic processes.

Oil and Grease (OG) concentration was determined based on land use. An empirical study of oil and grease concentrations by Stenstrom, Silverman and Bursatynsky (1984) revealed that the typical event mean concentrations range was 4.1mg/l for residential areas to 15.3 mg/l in parking lots. Therefore, the median value of 8 Mg/L discharged from the site’s drainage was used as a conservative estimate of a possible oil spill event. It was noted that the concentration was not driven by event intensity but mainly by the industrial activities of an area.

Definition of Ambient Environment

Ambient conditions for the project area were determined from the desktop studies of water quality surveys in the water conducted around the Bogue islands in early 2019. The three recording stations are shown in Figure 4-20, and the survey data is summarized in Table 4-14.

The Water Quality readings were averaged between the stations and then used in the model to establish ambient conditions in the bay.

Figure 4-20 Water Quality Stations around Bogue Island, used in stormwater discharge analysis

Table 4-14 Average biochemical water quality data and NRCA standards

STN.	Temp. (°C)	Cond. (mS/cm)	Salinity (ppt)	pH	D.O. (mg/l)	Turbidity (NTU)	TDS (g/l)
MARINE STATIONS							
Station 1	27.72	54.14	35.85	8.01	5.83	12.24	34.61
Station 2	24.84	52.18	34.43	7.29	3.44	56.8	33.39
Station 3	27.69	54.31	35.98	8.27	7.56	4.35	34.73
NRCA Marine Water Standard	-	-	-	*8 - 8.4*	-	-	-

STN.	BOD (mg/l)	TSS (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	FOG (mg/l)	Faecal Coliform (MPN/100ml)	TPH - GRO	TPH – DRO C10-	TPH – ORO

STN.	Temp. (°C)		Cond. (mS/cm)	Salinity (ppt)		pH	D.O. (mg/l)	Turbidity (NTU)	TDS (g/l)
							C6-C10 (mg/l)	C28 (mg/l)	C28-C35 (mg/l)
MARINE STATIONS									
Station 1	4.21	12.33	1.33	0.11	3.41	13.33	ND	ND	ND
Station 2	6.60	52.00	0.17	0.17	6.21	36.00	ND	0.14	ND
Station 3	4.98	4.00	1.60	0.08	2.64	10.00	ND	ND	ND
Marine Water Standard	*1.16*	-	*0.007 – 0.014*	*0.001-0.003*	-	*<2 - 13*	-	-	-

Values in red were non-compliant with their respective NRCA Standard.

ND – None Detected

Model Setup

The main considerations/variable inputs taken into account for the Water Quality Analysis in the Mike 21 Transport Module were the:

POLLUTANT DISCHARGE POINTS

Based on field surveys, three (3) stormwater/drainage outlets were identified as close to The Peninsula. As such, the analysis of said outlets was deemed necessary to determine possible impacts on water quality in the bay.

Figure 4-21 Stormwater outfalls in proximity to the Peninsula site

STORMWATER DISCHARGE RATE

The outfalls' stormwater discharge rates were retrieved from flow generated within the HEC RAS flood plain model. Instead of using a constant flow, a time variant distribution was used to give a more representative discharge behaviour, similar to one that could be observed in typical rainfall events.

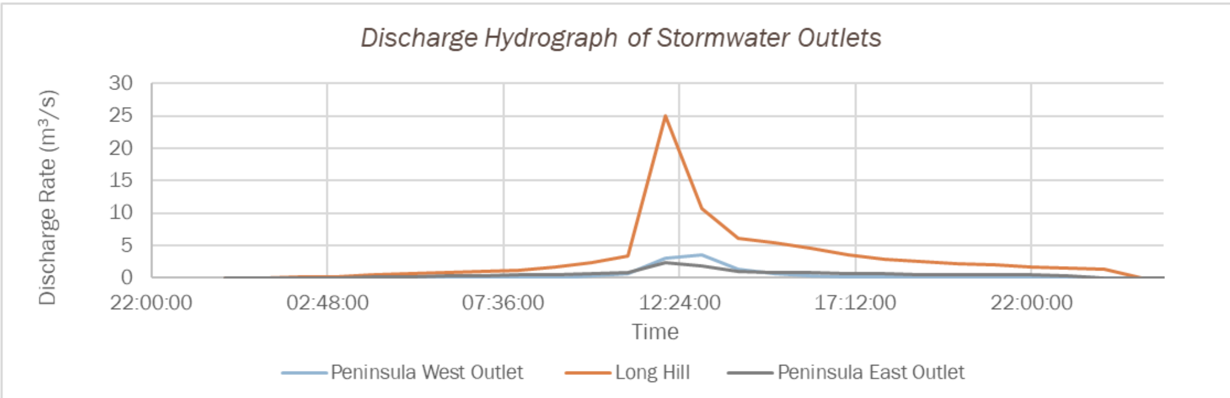


Figure 4-22 Flow hydrograph of stormwater outlets

SETTLING VELOCITY OF THE SEDIMENT (TSS)

Fine sands represented the Suspended Sediments generated at the various outfalls, silts and small clay content, based on the soil types located upstream of the Peninsula and within the catchment. A settling velocity of 0.001m/s was derived using Stoke's equation for settling solids. :

Plume Dispersion Model Results

In the Preconstruction phase, the existing drains and infrastructure were considered the sole sources of contaminants in the bay. This established an ambient baseline from which any impacts arising from the proposed development's construction and operation could be compared. The scenario examined a 2 RP rainfall event over 24 hours, and the effects that the runoff would have on the marine environment were modelled with the respective plume dispersion models.

The runoff from the catchment was assumed only to contribute to the environment's total suspended solids as the sheet flows pick up loose silt and sand then deposits into the nearshore area. This runoff forms a turbid plume with suspended sediments entering the bay, as seen in Figure 4-23. It is important to note that the major contributor to the area's TSS is the long hill drain, this is due to a relatively large volume of stormwater going through the drain.

The most pronounced effect of TSS is the increase in turbidity causing cloudiness or haziness in the fluid, the relationship between mg/l and NTU can be expressed in a 1:1.3 Ratio. The solids' concentration is estimated to be 50mg /l based on the flow scenario, soil type, and the catchment's land use. The plume generated at the mouth of the Long hill drain has the highest concentration of 50 mg. It disperses to ~200m seaward parallel to the site where the TSS returns to ambient. The estimated turbidity of the plume is 15 - 65 NTU. This means the water is noticeably cloudy and slightly opaque, making that area unsightly and mildly dangerous to marine life in the short term. However, the TSS quickly dissipates within 3 hrs to match ambient standards. It is also important to note that turbidity produced at the Peninsula West and East outfalls are about similar to the ambient concentrations and therefore not represented.

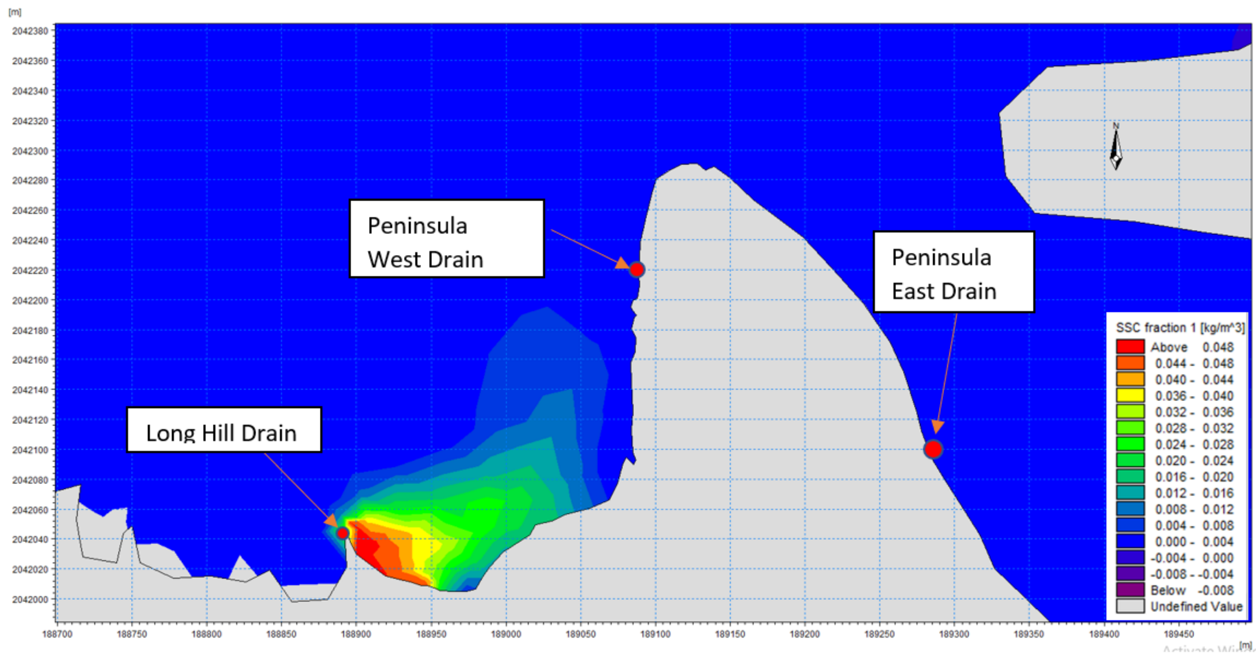


Figure 4-23 Ambient TSS plume at peak runoff

Limitations

The approach taken thus far using a conservative or non-decaying constituent is believed to be appropriate to understand the potential issues that operational and accidental pollutants can have on the marine environment. Some of the limitations encountered herein include limited water quality data in the bay and limited soil data at the shoreline. Additionally, a dye tracer study would allow for a greater understanding of the current movement and the plume dispersion properties in the bay.

4.1.10 Water Quality

4.1.10.1 Methods

The water quality monitoring exercises were conducted on three occasions: February 3, 2022, March 3, 2022, and April 7, 2022. Weather conditions were calm and cloudy on the first monitoring exercise, which was one day after a rain event on February 2, 2022. During the other two sampling events, weather was fair and sunny with calm seas. A total of eleven (11) stations were monitored, one of which was located on land within the wetland. Table 4-15 gives the location of these in the Jamaica Grid (JAD2001) and Figure 4-24 illustrates these locations.

Table 4-15 Location of water quality monitoring stations in JAD2001

STATION #	LOCATION (JAD2001)	
	NORTHING	EASTING
1	696472.908	616508.733
2	696250.278	616466.110
3	696060.047	616491.967
4	696027.256	616618.411
5	695891.167	616324.129
6	696021.116	616128.967
7	696165.748	615519.357
8	695884.495	615803.255
9	695479.547	615633.163
10	695238.767	615551.058
11	695004.886	615737.638

Figure 4-24 Map depicting the water quality monitoring stations

Water quality was monitored in-situ for temperature, conductivity, salinity, pH, dissolved oxygen, turbidity, TDS and light irradiance (Photosynthetically Active Radiation "PAR", used to calculate the light extinction coefficient) using a Hach Hydrolab DataSonde DS-5 multiprobe (Appendix 5). Whole water samples were taken at each station, stored on ice and transported to various labs for analysis. Samples were transported to Caribbean Environmental Testing and Monitoring Services (CETMS) Ltd. for laboratory analysis of TSS, nitrates, phosphates, and faecal coliform; to Environmental, Technical and Analytical Services (ETAS) Ltd. for laboratory analysis of BOD; to Scientific Research Council (SRC) and Environmental Solutions Ltd. (ESL) for laboratory analysis of faecal enterococci, and to International, Analytical Group (IAG), for laboratory analysis of Total Petroleum Hydrocarbons (carbon ranges C8-10, C10-28 and C28-40). All results were compared to the NRCA standards where applicable. See Appendix 6 for all laboratory test sheets and Appendix 7 for raw water quality data.

4.1.10.2 Results and Observations

The water quality results are shown below in Table 4-16 and Table 4-17. Station 9 was located within a drainage channel beside the mangroves to the West of the property and was regarded as brackish water and thus compared to the NRCA Ambient Freshwater Standards. The complete data set for all three sampling runs can be seen in Appendix 7.

Table 4-16 depicts the average *in-situ* water quality results. average temperature values were all considered normal for marine water. Marine water temperatures recorded were expected in a tropical marine area influenced by the Trade Winds (≈27 –30 ^{o}C). Conductivity, salinity and TDS values were all considered normal for marine water. Average dissolved oxygen (D.O.) values at marine locations were all within acceptable levels (>4 mg/l) and above the level that may be considered detrimental to aquatic life (≤ 3 mg/l). The extinction coefficient indicates the rate of loss of light with depth. Stations 8 and 10 showed the greatest loss of light with depth, which would indicate a presence of particles (biological or non-biological) in the water column affecting light penetration. Average pH values were considered normal for seawater and water turbidity remained low for all marine stations, ranging from 0 – 5.42 NTU.

All parameters were compliant for the terrestrial station excluding conductivity and TDS, however the proximity to the sea promotes increased salinity which may account for the increased values.

Table 4-16 Average *in-situ* Water Quality results

Stn	TEMP. °C	COND (mS/cm)	SAL (ppt)	pH	D.O. (mg/l)	Turb (NTU)	TDS (g/l)	EC
MARINE STATIONS								
1	27.56	54.22	35.95	8.07	6.04	0.19	34.71	0.3490
2	27.64	54.03	35.79	8.06	5.32	2.40	34.59	0.2422
3	27.45	54.03	35.81	8.08	6.07	1.16	34.51	0.4239
4	27.59	53.90	35.67	8.04	5.15	0.23	34.46	0.4037
5	27.72	54.01	35.81	8.07	5.73	0.54	34.74	0.6137
6	27.64	53.99	35.76	8.07	5.55	0.47	34.56	0.5041
7	27.76	54.09	35.83	8.06	6.09	0.78	34.57	0.2949
8	27.71	53.94	35.67	8.06	5.70	5.42	34.37	0.6962
10	27.48	53.94	35.88	8.05	4.98	3.00	34.51	0.8985
11	27.60	54.11	35.84	8.09	5.79	1.90	34.62	0.4467

Stn	TEMP. °C	COND (mS/cm)	SAL (ppt)	pH	D.O. (mg/l)	Turb (NTU)	TDS (g/l)	EC
NRCA Marine Water Standards	-	-	-	*8 – 8.4*	-	-	-	-
MANGROVE BRACKISH/FRESHWATER STATIONS								
9	23.98	3.74	2.01	7.61	2.93	21.43	2.39	-
NRCA Ambient Freshwater Standard	-	0.15 – 0.6	-	7 – 8.4	-	-	0.12 – 0.3	-

NB: Values in red are non-compliant with NEPA standards

Table 4-17 shows the average laboratory quality results. BOD and nitrate values at all station sampled were non-compliant with the NRCA standards. Phosphates and Faecal coliform values were non-compliant for most stations sampled however were compliant for the terrestrial station and stations 1 and 11 for faecal coliform. TSS values at most stations sampled mirror the turbidity values and remained low, indicating clear water, however they were elevated at station 9. The nitrate and phosphate nutrient values are considered normal for Jamaican coastal waters and seldom vary outside of this range. Faecal enterococci values varied across the stations ranging from 2.53 MPN/100ml at Station 1 to 1600 MPN/100mL at Station 9. High faecal enterococci levels are due to possible water contamination from wastewater and terrestrial run-off. Petroleum hydrocarbons were detected at Stations 7 (6.8 mg/l C10-C28; and 16 mg/l C28-C40) and 11 (1.7 mg/l C28-C40) only. This may possibly have been due to land run off especially that of Station 11 which is close to the mouth of a gully. Land-based activities such as mechanic/car repair shops and car-washes result in the discharge of oils and lubricants into gullies and waterways which drain into the lagoon.

Table 4-17 Average laboratory Water Quality results

Stn	BOD (mg/l)	TSS (mg/l)	NIT (mg/l)	PHOS (mg/l)	F.COLI (mpn/100ml)	Faecal Enterococci (MPN/100mL)	Total Petroleum Hydrocarbons (mg/L)
MARINE STATIONS							
1	1.51	4.00	2.00	1.99	5.37	2.53	ND
2	1.38	6.00	2.70	0.40	84.70	536.20	ND
3	1.52	5.00	1.67	0.10	28.70	537.60	ND
4	1.35	5.00	1.50	0.09	826.70	53.27	ND
5	1.51	7.67	1.63	0.10	30.37	132.60	ND
6	1.66	5.00	1.73	0.08	1183.37	155.93	ND
7	1.47	5.00	1.53	0.09	51.03	13.93	6.8 (C10-C28); 16 (C28-C40)
8	1.47	5.00	1.47	0.04	347.03	400.00	ND
10	1.39	5.00	1.70	0.13	550.70	96.20	ND
11	1.39	5.33	1.70	0.05	3.33	81.27	1.7 (C28-C40)
NRCA Marine Water Standards	*1.16*	-	*0.007 – 0.014*	*0.001-0.003*	*<2 - 13*	-	
MANGROVE BRACKISH/FRESHWATER STATIONS							
9	5.04	66.67	0.77	0.47	1776.67	1600.00	ND
NRCA Ambient Freshwater Standard	*0.8 – 1.7*	-	*0.1 – 7.5*	*0.01-0.8*	-	-	

NB: Values in red are non-compliant with NEPA standards

ND- None Detected

Temperature

Temperature values varied across the stations ranging from 23.98°C – 27.76°C. Highest temperatures were obtained at Station 7 whereas the lowest was obtained at Station 7, located on land (Figure 4-25). The water temperatures recorded for all marine stations were expected in a tropical marine area influenced by the Trade Winds (27 - 30°C). Station 9, which had a relatively low temperature, was located terrestrially, which lends itself to lower temperatures.

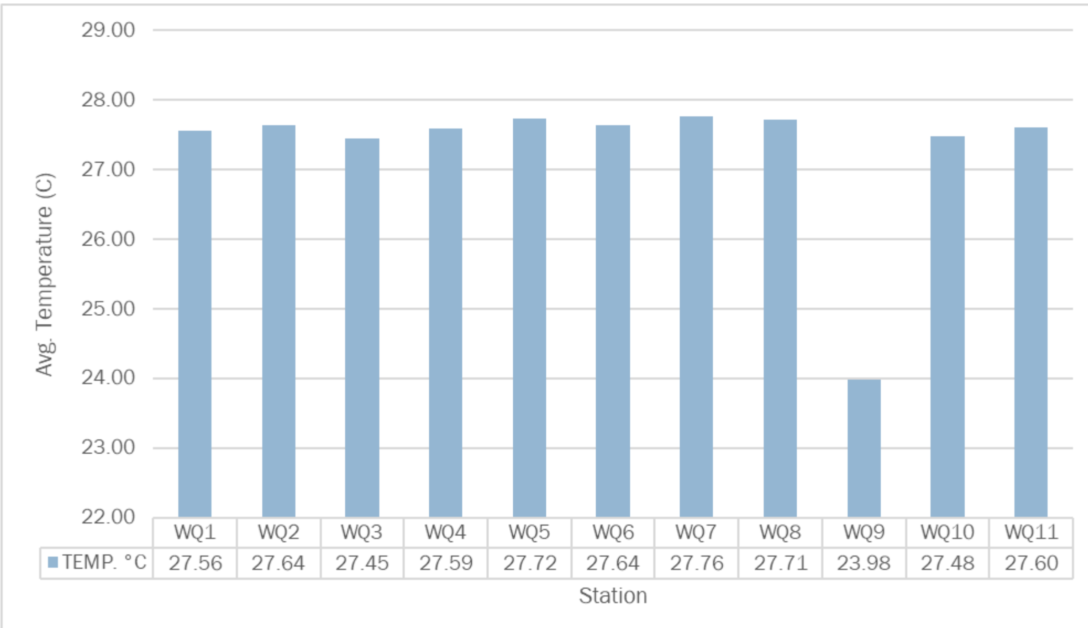


Figure 4-25 Average temperature values for each station

Conductivity (SpC)

Specific conductivity varied across the stations ranging from 3.74 – 54.22 mS/cm. All marine stations had values which were deemed normal for a tropical marine area (Figure 4-26). Station 9 had an average specific conductivity of 3.74, which was expected due to its brackish. terrestrial location.

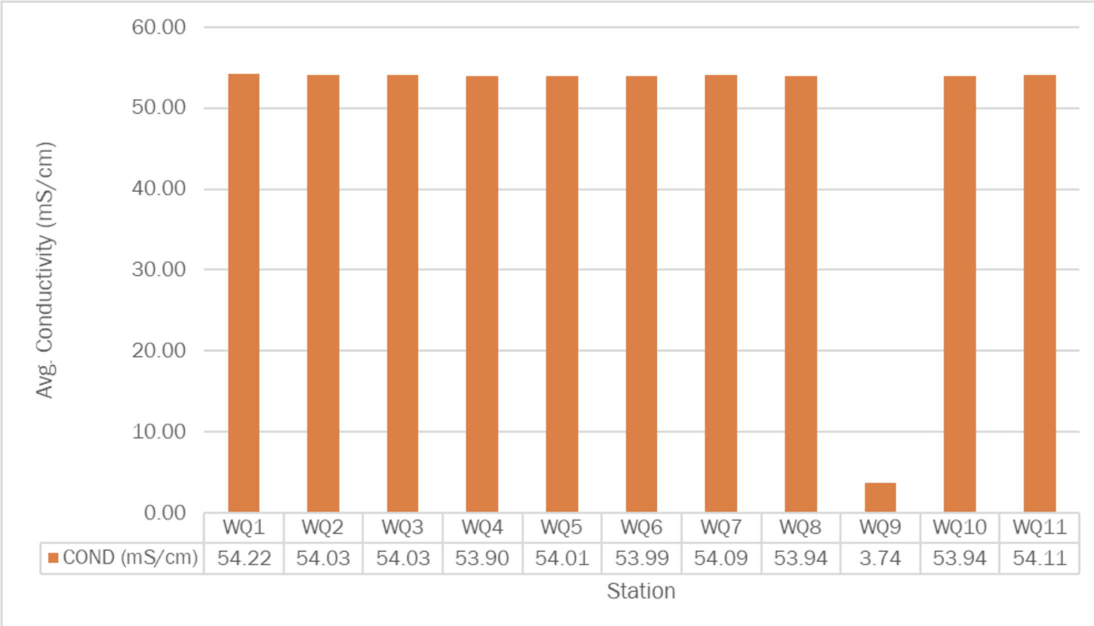


Figure 4-26 Average conductivity values for each station

Salinity

Salinity varied across the stations ranging from 2.01 – 35.95 ppt, all marine stations were deemed normal for a tropical marine area. Station 9 had the lowest salinity, located at a brackish terrestrial location (Figure 4-27).

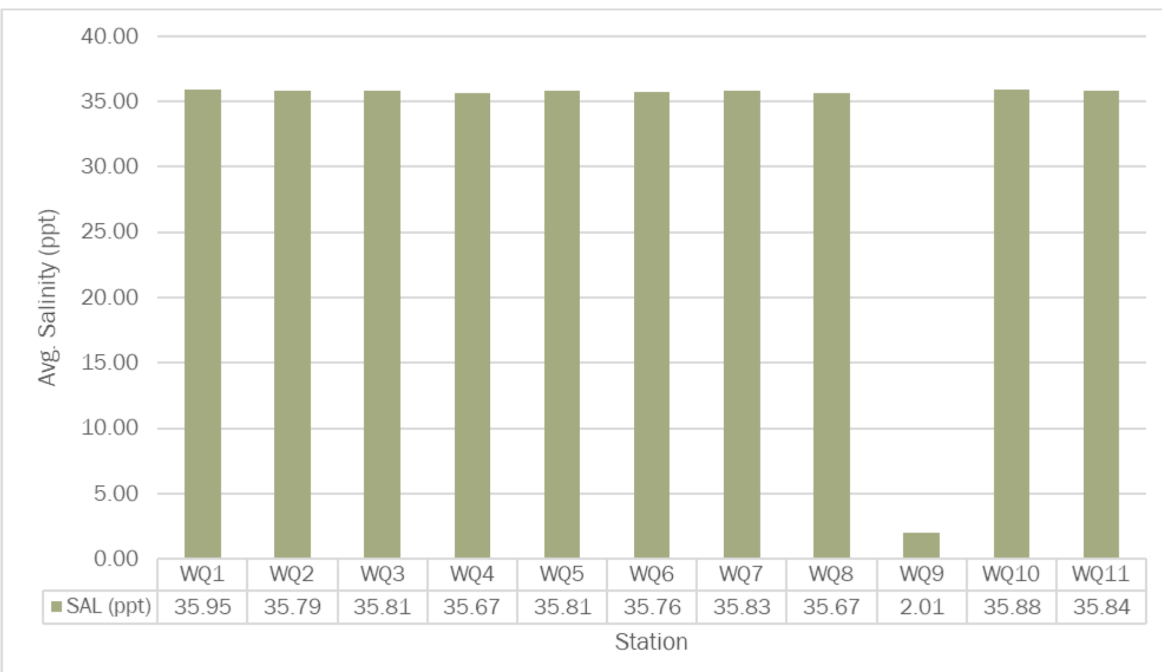
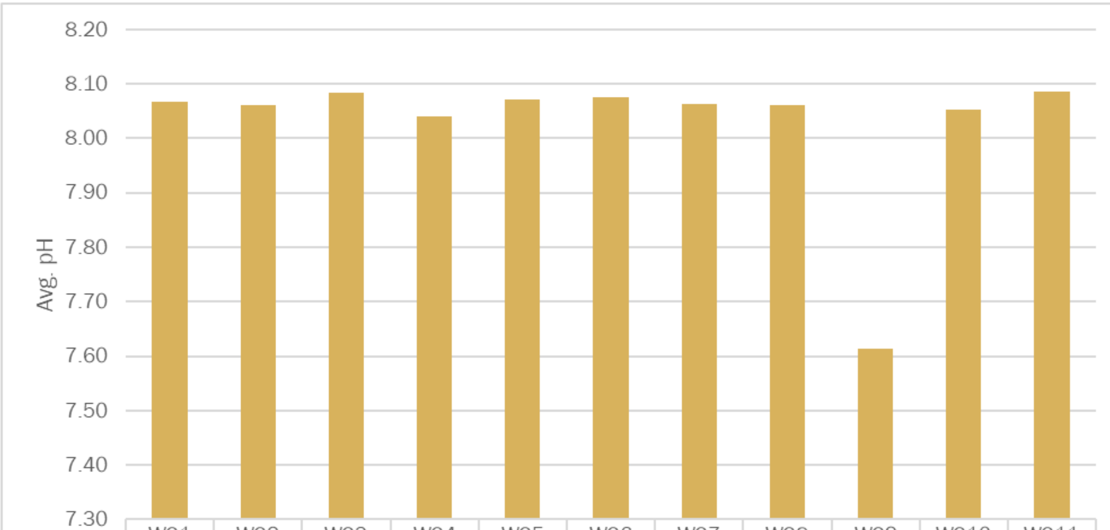


Figure 4-27 Average salinity values for each station

pH

The pH values showed some variation across the stations ranging from 7.61 - 8.09. In marine waters, pH levels tend to range between 8-9 pH units and all marine stations were within the respective NEPA marine standard (8 – 8.4). Higher pH indicates the possibility of photosynthesis changing the pH within the zone. The pH values obtained at Station 9, was lower due to the influence of fresh water, the NRCA ambient freshwater standard is 7.00 – 8.40 (Figure 4-28).

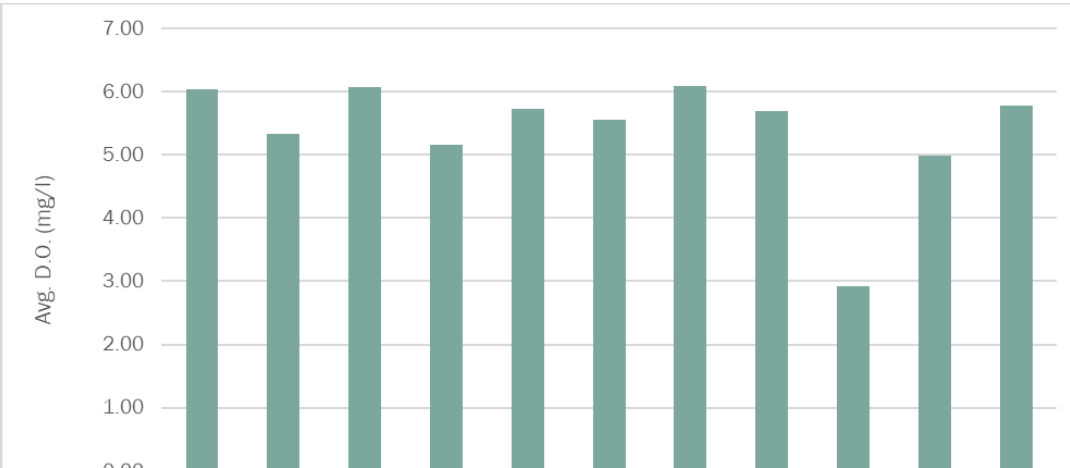


	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11
pH	8.07	8.06	8.08	8.04	8.07	8.07	8.06	8.06	7.61	8.05	8.09

Figure 4-28 Average pH values for each station

Dissolved Oxygen (DO)

Dissolved oxygen is the amount of elemental oxygen dissolved in water. Dissolved oxygen values varied across the stations ranging from 2.93 – 6.09 mg/l. (Figure 4-29). Dissolved oxygen levels at all locations except for Station 9, were within acceptable marine levels (>4.00 mg/l) and above the level that would be considered detrimental to aquatic life (3.00 mg/l). Station 9 had a dissolved oxygen level of 2.93 mg/l, however as it was not a marine station it is not subject to the aforementioned water quality standards.

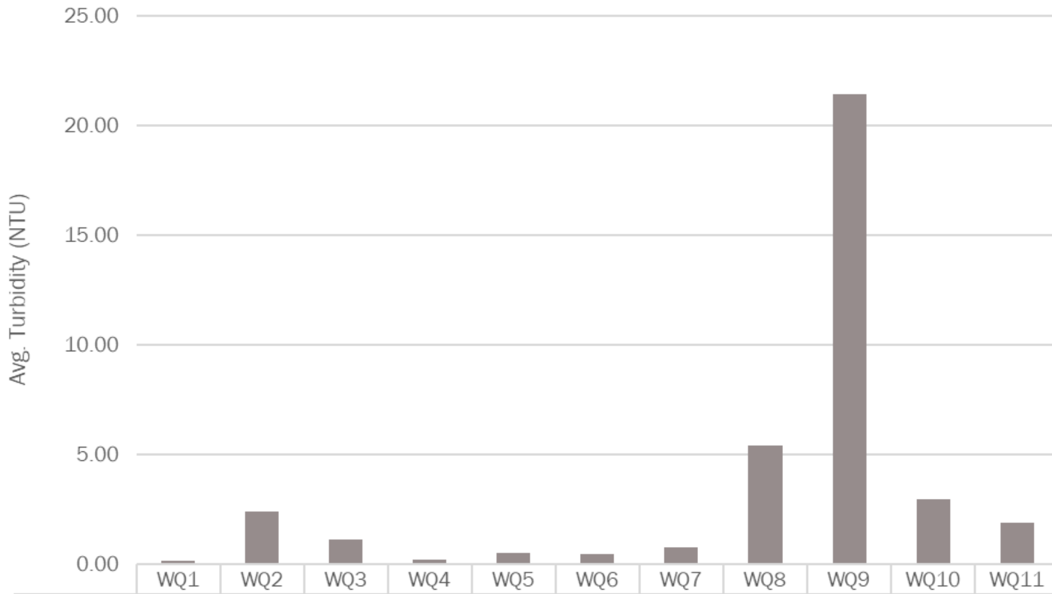


	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11
D.O. (mg/l)	6.04	5.32	6.07	5.15	5.73	5.55	6.09	5.70	2.93	4.98	5.79

Figure 4-29 Average dissolved oxygen values for each station

Turbidity

Turbidity varied across the stations ranging from 0.19 NTU to 21.43 NTU. The lowest turbidity occurred at station 1, while Station 9 had the highest turbidity value (Figure 4-30) this station was terrestrial, visibly turbid and was affected by shallow depth.



	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11
Turb (NTU)	0.19	2.40	1.16	0.23	0.54	0.47	0.78	5.42	21.43	3.00	1.90

Figure 4-30 Average turbidity values for each station

Total Dissolved Solids (TDS)

Total dissolved solids is a representation of the combined inorganic and organic dissolved content in the water, such as minerals and salts. The TDS values varied across the stations ranging from 2.39 – 34.74 g/l. The lowest value was obtained at the terrestrial station 9 (Figure 4-31). Station 9 had a low TDS value due to the influence of freshwater, the other TDS values were normal for seawater.

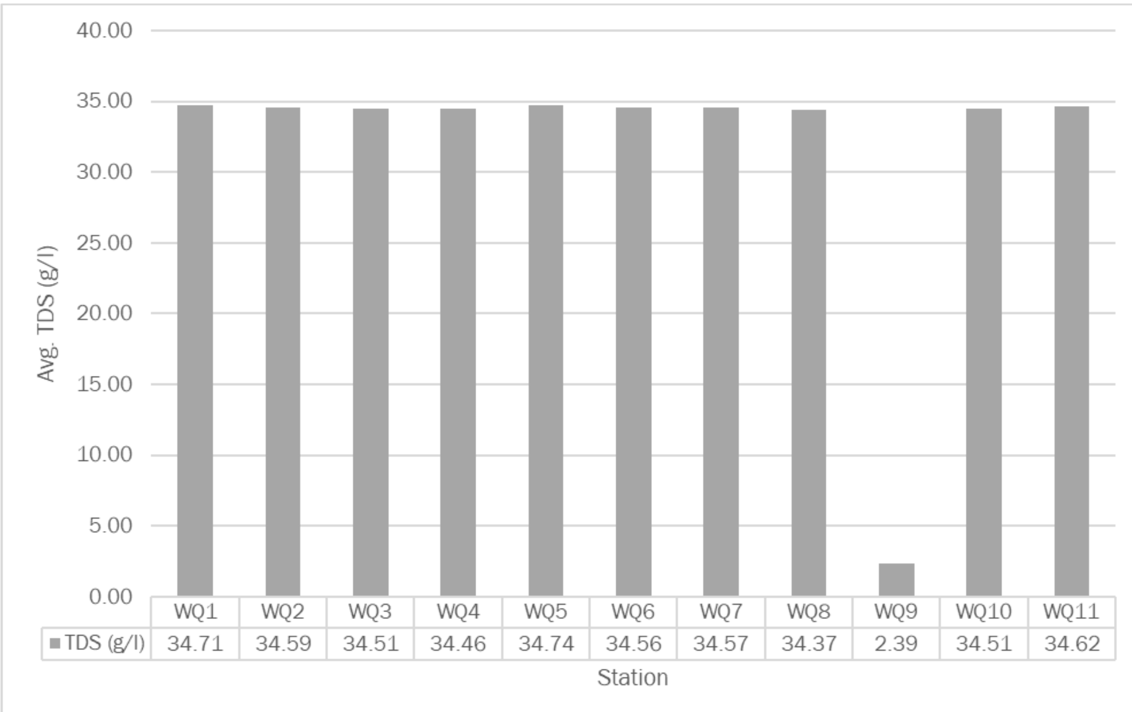


Figure 4-31 Average total dissolved solid values for each station

Extinction Coefficient

Light Extinction Coefficient (EC) refers to measures of light absorption within water or the rate of loss of light with depth. The larger the extinction coefficient the more particles (Biological or Non-Biological) are present within the water column which affect light penetration. EC values varied across the stations ranging from 0.2422 – 0.8985. Station 2 had the lowest EC value whereas the highest value was obtained at Station 10 (Figure 4-32) Stations 5, 8, and 10 showed the greatest loss of light with depth, indicating a greater presence of particles. No extinction coefficient was calculated for station 9, as the depth of the water was too shallow.

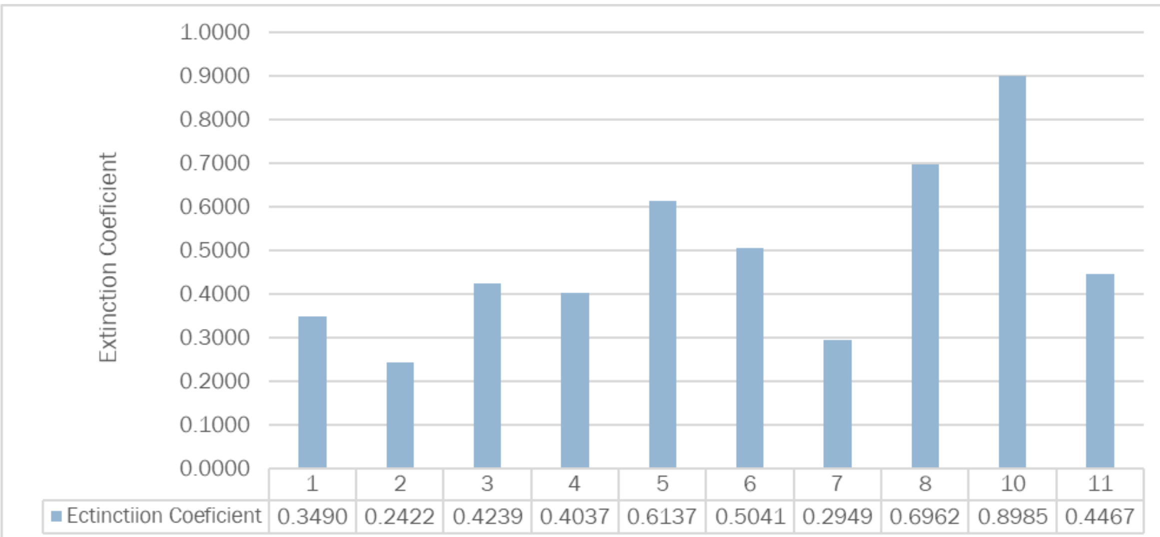
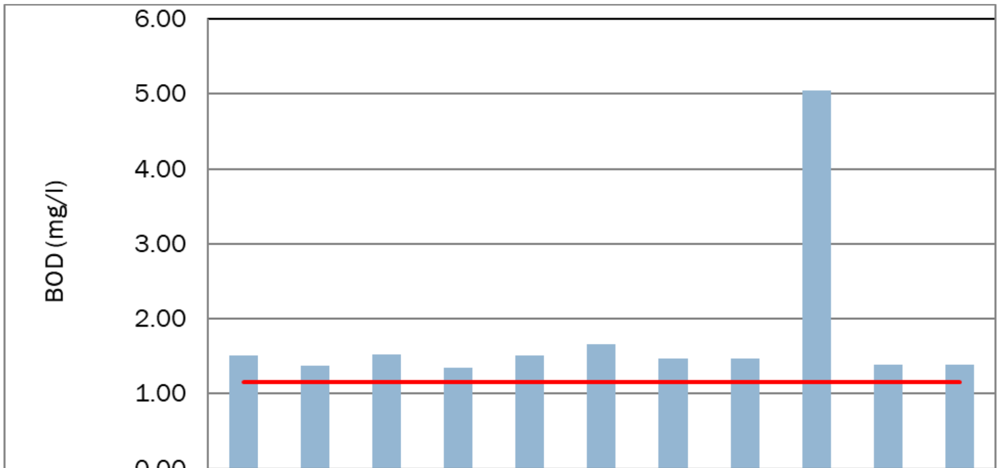


Figure 4-32 Average extinction coefficient values for each station

Biological Oxygen Demand (BOD)

Biological oxygen demand is the amount of dissolved oxygen by aerobic biological organisms to break down present organic material. BOD values varied across the stations ranging from 1.35 – 5.04(mg/l). Station 4 had the lowest BOD value whereas the highest value was obtained at Station 9 (Figure 4-33) BOD values at all station sampled were non-compliant with the NRCA standards however, these nutrient values are considered normal for Jamaican coastal waters and seldom vary outside of this range.



	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11
BOD (mg/l)	1.51	1.38	1.52	1.35	1.51	1.66	1.47	1.47	5.04	1.39	1.39
NEPA Std	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16

Figure 4-33 Average biological oxygen demand values for each station

Total Suspended Solids (TSS)

TSS concentrations indicate water clarity, with clear conditions being below 20mg/l, TSS values varied across the stations ranging from 4.00 – 66.67(mg/l). the marine stations sampled had fairly clear waters with the terrestrial station, station 9 having least clarity with a TSS of 66.67 (Figure 4-34). The higher value at Station 9 was most likely due to its shallow depth.

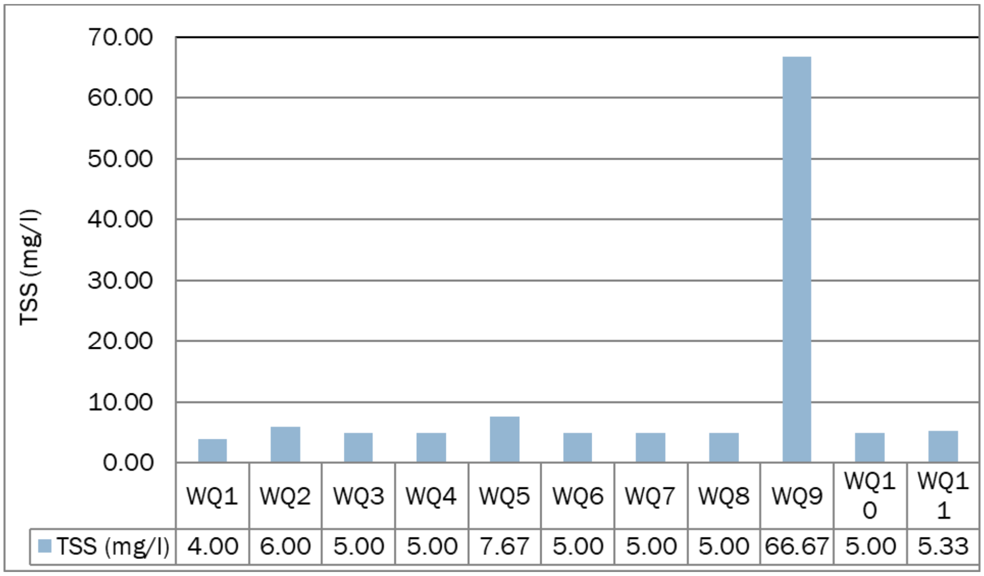
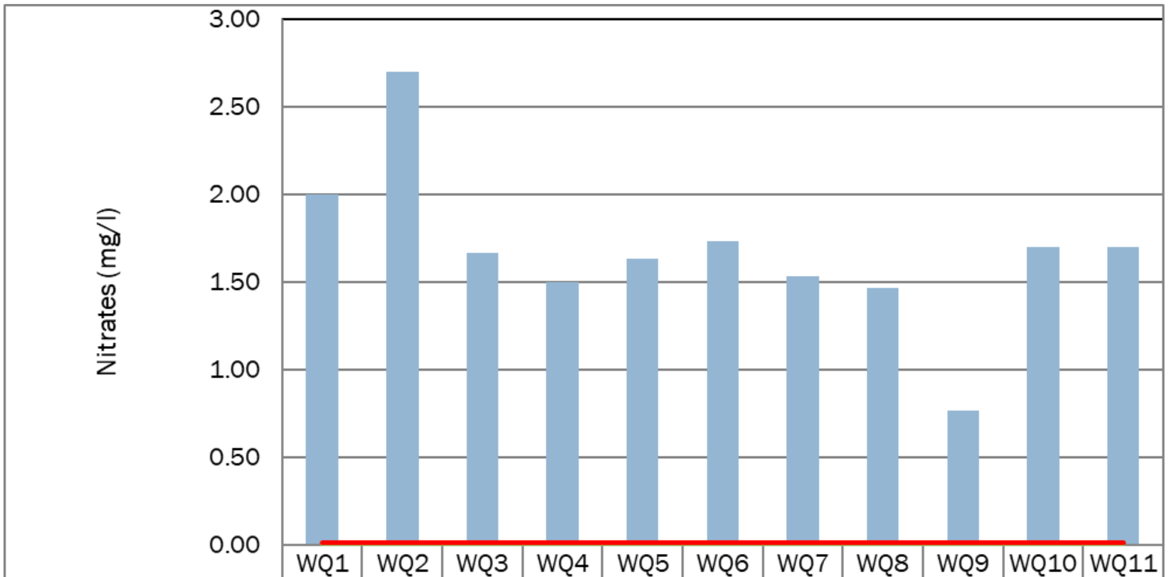


Figure 4-34 Average total suspended solid values for each station

Nitrates

Nitrate values varied across the stations ranging from 0.77 – 2.70 mg/l. All stations were above the NRCA marine standard for Seawater for nitrates. These nitrate values are typical for Jamaican coastal waters and seldom vary outside this range. High nitrate levels are due to water contamination from wastewater or fertilizer. The highest value was at Station 2 (Figure 4-35). Nitrate concentrations were non-compliant with NRCA Marine Water Quality Standards of 0.007 – 0.014 mg/l.

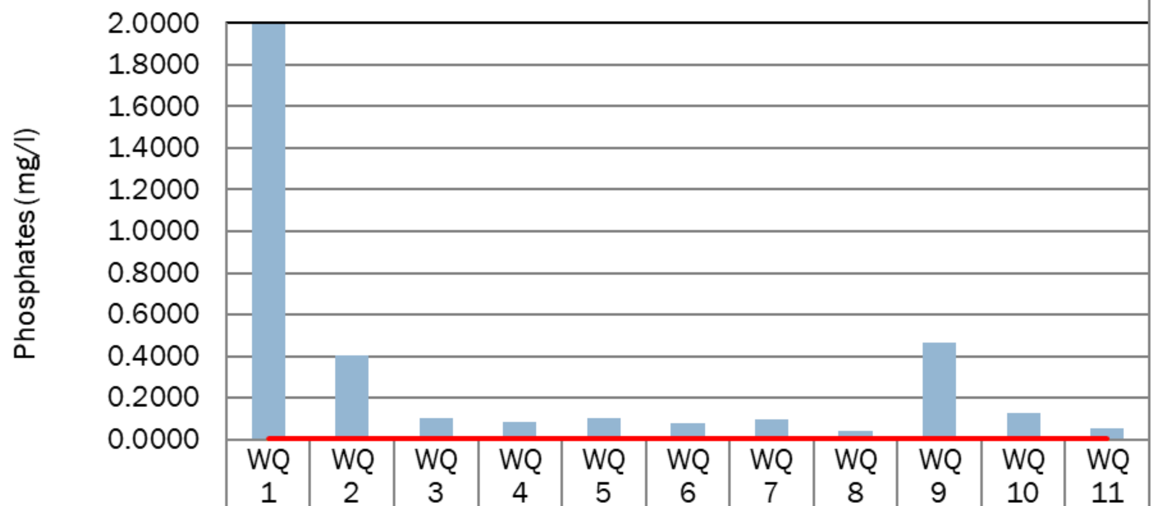


	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11
NIT (mg/l)	2.00	2.70	1.67	1.50	1.63	1.73	1.53	1.47	0.77	1.70	1.70
NEPA std (lower)	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
NEPA std (upper)	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014

Figure 4-35 Average nitrate values for each station

Phosphates

All stations were above the NRCA marine standard for Seawater for phosphates however these phosphate values are typical for Jamaican coastal waters. High phosphate levels are due to water contamination from poor agricultural practices, runoff from urban areas, or discharges from sewage treatment plants. Too much phosphorus can cause increased growth of algae and large aquatic plants, which can result in decreased levels of dissolved oxygen leading to eutrophication. Phosphate concentrations were non-compliant with NEPA Marine Water Quality Standards of 0.001-0.003 mg/l with phosphate values ranging from 0.0433 – 1.9933 mg/l (Figure 4-36).

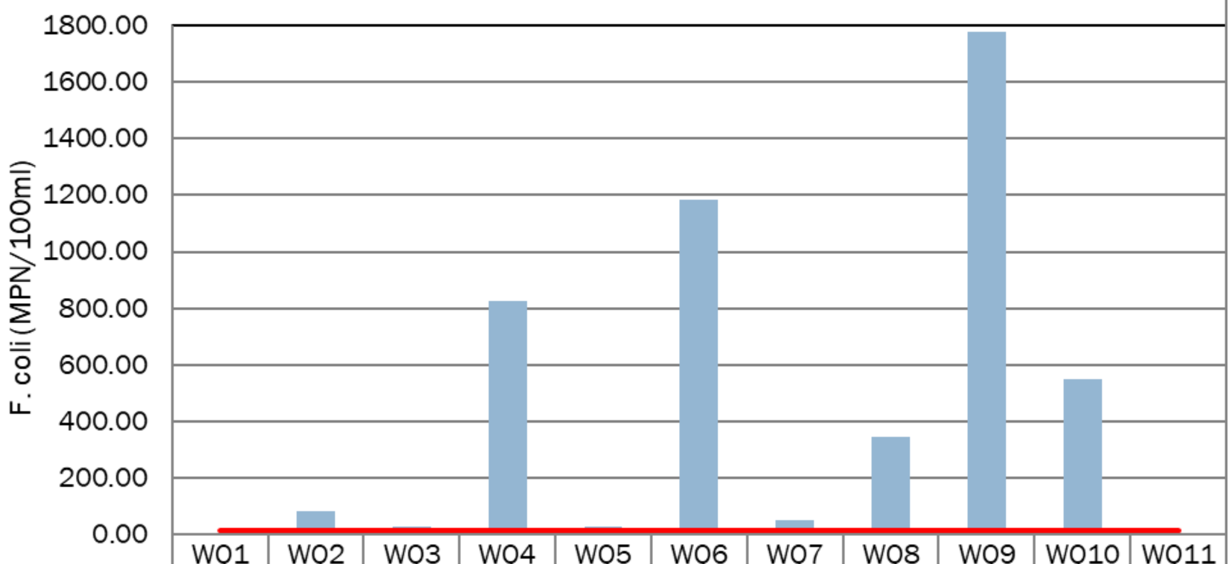


	WQ 1	WQ 2	WQ 3	WQ 4	WQ 5	WQ 6	WQ 7	WQ 8	WQ 9	WQ 10	WQ 11
PHOS (mg/l)	1.99	0.40	0.10	0.08	0.10	0.07	0.09	0.04	0.46	0.13	0.05
NEPA std (lower)	0	0	0	0	0	0	0	0	0	0	0
NEPA std (upper)	0	0	0	0	0	0	0	0	0	0	0

Figure 4-36 Average phosphate values for each station

Faecal Coliform

Faecal Coliform values varied across the stations ranging from 3.33 – 1776.67(MPN/100mL). All stations except for stations 1 and 11 were above the NRCA marine standard for Seawater for faecal coliform of <2 – 13(MPN/100mL). The highest value was at Station 9 (Figure 4-37). High faecal coliform levels are due to water contamination from wastewater and terrestrial run off.

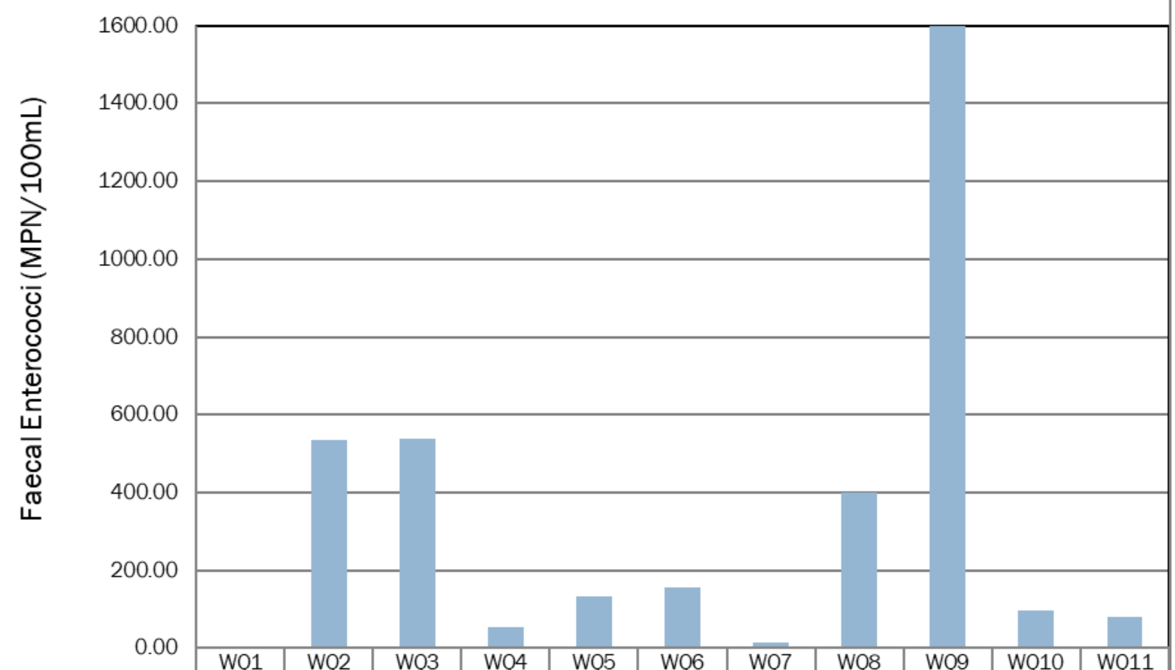


	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11
F.Coli	5.37	84.70	28.70	826.70	30.37	1183.3	51.03	347.03	1776.6	550.70	3.33
Series3	13	13	13	13	13	13	13	13	13	13	13

Figure 4-37 Average faecal coliform values for each station

Faecal Enterococci

Enterococci are indicators of the presence of faecal material in water and, therefore, of the possible presence of disease-causing bacteria, viruses, and protozoa. Faecal enterococci values varied across the stations ranging from 2.53 – 1600(MPN/100mL). The highest value was at Station 9 (Figure 4-38). High faecal enterococci levels are due to water contamination from wastewater and terrestrial run off.



	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11
F.Enterococci (MPN/100mL)	2.53	536.20	537.60	53.27	132.60	155.93	13.93	400.00	1600.00	96.20	81.27

Figure 4-38 Average faecal enterococci values for each station

4.1.11 Marine Benthic Sediments

4.1.11.1 Sediment Sample Analysis

Methodology

Six (6) sediment samples were taken using a sediment grab sampler on February 3, 2022 and analysed for the heavy metals (Pb - lead, As - Arsenic, Cd - Cadmium, Hg - Mercury) and Total Petroleum Hydrocarbons - Petroleum Ranges C8-C40, C8-C10 (gasoline), C10-C28 (diesel) and C28-C40 (oil). The sediment sampling locations are shown in Table 4-18 and depicted in Figure 4-39. The samples were stored on ice in a cooler and transported to Test America Pensacola Laboratory in Florida for analyses.

Table 4-18 Marine benthic sediment sampling locations (JAD2001)

STATION #	LOCATION (JAD2001)	
	EASTINGS	NORTHINGS
ST1	650197.98329	699613.546608
ST2	650313.539984	699764.608611
ST3	650384.514913	699883.422148
ST4	650598.827841	699645.296672
ST5	650578.984052	699827.859537
ST6	651216.63116	699429.39624

Results

Arsenic values ranged from a low of 4.4 mg/kg at Station ST3 to a high of 7.7 mg/kg at Station ST6, while lead values ranged from a low of 3.0 mg/kg at Station ST4 to a high of 10 mg/kg at Station ST1 (Table 4-19). No arsenic was detected at Stations ST4 and ST5. Mercury was detected at Station ST2 (0.047 mg/kg) and Station ST6 (0.091 mg/kg) only. No or petroleum hydrocarbons were detected in any of the samples taken. When these metal concentrations were compared to the average levels found in Jamaican soil (Table 4-20), all current values were below the reported average for each metal.

Table 4-19 Marine benthic sediment values

STATION	Arsenic (mg/kg)	Cadmium (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	TPH C8-C40 (mg/kg)	TPH C8-C10 (mg/kg)	TPH C10-C28 (mg/kg)	TPH C28-C40 (mg/kg)
ST1	5.9	ND	10.0	ND	ND	ND	ND	ND
ST2	6.2	ND	5.2	0.047	ND	ND	ND	ND
ST3	4.4	ND	5.8	ND	ND	ND	ND	ND
ST4	ND	ND	3.0	ND	ND	ND	ND	ND
ST5	ND	ND	6.1	ND	ND	ND	ND	ND
ST6	7.7	ND	9.0	0.091	ND	ND	ND	ND

ND – None Detected

Table 4-20 Metal Concentrations in Jamaican Soil

Metal	Avg. Concentration (mg/KG)	Range (mg/Kg)	95th Percentile (mg/KG)
Arsenic	25	1.4-203	<64.9
Cadmium	20	0.2-409	<77.6
Lead	46.5	6-897	<90
Mercury	0.2	0.04-0.83	<0.46

Source: A geochemical atlas of Jamaica, Centre for Nuclear Sciences, UWI, 1995, Canoe Press.

Figure 4-39 Map showing sediment trap and benthic sediment sampling locations

4.1.11.2 Marine Sedimentation Rate

Methodology

Baseline sedimentation data were collected using sediment traps. The sediment trap dimensions were approximately 21.4” (54.3 cm) long with an internal diameter of 3” (7.6 cm) (Plate 4-1 shows an example of the sediment trap used). A total of six (6) sediment traps were deployed in and around the project area (Table 4-18, Figure 4-39). The traps were deployed on March 3, 2022, and retrieved on April 7, 2022, for a total of 35 days. Sediment Trap Station ST4 could not be located on April 7th during the retrieval; data for this station is therefore unavailable.

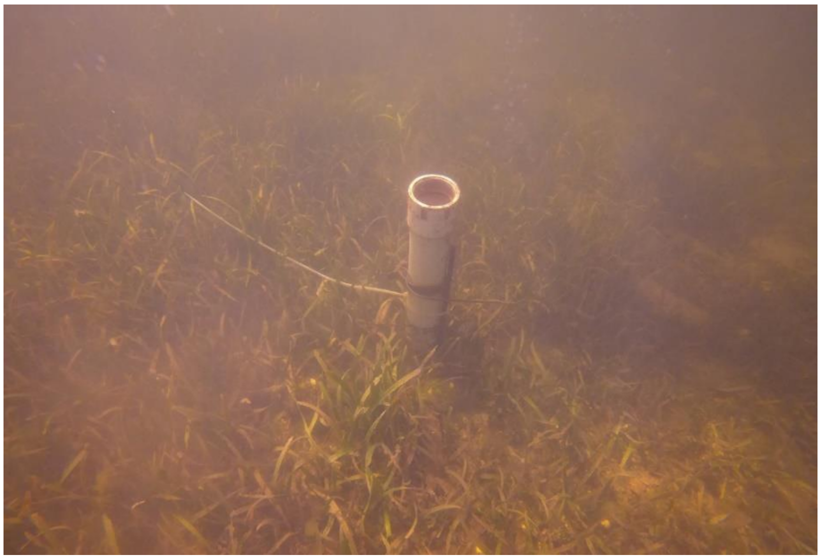


Plate 4-1 An example of the Sediment Trap deployed

Sediment traps were taken to the Caribbean Environmental Testing and Monitoring Services Limited for analysis. The contents of the sediment traps were filtered through a filter paper, dried, and then weighed. The results are represented in the form of “Mass of Sediment Recovered”. Using the results retrieved from the laboratory, the sedimentation rate per day ($mg/cm^2/day$) was calculated by dividing the mass of sediment recovered by the number of days deployed and the area of the sediment trap opening.

$$\textbf{\textit{Sedimentation Rate per day}} = \frac{\textit{Mass of Sediment Recovered}}{(\textit{\# of days deployed}) \times (\textit{area of trap opening})}$$

Results

Sedimentation rates ranged from a low of 0.006 $mg/cm^2/day$ at Station ST3, to a high of 0.044 $mg/cm^2/day$ at Station ST6 (

Table 4-21). The highest sedimentation rate was observed at Station ST6. Station ST6 is located approximately 600 metres east of the project site.

Table 4-21 Sedimentation Rates at each Location

Sediment Trap Locations	Mass of Sediment Recovered (mg)	Area of trap opening (cm^2)	Deployment date	Retrieval date	# of days deployed	Sedimentation Rate ($mg/cm^2/day$)
ST1	16.0	45.61	3.3.2022	7.4.2022	35	**0.010**
ST2	42.0	45.61	3.3.2022	7.4.2022	35	**0.026**
ST3	11.0	45.61	3.3.2022	7.4.2022	35	**0.006**
ST4	N/A	N/A	N/A	N/A	N/A	N/A
ST5	12.0	45.61	3.3.2022	7.4.2022	35	**0.007**
ST6	70.0	45.61	3.3.2022	7.4.2022	35	**0.044**

Comparison with other location

Marine sedimentation rates were reported for the Environmental Impact Assessment for the Princess Hotels and Resorts Development at Cove, Hanover (C.L. Environmental Co. Ltd., 2020). Sedimentation rates for stations in similar areas (shallow depth and in sheltered bay areas with some land run-off) ranged from a low of 0.01 $mg/cm^2/day$ to a high of 0.047 $mg/cm^2/day$ which is similar to results obtained for this project area.

4.1.12 Noise

4.1.12.1 Methodology

Noise level readings were taken from 12:00am Monday January 10^{th}, 2022 to 12:00am Thursday January 13^{th}, 2022, by using Brüel & Kjaer noise analysers setup in outdoor monitoring kits. The octave band analysis was conducted concurrently with the noise level measurements. Measurements were taken in the third octave which provided thirty-three (33) octave bands from 12.5 Hz to 20 kHz (low, medium and high frequency bands).

The noise meters were calibrated pre-and post-noise assessment by using a Brüel & Kjaer Type 4231 sound calibrator (Appendix 8). The meters were programmed to collect third octave, average sound level (Leq) over the period, Lmin (The lowest level measured during the assessment) and Lmax (The highest level measured during the assessment) every ten seconds. Seven (7) noise meters with outdoor monitoring kits were setup.

Table 4-22 and Figure 4-40 lists and shows the locations of the noise monitoring stations. These meters were left for the entire seventy-two (72) hour assessment period in an outdoor measuring system and programmed to collect data every 10 seconds. A windscreen (sponge) was placed over the microphone to prevent measurement errors due to noise caused by wind blowing across the microphone. The microphone of the meters was at a height of approximately 1.5m above ground. There were no vertical reflecting surfaces within 3 m (10 feet) of the microphone. Noise statistics (L_{10} and L_{90}) were also calculated at each location.

Table 4-22 Noise and particulate monitoring location coordinates (JAD2001)

STATION #	LOCATION (JAD2001)	
	NORTHINGS	NORTHINGS
N1P1	650500.502815	699357.900803
N2P2	650394.669270	699580.151247
N3P3	650416.497439	699756.099516
N4P4	650573.924837	699560.307458
N5P5	650104.553065	699509.771940
N6P6	650258.540873	699262.121445
N7P7	650880.048366	698994.627160

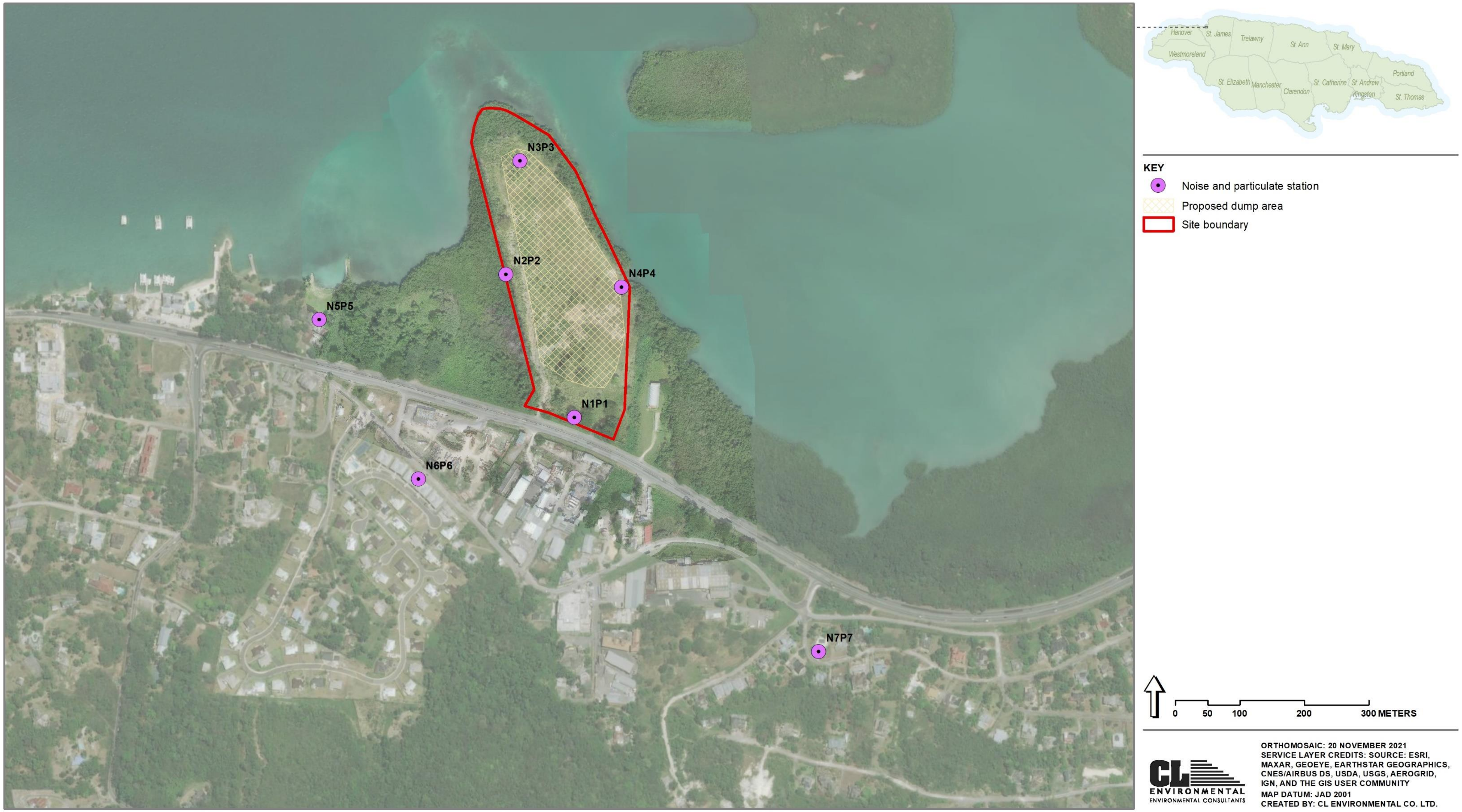


Figure 4-40 Location of noise and particulate monitoring stations

4.1.12.2 Results

Table 4-23 shows the minimum, maximum and average noise levels over the 72-hour assessment period, as well as the geometric mean centre frequencies obtained at each station.

Table 4-23 Ambient Noise data at all stations

Stn.#	Average Leq (72 hr)	Min (dBA)	Max (dBA)	Geometric Centre Frequency (Hz)	Octave Band Range (Hz)
N1	62.0	33.9	92.0	25, 63	22-28, 56-71
N2	55.3	31.4	86.8	63	56-71
N3	56.6	32.7	87.0	63	56-71
N4	51.4	33.4	82.1	63	56-71
N5	60.2	30.5	85.1	50, 63	45-56, 56-71
N6	67.8	35.5	97.0	63	56-71
N7	60.1	35.6	87.0	31.5, 63	28-35, 56-71

STATION 1

During the 72-hour period, noise levels at this station ranged from a low (Lmin) of 33.9 dBA to a high (Lmax) of 92.0 dBA. Average noise level for this period was 62.0 L_{Aeq} (72h). The fluctuation in noise levels over the 72-hour period is depicted in Figure 4-41.

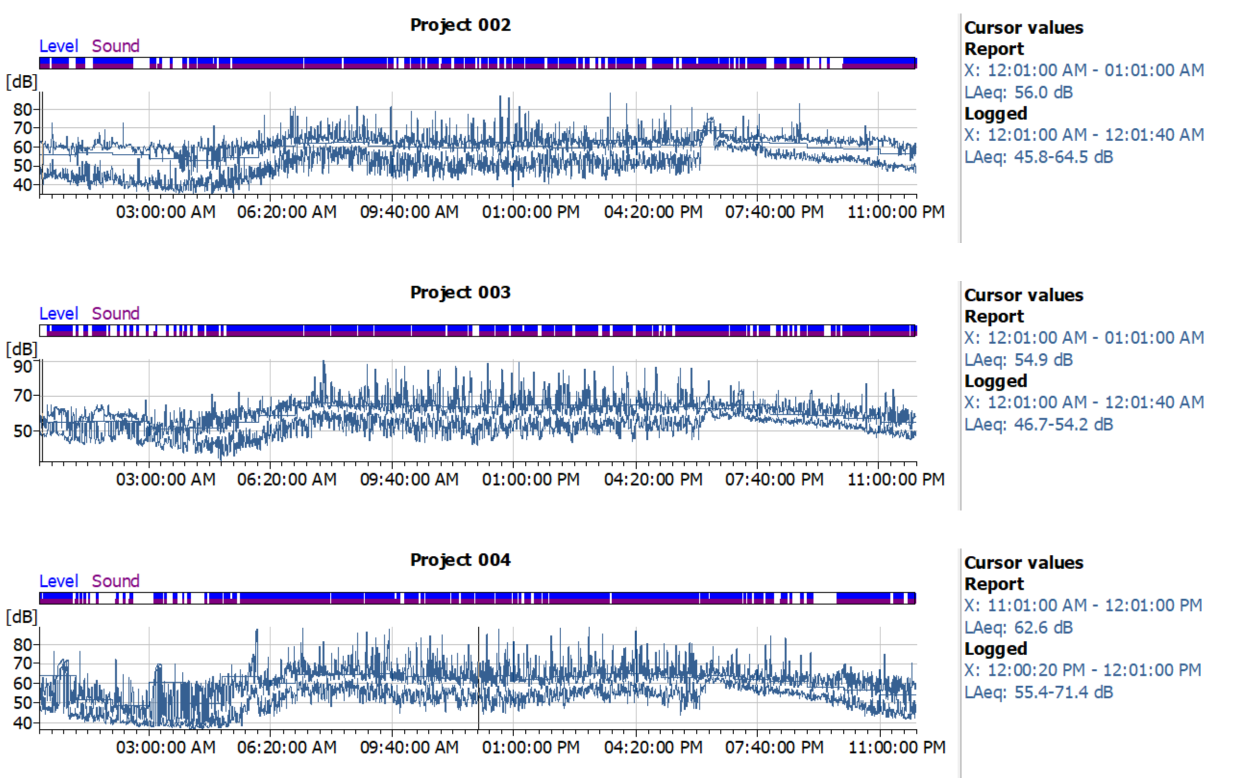


Figure 4-41 Noise fluctuation (Leq) over 72 hours at Station 1 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

OCTAVE BAND ANALYSIS AT STATION 1

The noise at this station during the 72-hour period was in the low frequency band with a dominant geometric mean frequency of 25 Hz and 63 Hz (octave frequency range is 22 - 28 Hz and 56 – 71 Hz respectively) (Figure 4-42).

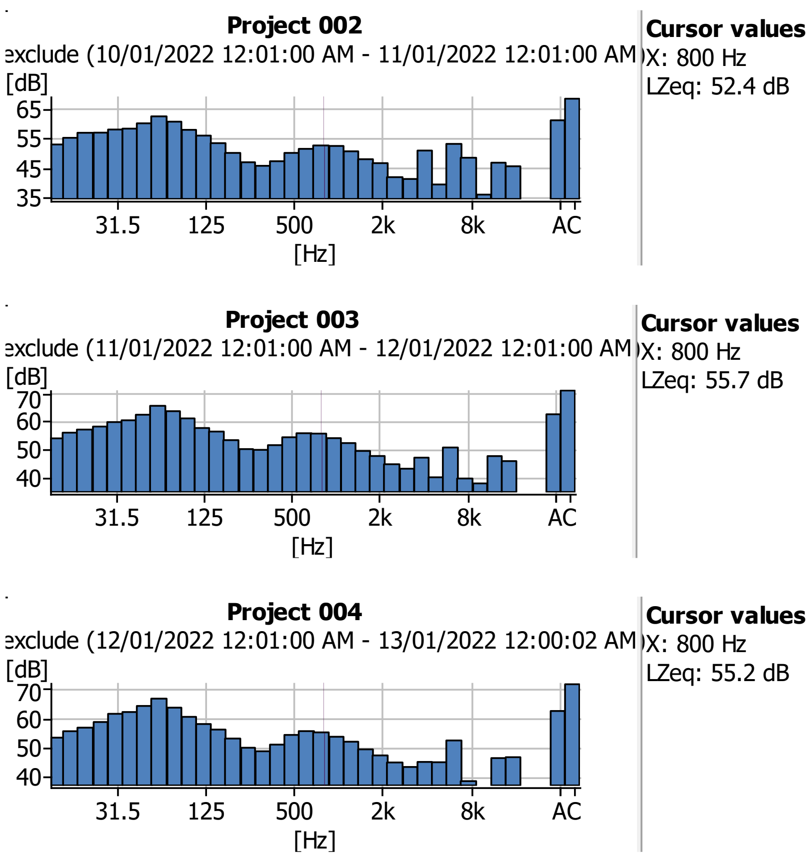


Figure 4-42 Octave band spectrum of noise at Station 1 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

L10 AND L90

The two most common **L_n** values used are **L_{10}** and **L_{90}** and these are sometimes called the 'annoyance level' and 'background level' respectively. **L_{10}** is almost the only statistical value used for the descriptor of the higher levels, but **L_{90}**, is widely used to describe the ambient or background level. L10-L90 is often used to give a quantitative measure as to the spread or "how choppy" the sound was.

L10 is the noise level exceeded for 10% of the time of the measurement duration. This is often used to give an indication of the upper limit of fluctuating noise, such as that from road traffic. L90 is the noise level exceeded for 90% of the time of the measurement duration.

The difference between L10 and L90 gives an indication of the noise climate. When the difference is < 5 dBA then it is considered that there are no significant fluctuations in the noise climate, moderate fluctuations 5-15 dBA and large fluctuations >15 dBA.

The overall L10 and L90 at this station for the time assessed were 63.2 dBA and 48.6 dBA respectively.

STATION 2

During the 72-hour period, noise levels at this station ranged from a low (Lmin) of 31.4 dBA to a high (Lmax) of 86.8 dBA. Average noise level for this period was 55.3 L_{Aeq} (72h). The fluctuation in noise levels over the 72-hour period is depicted in Figure 4-43.

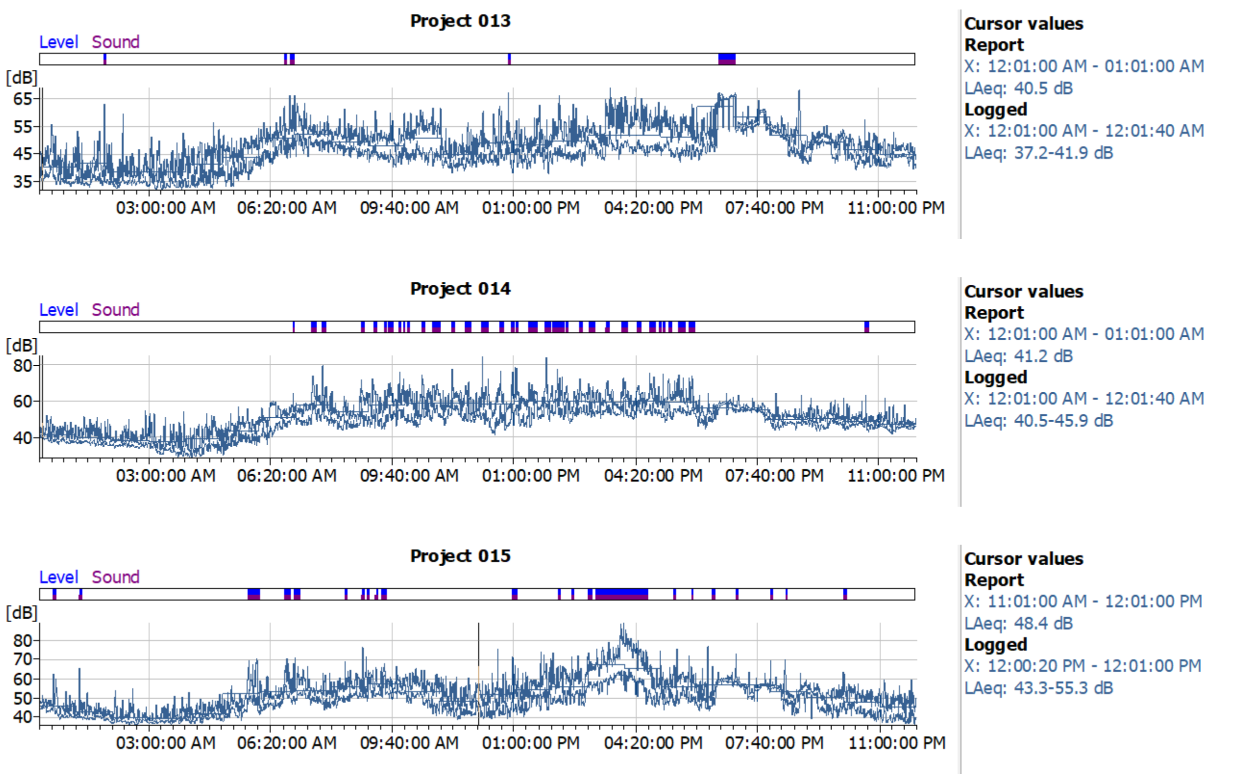


Figure 4-43 Noise fluctuation (Leq) over 72 hours at Station 2 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

OCTAVE BAND ANALYSIS AT STATION 2

The noise at this station during the 72-hour period was in the low frequency band with a dominant geometric mean frequency of 63 Hz (octave frequency range is 56 - 71 Hz) (Figure 4-44).

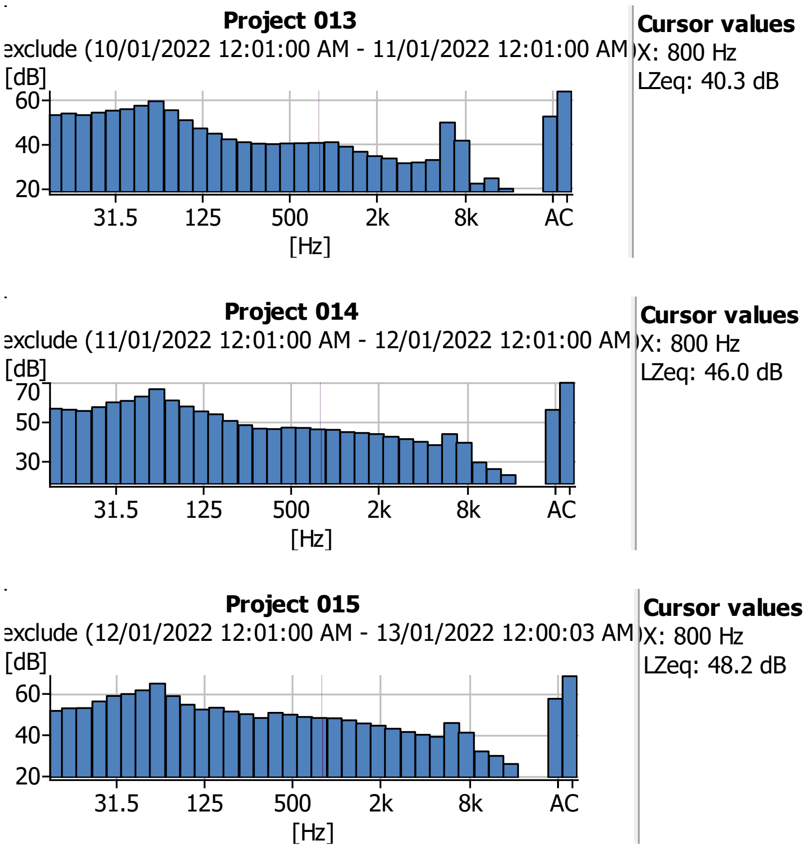


Figure 4-44 Octave band spectrum of noise at Station 2 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

L10 AND L90

The overall L10 and L 90 at this station for the time assessed were 59.5 dBA and 37.1 dBA respectively.

STATION 3

During the 72-hour period, noise levels at this station ranged from a low (Lmin) of 32.7 dBA to a high (Lmax) of 87.0 dBA. Average noise level for this period was 56.7 L_{Aeq} (72h). The fluctuation in noise levels over the 72-hour period is depicted in Figure 4-45.

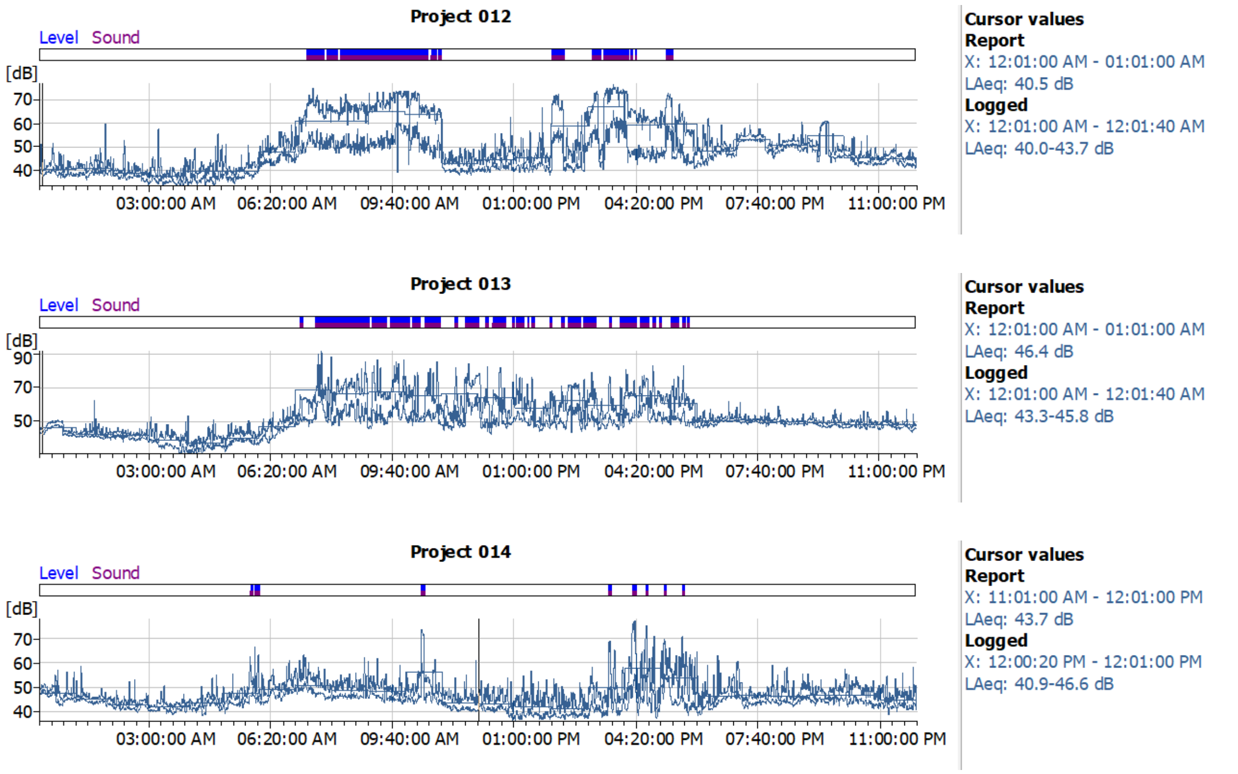


Figure 4-45 Noise fluctuation (Leq) over 72 hours at Station 3 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

OCTAVE BAND ANALYSIS AT STATION 3

The noise at this station during the 72-hour period was in the low frequency band centred around the geometric mean frequency of 63 Hz. (octave frequency range is 56 - 71 Hz) (Figure 4-46).

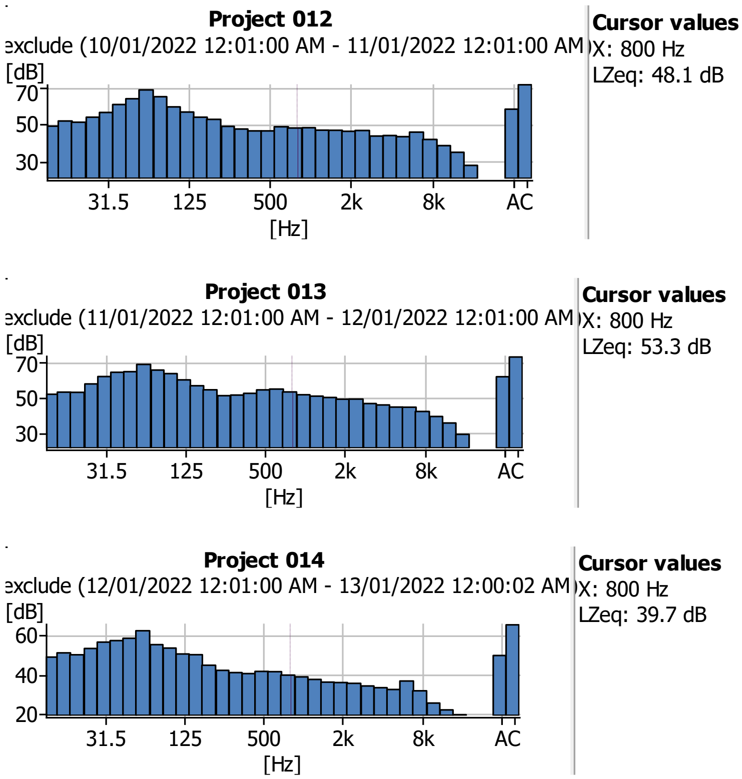


Figure 4-46 Octave band spectrum of noise at Station 3 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

L10 AND L90

The overall L10 and L90 at this station for the time assessed were 62.2 dBA and 38.4 dBA respectively.

STATION 4

During the 72-hour period, noise levels at this station ranged from a low (Lmin) of 33.4 dBA to a high (Lmax) of 82.1 dBA. Average noise level for this period was 51.4 L_{Aeq} (72h). The fluctuation in noise levels over the 72-hour period is depicted in Figure 4-47.

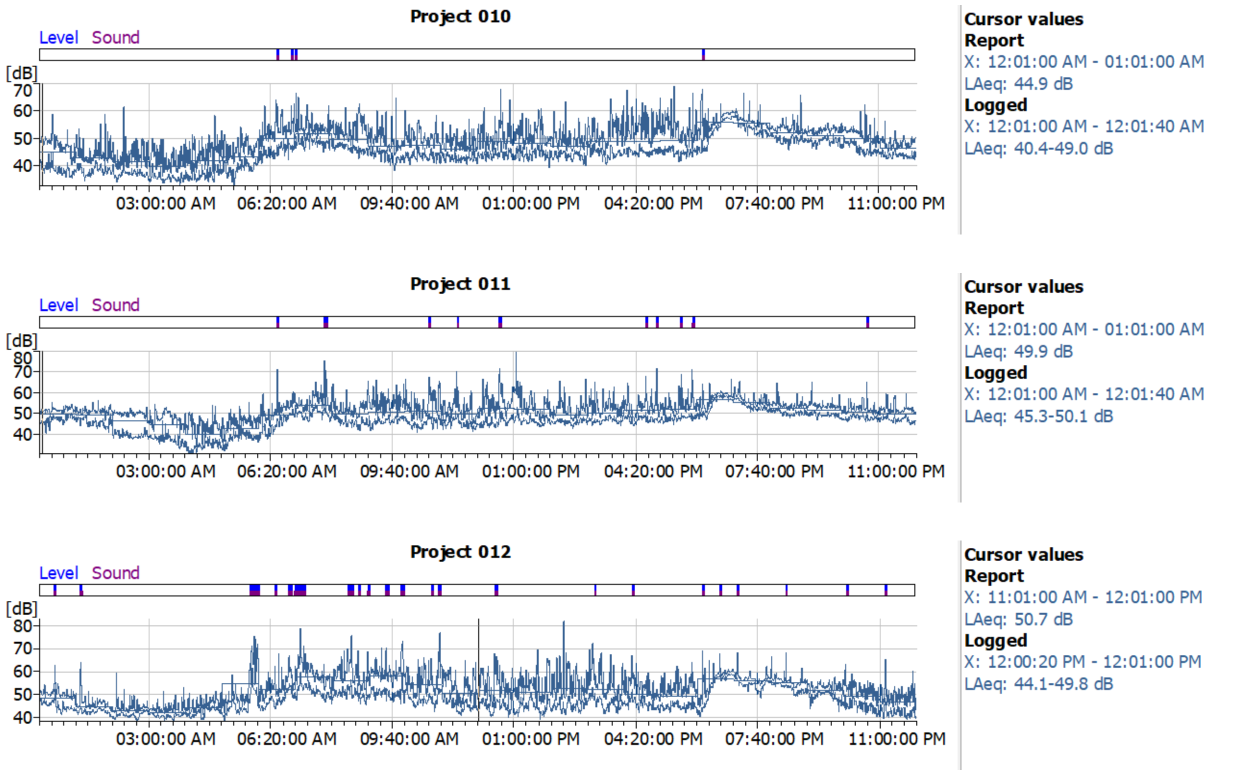


Figure 4-47 Noise fluctuation (Leq) over 72 hours at Station 4 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

OCTAVE BAND ANALYSIS AT STATION 4

The noise at this station during the 72-hour period was in the low frequency band with a dominant geometric mean frequency of 63 Hz. (octave frequency range is 56 - 71 Hz) (Figure 4-48).

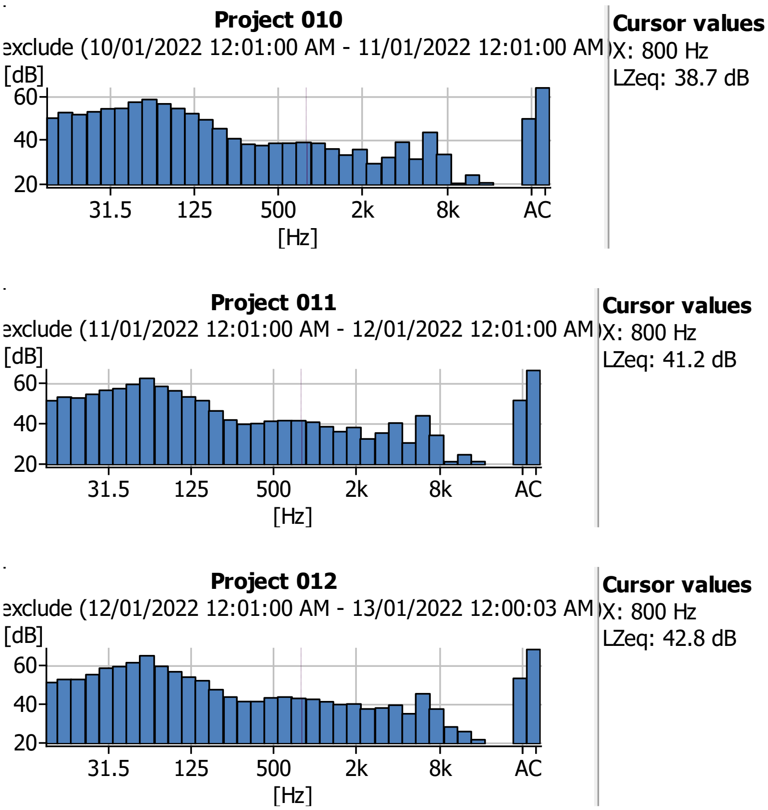


Figure 4-48 Octave band spectrum of noise at Station 4 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

L10 AND L90

The overall L10 and L 90 at this station for the time assessed were 53.9 dBA and 42.5 dBA respectively.

STATION 5

During the 72-hour period, noise levels at this station ranged from a low (Lmin) of 30.5 dBA to a high (Lmax) of 85.1 dBA. Average noise level for this period was 60.2 L_{Aeq} (72h). The fluctuation in noise levels over the 72-hour period is depicted in Figure 4-49.

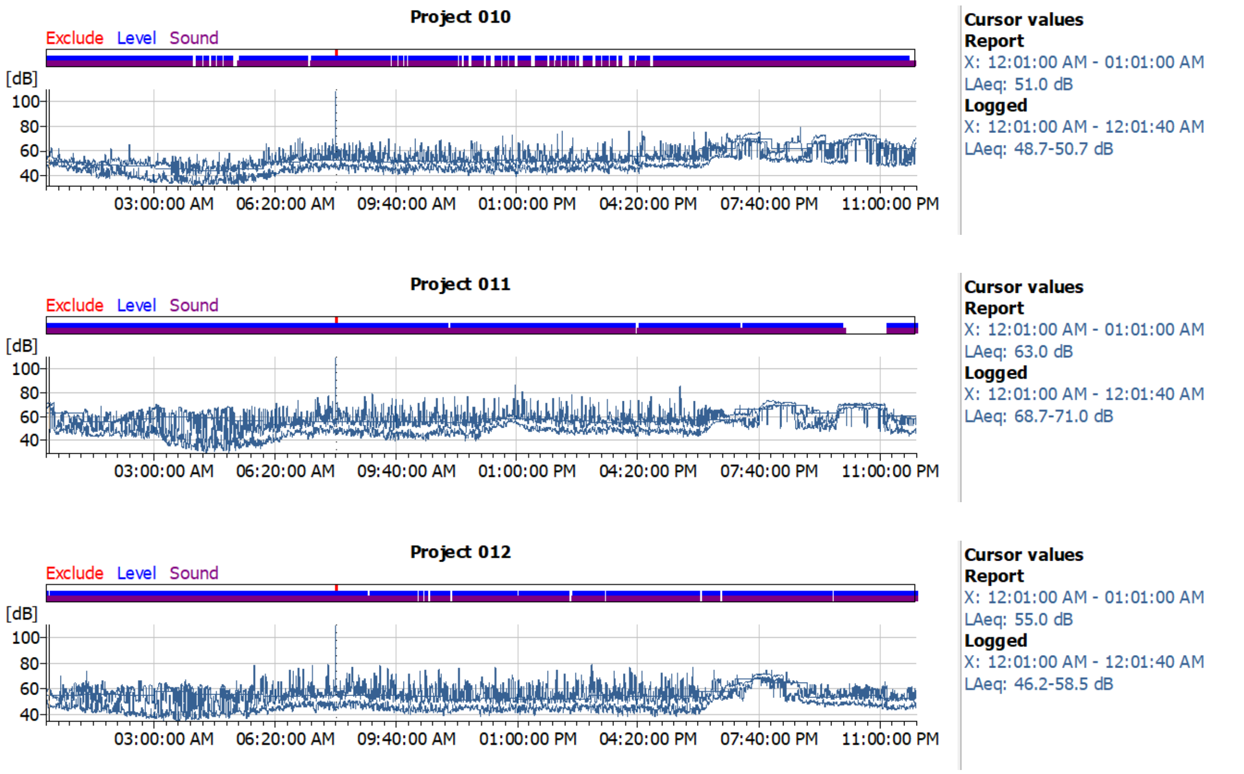


Figure 4-49 Noise fluctuation (Leq) over 72 hours at Station 5 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

OCTAVE BAND ANALYSIS AT STATION 5

The noise at this station during the 72-hour period was in the low frequency band centred around the geometric mean frequency of 50 Hz and 63 Hz (octave frequency range is 45 - 56 Hz and 56 – 71 Hz respectively) (Figure 4-50).

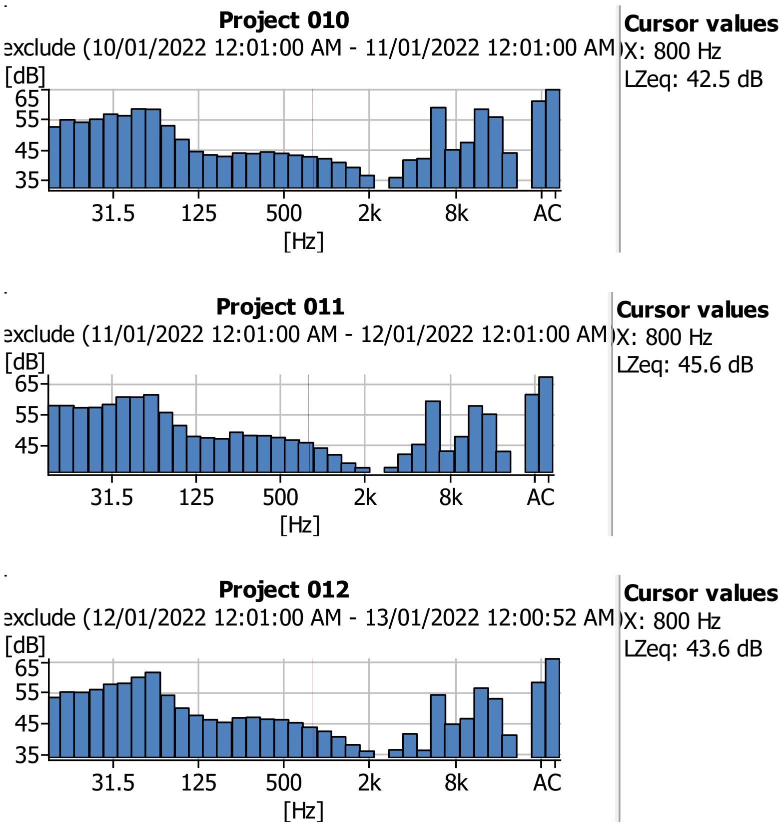


Figure 4-50 Octave band spectrum of noise at Station 5 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

L10 AND L90

The overall L10 and L90 at this station for the time assessed were 66.0 dBA and 42.6 dBA respectively.

STATION 6

During the 72-hour period, noise levels at this station ranged from a low (Lmin) of 35.5 dBA to a high (Lmax) of 97.0 dBA. Average noise level for this period was 67.8 L_{Aeq} (72h). The fluctuation in noise levels over the 72-hour period is depicted in Figure 4-51.

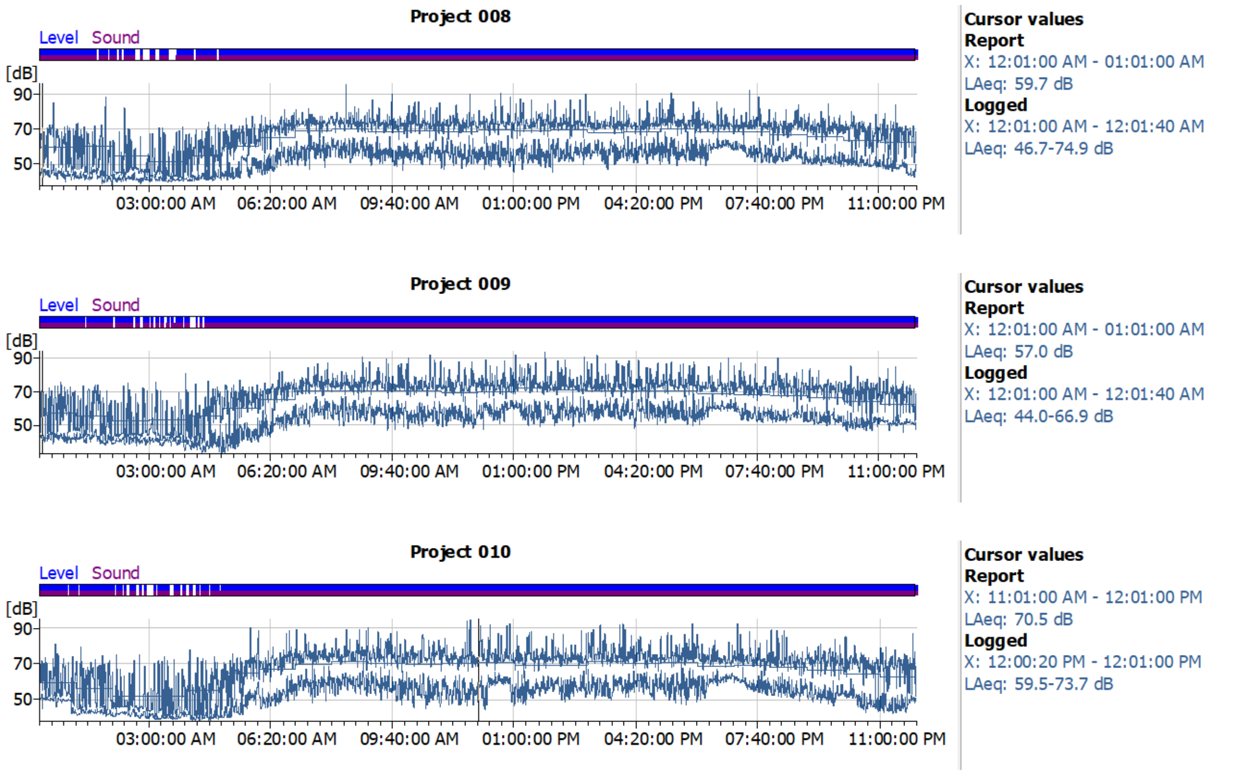


Figure 4-51 Noise fluctuation (Leq) over 72 hours at Station 6 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

OCTAVE BAND ANALYSIS AT STATION 6

The noise at this station during the 72-hour period was in the low frequency band centred around the geometric mean frequency of 63 Hz (octave frequency range is 56 - 71 Hz) (Figure 4-52).

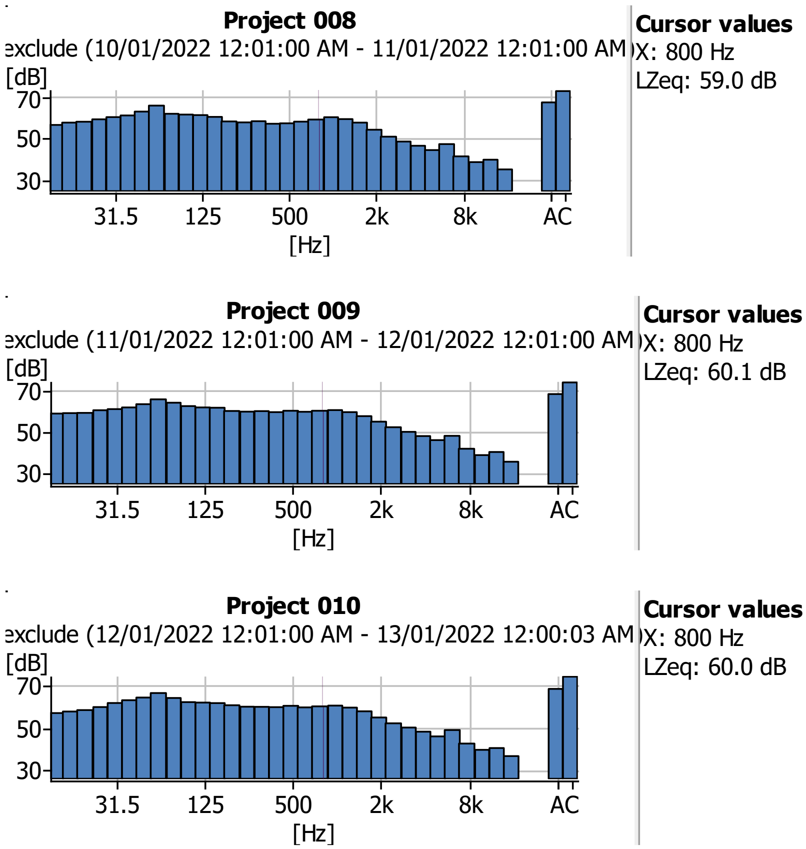


Figure 4-52 Octave band spectrum of noise at Station 6 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

L10 AND L90

The overall L10 and L90 at this station for the time assessed were 71.4 dBA and 43.2 dBA respectively.

STATION 7

During the 72-hour period, noise levels at this station ranged from a low (Lmin) of 35.6 dBA to a high (Lmax) of 87.0 dBA. Average noise level for this period was 60.1 L_{Aeq} (72h). The fluctuation in noise levels over the 72-hour period is depicted in Figure 4-53.

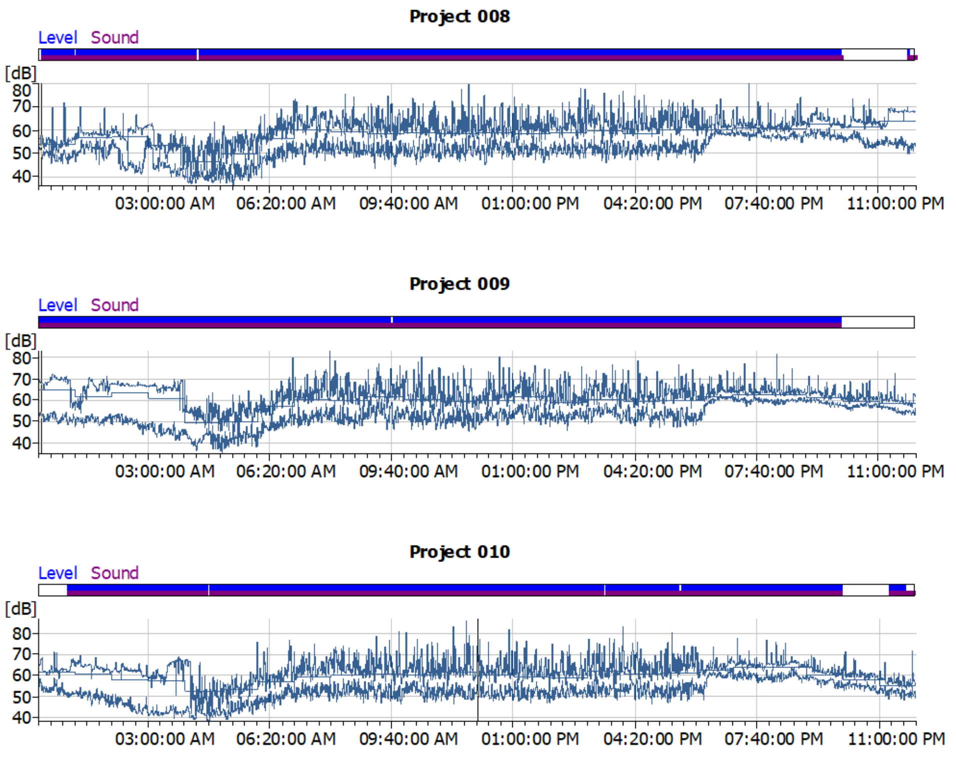


Figure 4-53 Noise fluctuation (Leq) over 72 hours at Station 7 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

OCTAVE BAND ANALYSIS AT STATION 7

The noise at this station during the 72-hour period was in the low frequency band centred around the geometric mean frequency of 63 Hz and 31.5 Hz (octave frequency range is 56-71 Hz and 28 – 35 Hz respectively) (Figure 4-54).

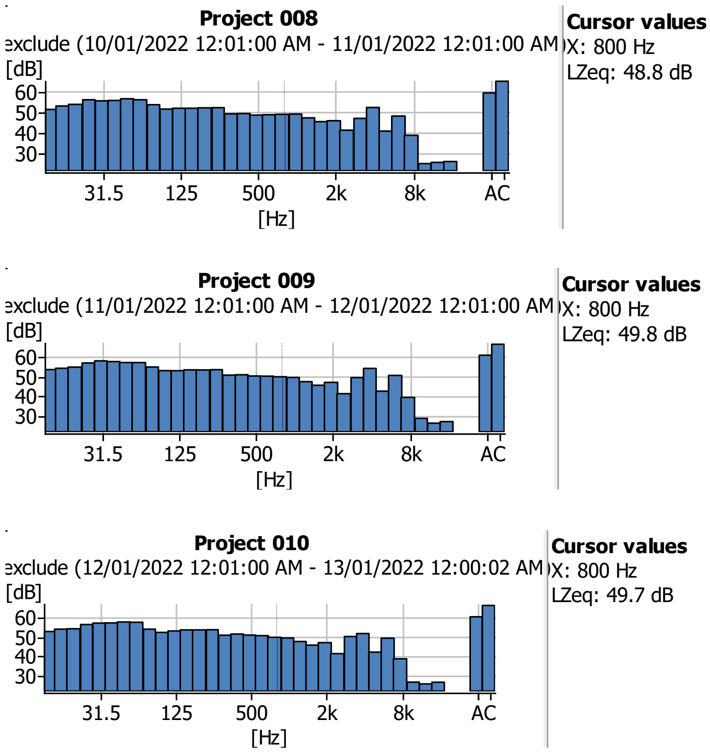


Figure 4-54 Octave band spectrum of noise at Station 7 (top: January 10-11, middle: January 11-12, bottom: January 12-13)

L10 AND L90

The overall L10 and L 90 at this station for the time assessed were 63.7 dBA and 49.1 dBA respectively.

Comparisons of Ambient Noise Levels with NRCA Daytime and Night-Time Guidelines

During the daytime, noise levels at all Stations except residential station 6 (69.6 dBA and station 7 (60.8 dBA) were compliant with respective NRCA daytime standards (Table 4-24). During the night-time, noise levels at all Stations except residential station 5 (53.3 dBA), station 6 (58.5 dBA) and station 7 (57.4 dBA) were compliant with respective NRCA night-time standards.

Table 4-24 Comparison of daytime and night-time noise levels at the stations with the NRCA guidelines

Stn.#	Zone	7 am. - 10 pm (dBA)	NRCA Standard (dBA)	10 pm. - 7 am (dBA)	NRCA Standard (dBA)
1	Commercial	63.3	*65*	56.4	*60*
2	Commercial	57.1	*65*	42.8	*60*
3	Commercial	55.3	*65*	42.5	*60*
4	Commercial	51.8	*65*	47.3	*60*
5	Residential	54.5	*55*	53.3	*50*
6	Residential	69.6	*55*	58.5	*50*
7	Residential	60.8	*55*	57.4	*50*

NB. Numbers in red are non-compliant with the standard/guideline

Daytime noise sources detected at noise monitoring stations which were above NRCA guideline values, included: motor vehicle noises, crickets chirping and frogs calling.

Night time noise sources detected at noise monitoring stations which were above NRCA guideline values, included: motor vehicle noises, horns honking, birds calling, crickets chirping and frogs calling.

Noise from Friendly Irons Shooting Range

Noise monitoring Station 1 was located 115 m west of the shooting range while noise monitoring station 4 was located 150 m north-northwest of the shooting range. Throughout the 72-hour monitoring period, there were no noises detected at either monitoring station which resembled gunshots that would have been from the Friendly Irons Shooting Range. The daytime average noise level at Station 1 was 63.3 dBA which was compliant with the NRCA daytime noise guideline for commercial areas (65 dBA). The majority of noise detected at this station was from vehicular traffic from the Bogue Main Road. The daytime average noise level at Station 4 was 51.8 dBA which was also compliant with the NRCA daytime noise guideline for commercial areas.

4.1.13 Particulates

4.1.13.1 Definitions

Coarse particles are airborne pollutants that fall between 2.5 and 10 micrometres in diameter. Fine particle are airborne pollutants that fall below 2.5 micrometres in diameter. Sources of coarse particles include crushing or grinding operations and dust stirred up by vehicles traveling on roads. Sources of fine particles include all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

4.1.13.2 Methodology

PM10 and PM2.5 particulate sampling exercises were conducted at the seven (7) locations (where noise monitoring was conducted) for 24 hours each on three (3) separate sampling occasions using Airmetrics Minivol Tactical Air Samplers (Calibration Certificate in Appendix 9). The locations are listed in Table 4-22 and illustrated in Figure 4-40. The PM10 sampling exercise was conducted from 12:00am – 12:00am on January 10th, 15th and February 8th, 2022, whilst the PM2.5 sampling exercises were conducted from 12:00am – 12:00am on January 12th, February 6th and February 10th, 2022.

4.1.13.3 Results

PM10

The summarized results of the PM10 sampling run are shown in Table 4-25. All locations had particulate PM10 values compliant with the 24-hour NRCA standard of 150 μg/m^3. Detailed PM10 results are shown in Table 4-26.

Table 4-25 Summarized PM 10 Results

STATION	AVERAGE PM10 RESULT (µg/m³)	RANGE (µg/m³)	NRCA STD. (µg/m³)
STN 1	**29.49**	20.83 – 38.06	150
STN 2	**17.87**	14.58 – 22.92	150
STN 3	**19.44**	9.17 – 30.42	150
STN 4	**21.73**	13.47 – 36.81	150
STN 5	**20.45**	15.69 – 27.50	150
STN 6	**26.53**	19.58 – 35.69	150
STN 7	**23.19**	17.78 – 26.81	150

Table 4-26 Detailed PM10 Results

Sampling Date	STATION	Result [PM_{10}]/ugm⁻³	NRCA PM10 Std [PM10]/ugm-3
January 10, 2022	STN 1	38.06	150
	STN 2	22.92	
	STN 3	30.42	
	STN 4	36.81	
	STN 5	27.50	
	STN 6	35.69	
	STN 7	26.81	
January 15, 2022	STN 1	29.58	150
	STN 2	16.11	
	STN 3	18.75	
	STN 4	14.93	
	STN 5	15.69	
	STN 6	24.31	
	STN 7	17.78	
February 8, 2022	STN 1	20.83	150
	STN 2	14.58	
	STN 3	9.17	
	STN 4	13.47	
	STN 5	18.15	
	STN 6	19.58	
	STN 7	25.00	

PM2.5

The results of the PM2.5 sampling run are shown in Table 4-27. All locations had average particulate PM2.5 values compliant with the 24-hour USEPA PM2.5 standard of 35µg/m³. Detailed PM2.5 results are shown in Table 4-28.

Table 4-27 Summarized PM 2.5 Results

STATION	AVERAGE PM2.5 RESULT (µg/m³)	RANGE (µg/m³)	USEPA STD. (µg/m³)
STN 1	**8.24**	5.28 – 11.53	35
STN 2	**11.53**	11.53 – 11.53	35
STN 3	**6.64**	3.11 – 8.89	35
STN 4	**7.87**	1.94 – 10.83	35
STN 5	**8.91**	2.08 – 12.55	35
STN 6	**9.68**	2.92 – 13.06	35
STN 7	**8.66**	2.36 – 11.81	35

Table 4-28 Detailed PM2.5 Results

Sampling Date	STATION	Result [PM2.5]/ugm^{-3}	USEPA PM2.5 Std [PM2.5]/ugm-3
January 12, 2022	STN 1	5.28	35
	STN 2	N/A	
	STN 3	3.11	
	STN 4	1.94	
	STN 5	2.08	
	STN 6	2.92	
	STN 7	2.36	
February 6, 2022	STN 1	7.92	35
	STN 2	11.53	
	STN 3	8.89	
	STN 4	10.83	
	STN 5	12.55	
	STN 6	13.06	
	STN 7	11.81	
February 10, 2022	STN 1	11.53	35
	STN 2	11.53	
	STN 3	7.92	
	STN 4	10.83	
	STN 5	12.08	
	STN 6	13.06	
	STN 7	11.81	

4.1.14 Sources of Existing Pollution

Pollution sources include various drains and gullies which discharge into the Bogue Lagoon which may result in sedimentation, oils and grease, and nutrient loading. Commercial and recreational boating activity within the lagoon may also result in groundings, propeller and anchor damage and spills of toxic/hazardous fuels and materials, all of which negatively impact water quality and benthic communities such as mangrove, seagrasses and coral reefs. There is also a risk of increased marine solid waste from boating activities.

Other forms include indiscriminate solid waste disposal on and around the site, air pollution and noise pollution from vehicular traffic along the Bogue main road (truck engine brakes, honking of horns, exhaust emissions etc) and indiscriminate burning around the general area.

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 Bogue Lagoon Special Fishery Conservation Area (SFCA)

The project area falls within the Bogue Lagoon SFCA. Established July 25, 1979, the Bogue Lagoon Fish Sanctuary (now a Special Fishery Conservation Area), was one of Jamaica's first fish sanctuaries, and has an area of 450 hectares. Initially established as a Game Reserve, the Bogue Lagoon continues to serve as a critical nursery for juvenile fish and crustaceans in the Montego Bay area. Special Fishery Conservation Areas are no-fishing zones reserved for the reproduction of fish populations. Their nature reserve statuses are declared by the Ministry of Agriculture under Orders privileged through Section 18 of the then Fishing Industry Act of 1975 (replaced by the now Fisheries Act 2018). It is, therefore, illegal and punishable by law to engage in any unauthorized fishing activities in the demarcated zones.

The proposed project is located within the following areas which are protected under various legislation:

- Bogue Lagoon Creek Game Reserve
- Bogue Islands Lagoon SFCA
- Montego Bay Marine Park

This is depicted in Figure 4-55.

Figure 4-55 Location of project in relation to various legislated protected areas

4.2.2 Terrestrial Flora and Fauna

4.2.2.1 Methods

The property was zoned according to vegetation type (scrubland and mangroves) (Figure 4-56) (Plate 4-2). It should be noted that vegetation within the scrubland area was partially cleared before the study was carried out. The fauna and flora surveys were conducted mainly along and off the roads and trails throughout the project area over one month. A DAFOR scale was used to rank species abundance in the study (Table 4-29).

Plate 4-2 Scrubland vegetation on the property

Table 4-29 DAFOR scale used to categorize the species observed in the study.

	The total number of species observed during the survey
Dominant	≥ 20
Abundant	15 – 19
Frequent	10 – 14
Occasional	5- 9
Rare	< 4

Figure 4-56 Vegetation zones, trails and AudioMoth® locations used during the terrestrial flora and fauna assessment

Flora Assessment

The vegetation present on site was assessed by utilising a series of walkthroughs within the boundaries of the development site. All plant species encountered within the boundary were recorded. In addition, the name, perceived dominance and growth form for each species were noted. The dominance was graded using the DAFOR scale.

The common names of most of the species sighted were assigned in situ. In the case of unknown species, voucher specimens were collected and identified at the University of the West Indies (UWI) Herbarium. All plants were identified to the species level by examining morphological features such as leaf arrangement, leaf pattern, and pattern of branching and morphology of floral and fruiting structure in conjunction with the use of Flowering Plants of Jamaica (Adams, 1972) and preserved reference specimens of the herbarium.

Avifauna Survey

The avian (birds) study was conducted mainly using the Line transect method. The method entails walking at a steady pace along the selected path for a given distance while recording all bird species seen or heard (Bibby et al. 2000). This method was carried out over four days and one night. Birds that were observed for the first time while conducting other fauna study but was not observed using the line transect were also added to the list.

The community members and the workers on site were informally interviewed about the birds they observed on the property. Special emphasis was placed on nocturnal birds.

The Audio Moth devices used for the bat survey also recorded nocturnal birds in the area. The audio files from the detectors left in the field for seven nights were analyzed using the Kaleidoscope Pro software from Wildlife acoustics.

Reference material used in species identification (pictures and calls) includes Merlin App (Cornell University 2021), Ebird (Fink et al. 2018), Birds of Jamaica (Downer et al. 1990) and Bird of the West Indies (Raffaele et al. 2020).

Arthropod Survey

The arthropod assessment was carried out within the selected regions within each vegetation zone. The possible hiding places for arthropods, including tree trunks, leaves, dry wood, and sticks, were actively searched. Insects in flight such as dragonflies and butterflies were recorded. Sweep nets were also used to collect arthropods from foliage within each vegetation zone. This method was useful in collecting cryptic and less active species.

Arthropods encountered in the field were identified on the spot; however, arthropods that could not be identified in the field were collected, photographed, and classified at the collections at the Department of Life Sciences, University of the West Indies. Other reference materials used include the Inaturalist App (iNaturalist 2020) and books such as Butterflies of Jamaica (Garraway and Bailey 2005) and Borror and DeLong’s Introduction to the Study of Insects (Triplehorn et al. 2005).

Herpetofauna Survey

The Herpetofauna surveys were conducted during the day and night by actively searching the areas /where they are highly likely to be found, such as trees, stone piles, and other debris within the vegetation zones. Herpetofauna were also identified by their calls. All specimens were identified to at least family and to species where possible. In addition, some specimens were captured and photographed for further examination and subsequently returned to the habitat. The resource material includes Amphibians and Reptiles of Caribbean Islands keys (Caribherp, 2021) and Amphibians and reptiles of the West Indies (Schwartz & Henderson, 1991).

The Audio Moth devices used for the bat survey also recorded vocal Herpetofauna (frogs and croaking lizards) in the area. The audio files were analysed using the Kaleidoscope Pro software from Wildlife acoustics.

Bat Assessment

The bat assessment was carried out using two methods: stationary detectors and a Handheld bat detector along a transect. AudioMoth® acoustic recorders were deployed at random sample sites throughout the project area (Figure 4-56). The AudioMoth® acoustic detectors were configured to start recording from 18:00 to 06:00 for 7 nights. The sample rate was 384 kHz, and the gain was set at medium. The sleep duration was 30 seconds, and the recording duration was 5 seconds. The devices were deployed at least 2 m above the ground.

The AnabatWalkabout® detector was configured to automatically record audio files for 15 seconds once the device was triggered by a frequency of as low as 8 kHz. The recordings are of high resolution, up to 500 kHz sample rate recordings. The study was carried out from 5:50 PM to 9:30 PM for two nights along the established trails on the property at a steady pace.

4.2.2.2 Results and Discussion

Flora Assessment

The plant diversity on the property was relatively low; 49 plant species from 32 families were encountered, most of them being trees and shrubs. In addition, a few climbers and epiphytes were observed on the property (Table 4-30).

The study area is located on a property that has been heavily modified by human activity, and the natural vegetation has been significantly impacted. Apart from the few coastal species encountered, such as Black Mangrove (*Avicennia germinans*), Seaside Mahoe (*Thespesia populnea*) and Seaside Purslane (*Sesuvium portulacastrum*), most of the other plant species recorded in the survey are either ornamental plants, crops or plants associated with anthropogenic disturbances.

Most of the trees encountered at the site were relatively small (< 30 cm DBH). Most of the species encountered during the assessment are classified by Adams (1972) as being very common, commonly found in thickets and wastelands, and commonly found in secondary woodlands. The distribution of the plant species encountered is even across Jamaica, especially in places with significant anthropogenic impacts.

Of the 46 plant species found within the study site, one endemic species was observed, Swamp Cabbage (*Roystonea princeps*). None of the species encountered during this study have any special conservation status; neither were any species listed as rare in Jamaica.

Table 4-30 List of floral species identified in the study area

Family	Scientific Name	Common Name	Distribution Island wide (Adams 1972)	DAFOR
Fabaceae	*Acacia auriculiformis*	Earleaf Acacia		R
Mimosaceae	*Acacia farnesiana*		Naturalised locally, in secondary woodlands and thickets on arid limestone	R
Amaranthaceae	*Achyranthes indica*	Devil's Horse Whip	Common as weed of cultivations and disturbed waste places	A
Mimosaceae	*Albizia lebbeck*	Woman's Tongue	Locally common, naturalised in open secondary woodlands, mostly on gravely soil near habitations	O
Avicenniaceae	*Avicennia germinans*	Black Mangrove	Common in all saline communities around the coast and on the cays	F
Asteraceae	*Bidens pilosa*	Spanish Needle	A common weed of roadsides and waste places	A
Blechnaceae	*Blechnum occidentale*			R
Nyctaginaceae	*Boerhavia coccinea*	Hog Weed	Common, a weed of rough disturbed pastures, waste places and sand dunes	A
Acanthaceae	*Brillantaisia owariensis*			A
Fabaceae	*Canavalia maritima*	Seaside Bean	Very common, on the strand and waste places near the sea	F
Solanaceae	*Capsicum frutescens*	Bird Pepper	Occasional in thickets and waste places	R
Caricaeae	*Carica papaya*	Papaya	Common in cultivation, hardly naturalised	R
Caesalpiniaceae	*Cassia fistula*	Golden Shower Tree	Commonly planted	R
Moraceae	*Cecropia peltata*	Trumpet Tree	Common, especially on recently cleared forested land	O
Vitaceae	*Cissus sicyoides*	Soldier Wiss	Very common, on trees, walls, fences and thickets	F
Arecaceae	*Cocos nucifera*	Coconut	Commonly cultivated	A
Boraginaceae	*Cordia gerascanthus*	Spanish Elm	Common on limestone hills, mainly in dry areas	R
Fabaceae	*Crotalaria retusa*	Rattleweed	Common, along roadside and in waste places	F
Poaceae	*Cynodon dactylon*	Bermuda Grass	Commonly cultivated or encouraged as a lawn grass, particularly in the drier areas, also a weed of roadsides, pastures and waste places	F
Rutaceae	*Fagara martinicensis*	Prickly Yellow	Common, especially in secondary formations	R
Sterculiaceae	*Guazuma ulmifolia*	Bastard Cedar	Very common along roadsides, in pastures and in open secondary woodlands	O
Euphorbiaceae	*Jatropha curcas*	Physic Nut	Frequent, mostly near habitations	O
Combretaceae	*Laguncularia racemosa*	White Mangrove	Common along the margins of lagoons and brackish creeks and also in the cays	A
Verbenaceae	*Lantana camara*	Wild Sedge	Very common in rough pastures, waste places and thickets	A

Family	Scientific Name	Common Name	Distribution Island wide (Adams 1972)	DAFOR
Mimosaceae	*Leucaena leucocephala*	Lead Tree	Common along roadsides and in shady waste places and thickets	O
Verbenaceae	*Lippia nodiflora*		Common in damp, low-lying grassland, coastal thickets and on upper beaches	O
Anacardiaceae	*Mangifera indica*	Mango	Cultivated and Naturalised	R
Convolvulaceae	*Merremia quinquefolia*	Rock Rosemary	Common on fences and in thickets and waste places	O
Mimosaceae	*Mimosa pudica*	Shame Old Lady	A common weed of pastures and open stabilised waste places	F
Cucurbitaceae	*Momordica balsamina*	Cerasi	Rare in the wild state	O
Musaceae	*Musa sapientum*	Banana	Commonly cultivated	R
Poaceae	*Paspalum plicatulum*		Very common in open waste grounds, pasture margins and along thickets	D
Passifloraceae	*Passiflora sexflora*	Goat Foot	Common in thickets and woodland margins and on rocky banks	F
Phytolaccaceae	*Petiveria alliacea*	Guinea Hen Weed	Locally common as a weed of semi-shaded roadsides and rough well, drained, undisturbed ground	A
Nyctaginaceae	*Pisonia aculeata*	Cockspur	Common in secondary thickets and woodland margins, mostly on limestone	F
Asteraceae	*Pluchea carolinensis*	Wild Tobacco	Common in saline thickets and open waste places on limestone	F
Rhizophoraceae	*Rhizophora mangle*	Red Mangrove	Common along muddy shores and in estuarine swamps, occasionally inland	D
Euphorbiaceae	*Ricinus communis*	Castor Oil	Common as a cultivated plant and on waste ground	O
Arecaceae	*Roystonea princeps**	Swamp Cabbage	Uncommon and rather local, restricted to the western parishes, in small colonies or scattered individuals on poorly drained lowlands and the morass	O
Acanthaceae	*Ruellia tuberosa*	Duppy Gunshot	Very common in pastures and waste places and on roadside banks	F
Mimosaceae	*Samanea saman*	Guango	Common in inhabited areas and in old pastures where planted, naturalised in riparian forests and secondary communities on level ground	O
Aizoaceae	*Sesuvium portulacastrum*	Seaside Purslane	Common on salinas, at mangrove margins and on sandy or rocky brackish waters	O
Solanaceae	*Solanum erianthum*	Wild susumber	Frequent, in thickets and steep banks on limestone	O
Rubiaceae	*Spermacoce tenuior*		Rather uncommon, in swamps and at pond margins	R
Poaceae	*Sporobolus virginicus*		Abundant and gregarious, sometimes forming continuous swards along sandy shores and mangrove margins	A
Combretaceae	*Terminalia catappa*	West Indian Almond	Commonly planted and naturalised, especially near the sea in wet areas	F
Malvaceae	*Thespesia populnea*	Seaside Mahoe	Common in littoral situations	O
Araceae	*Xanthosoma sagittifolium*	Coco	Commonly cultivated	R
Poaceae	*Zoysia tenuifolia*		Cultivated for lawns	D

Endemic species - *

Bird Surveys

Forty-six (46) bird species, including 6 residents- endemics, 9 migrants, and 31 residents- non-endemic were identified during the assessment of the property (Table 4-31). The bird species composition consists of a mixture of dry forest species (White-crowned Pigeon, Caribbean Dove, Parakeets, Hummingbirds, Jamaican Woodpeckers, Orioles, Vireos and Migrant warblers) and wetland species (Downer and Sutton 1990). The most abundant bird species was the Antillean Palm swifts, where several were seen in the late evening flying over the property. They are aerial predators and were foraging for insects.

Eleven wetland bird species were encountered in the study (Great Blue Heron, Cattle Egret, Little Blue Heron, Great Blue Heron, Snowy Egret, Great Egret, Black-crowned Night-Heron, Yellow-crowned Night Heron, Brown Pelican, White Ibis, and Glossy Ibis). Most of the species were observed in the mangroves in the study. Only the Cattle Egret and the night herons were observed roosting in the mangroves. Winter migrants usually arrive in Jamaica as early as September and depart in May. Nine migrants, including 8 Warblers and 1 Northern Water Thrush, were observed, and the majority were seen foraging in the mangroves.

Six endemics were observed in the study. Two species, the White-Crowned Pigeon and the Jamaican Parakeet are listed as Near Threatened by the IUCN, while the other endemics are listed as Least Concern. A pair of Jamaican Parakeets were observed nesting in a termite mound in a Guango tree on the property (Plate 4-3).

Table 4-31 Birds observed during the assessment of the property at Reading Pen for the proposed development

Common Name	Scientific Name	Range	IUCN	DAFOR
American Kestrel	*Falco sparverius*	*Resident*	LC	R
American Redstart	*Setophaga ruticilla*	*Migrant*	LC	O
Antillean Palm-Swift	*Tachornis phoenicobia*	*Resident*	LC	F
Bananaquit	*Coereba flaveola*	*Resident*	LC	R
Barn Owl	*Tyto alba*	*Resident*	LC	R
Black-crowned Night-Heron	*Nycticorax nycticorax*	*Resident*	LC	O
Black-faced Grassquit	*Melanospiza bicolor*	*Resident*	LC	R
Black-throated Blue Warbler	*Setophaga caerulescens*	*Migrant*	LC	R
Brown Pelican	*Pelecanus occidentalis*	*Resident*	LC	R
Cape May Warbler	*Setophaga tigrina*	*Migrant*	LC	R
Cattle Egret	*Bubulcus ibis*	*Resident*	LC	O
Cave Swallow	*Petrochelidon fulva*	*Resident*	LC	O
Common Ground Dove	*Columbina passerina*	*Resident*	LC	O
Common Yellowthroat	*Geothlypis trichas*	*Migrant*	LC	O
Glossy Ibis	*Plegadis falcinellus*	*Resident*	LC	R
Great Blue Heron	*Ardea herodias*	*Resident*	LC	R
Great Egret	*Ardea alba*	*Resident*	LC	R
Greater Antillean Grackle	*Quiscalus niger*	*Resident*	LC	O

Common Name	Scientific Name	Range	IUCN	DAFOR
Green Heron	*Butorides virescens*	*Resident*	LC	R
Jamaican Euphonia	*Euphonia jamaica*	*Endemic*	LC	R
Jamaican Mango	*Anthracothorax mango*	*Endemic*	LC	R
Jamaican Oriole	*Icterus leucopteryx*	*Resident*	LC	R
Jamaican Vireo	*Vireo modestus*	*Endemic*	LC	R
Jamaican Woodpecker	*Melanerpes radiolatus*	*Endemic*	LC	R
Little Blue Heron	*Egretta caerulea*	*Resident*	LC	R
Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	LC	O
Louisiana Waterthrush	*Parkesia motacilla*	*Migrant*	LC	R
Magnificent Frigatebird	*Fregata magnificens*	*Resident*	LC	R
Northern Mockingbird	*Mimus polyglottos*	*Resident*	LC	O
Northern Parula	*Setophaga americana*	*Migrant*	LC	R
Jamaican Parakeet	*Eupsittula nana*	*Endemic*	NT	O
Palm Warbler	*Setophaga palmarum*	*Migrant*	LC	R
Prairie Warbler	*Setophaga discolor*	*Migrant*	LC	O
Smooth-billed Ani	*Crotophaga ani*	*Resident*	LC	F
Snowy Egret	*Egretta thula*	*Resident*	LC	R
Streamertail	*Trochilus polytmus*	*Endemic*	LC	R
Turkey Vulture	Cathartes aura	*Resident*	LC	R
Vervain Hummingbird	*Mellisuga minima*	*Resident*	LC	R
White Ibis	*Eudocimus albus*	*Resident*	LC	R
White-crowned Pigeon	*Patagioenas leucocephala*	*Resident*	NT	O
White-winged Dove	*Zenaida asiatica*	*Resident*	LC	O
Yellow Warbler	*Setophaga petechia*	*Resident*	LC	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	R
Zenaida Dove	*Zenaida aurita*	*Resident*	LC	R

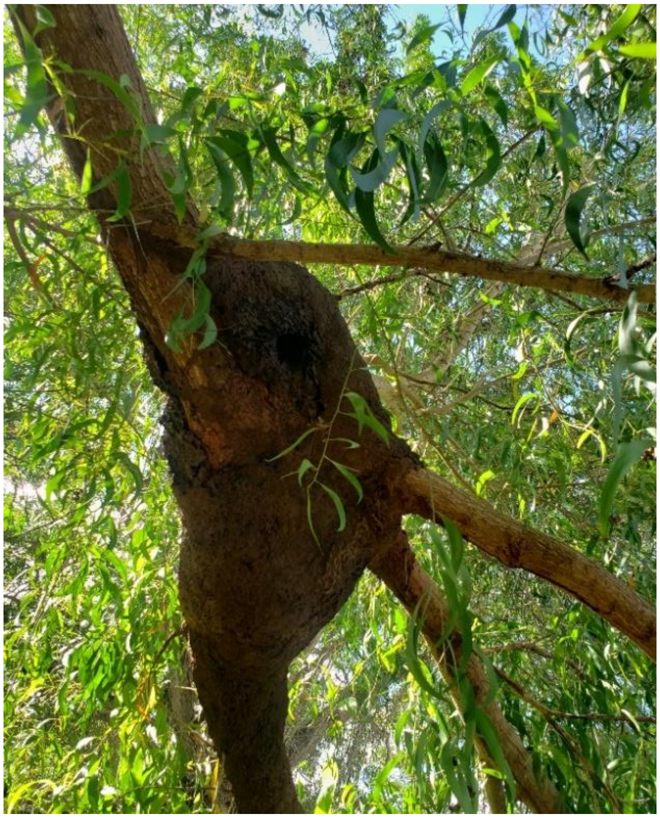


Plate 4-3 Termite mound on site being used as a nest by Jamaican parakeets

Herpetology

Only Two of the 27 amphibians found in Jamaica were observed in the study area. This includes the introduced species such as Whistling Frog (*Eleutherodactylus johnstonei*) and Cuban Flat-headed Frog (*Eleutherodactylus planirostris*) (Table 4-32). The low number of amphibians observed could be as a result of the project area being so close to the sea and also the absence of freshwater bodies on the property.

Seven reptiles (lizards (6) and snakes (1)) were identified during the study. Only one snake, *Typhlops jamaicensis*, was identified in the scrub forest in the project area. No galliwasp species were encountered in the study area. Four of the Six (6) lizards recorded are endemic and are widely distributed throughout the island. The most abundant reptile in the study area was the Jamaican Brown Anole (*Anolis lineatopus*).

None of the amphibians and reptiles encountered in the study have any special conservation status; neither was any species listed as rare in Jamaica.

Table 4-32 Herpetofauna observed in the area for proposed development at Reading Pen

Class	Family	Scientific Name	Common Name	Range	IUCN Status*	Open Field	Forest
Amphibia	Eleutherodactylidae	*Eleutherodactylus johnstonei*	Lesser Antillean Frog	Int	LC	D	A
Amphibia	Eleutherodactylidae	*Eleutherodactylus planirostris*	Cuban Flat-headed Frog	Int	LC		O
Reptilia	Dactyloidae	*Anolis garmani*	Jamaican Giant Anole	End	LC		F
Reptilia	Dactyloidae	*Anolis lineatopus*	Jamaican Brown Anole	End	LC	R	D
Reptilia	Dactyloidae	*Anolis grahami*	Jamaican Turquoise Anole	End	LC	O	O
Reptilia	Dactyloidae	*Anolis opalinus*	Jamaican Opal-bellied Anole	End	LC		O
Reptilia	Sphaerodactylidae	*Aristelliger praesignis*	Jamaican Croaking Gecko	N	LC		O
Reptilia	Sphaerodactylidae	*Sphaerodactylus argus*	West Caribbean Ocellated Geckolet	N	LC		R
Reptilia	Typhlopidae	*Typhlops jamaicensis*	Jamaican Blind snake	End	LC		R

Arthropods

LEPIDOPTERANS (BUTTERFLIES AND MOTHS)

Seventeen species of Lepidopterans from 6 families were observed in the study area (Table 4-33). In terms of endemism, no endemic species were encountered in the study area. The majority of the butterfly species were observed in the scrubland and only a few in the mangroves. It should be noted that the survey was carried out after a large amount of the vegetation was cleared, which affected the number of lepidopterans in the area. None of the butterflies encountered are considered to have special conservation needs.

Table 4-33 The Lepidopterans observed during the assessment of the area

Order	Family	Scientific names	Common names	Status, range Jamaican distribution	Scrubland	Mangroves
Lepidoptera	Hesperiidae	*Burnsius oileus*	Tropical Checkered-Skipper	Widespread, North and South America	O	
Lepidoptera	Hesperiidae	*Cymaenes tripunctus*	Three-spotted Skipper	Caribbean, Central America, North America and South America	R	
Lepidoptera	Hesperiidae	*Pyrgus oileus*	Tropical checkered skipper	Peninsular Florida, the Gulf Coast, and southern Texas, south through the West Indies, Mexico and Central America to Costa Rica	R	
Lepidoptera	Lycaenidae	*Hemiargus ceraunus*	The Hanno Blue	Widespread and very common	O	
Lepidoptera	Lycaenidae	*Leptotes cassius*	Cassius Blue	Widespread and very common	O	
Lepidoptera	Nymphalidae	*Anartia jatrophae*	White Peacock	Widespread and common. Southern US to Argentina	O	

Order	Family	Scientific names	Common names	Status, range Jamaican distribution	Scrubland	Mangroves
Lepidoptera	Nymphalidae	*Danaus gilippus jamaicensis*	Jamaican Queen	End. Ss.	R	
Lepidoptera	Nymphalidae	*Dione vanillae*	The Tropical Silverspot	Widespread and very common	R	
Lepidoptera	Nymphalidae	*Dryas iulia delilah*	Julia	Endemic Ss.; widespread, common	R	
Lepidoptera	Nymphalidae	*Euptoieta hegesia*	Mexican fritillary	Widespread, North and South America	R	
Lepidoptera	Nymphalidae	*Junonia zonalis*	West Indian Buckeye	Bahamas, Cuba, Hispaniola, Caymans Islands, Jamaica	O	R
Lepidoptera	Papilionidae	*Papilio andraemon*	Andraemon Swallowtail	Introduced from Cuba in the 1940s, citrus pest. Greater Antilles	R	
Lepidoptera	Pieridae	*Ascia monuste*	Great Southern White; Antillean Great White	N; widespread, common and pest of crucifers. Southern US to Argentina	F	
Lepidoptera	Pieridae	*Eurema nise*	Mimosa Yellow; Cramer's Little Sulphur	Widespread, common. Southern US to Argentina	R	
Lepidoptera	Pieridae	*Phoebis sennae*	Cloudless Sulphur	Widespread and common. Southern US to Argentina	O	R
Lepidoptera	Pieridae	*Pyrisitia lisa*	`	Widespread, common. Southern US to Argentina	O	
Lepidoptera	Crambidae	*Spoladea recurvalis*	Hawaiian beet webworm	Widespread and very common	R	

OTHER ARTHROPODS (INSECTS (NON-LEPIDOPTERANS), SPIDERS, MILLIPEDES)

Seventeen species of arthropods from 13 families were identified in the study (Table 4-34). There were no endemic species and also species (Insects (non-lepidopterans), spiders, millipedes) of special conservation status/ needs within the project area.

Table 4-34 Arthropod species observed during the assessment of the area

Order	Family	Scientific names	Common names	Mangroves	Scrubland
Araneae	Araneidae	*Argiope sp.*	Orbweavers	R	O
Araneae	Araneidae	*Gasteracantha cancriformis*	Black Crab spider	R	R
Coleoptera	Cerambycidae	*Oxymerus aculeatus lebasi*	A Brazilian Longhorn Beetle. West Indies and South America		A
Diptera	Muscidae	*Musca domestica*	housefly	R	
Diptera	Muscidae	*Musca sp*			O
Hempitera	Pentatomidae	*Nezara viridula*	Stink bug		O
Hemiptera	Pyrrhocoridae	*Dysdercus andreae*	Cotton Stainer	F	O
Hymenoptera	Formicidae	*Pheidole sp.*	Black ants		O
Hymenoptera	Vespidae				O
Hymenoptera	Xylocopinae	*Xylocopa mordax*			R

Order	Family	Scientific names	Common names	Mangroves	Scrubland
Isopetera	Termitidae	*Nasutitermes costalis*	Termites, Duck ants Widespread.	O	F
Ixodida	Ixodidae	*Rhipicephalus microplus*	Cattle tick		
Odonata	Libellulidae	*Orthemis sp*	Green Dragonfly	R	O
Odonata	Libellulidae	*Unknown species 2*	Red Dragonfly	R	O
Odonata	Libellulidae	*Pantala flavescens*	Wandering Glider		O
Orthoptera	Gryllidae	*Gryllus assimilis*	Jamaica Field Cricket	R	
Orthoptera	Tettigoniidae	*Unknown species*			O

Bats

Of the 21 species of bats that have been reported in Jamaica, only nine were identified from the analysis of the acoustic data from the devices in the project area (Table 4-35). None of the species identified is endemic to Jamaica. Due to the size of the property, it could not be deduced if the bats were foraging in the mangroves vs scrubland. The species trophic guild includes Frugivore (n=1), Piscivore (n=1) and Insectivore (n=7). Of the insectivores, the 3 species are normally found in cluttered (forested areas) and 4 in open spaces.

None of the bats encountered has special protection status or is deemed endangered. During the study, no bat roosts, including trees, caves, or rock holes, were encountered in the project area.

Table 4-35 Bat species encountered within the project area, their respective diet, range, and conservation status

Species	Common name	Diet	IUCN	Range	Roost	Foraging Behaviour	Mangrove	Open Fields
Artibeus jamaicensis	Jamaican Fruit Bat	Frugivore	LC	Native	Cave, man-made structure, foliage	Fruit Feeder: trees in forested and disturbed areas	x	
Eumops glaucinus	Wagner's Bonneted Bat	Insectivore	LC	Native	Cave, man-made structures	Open-space, aerial awking		x
Molossus molssus	Pallas' Mastiff Bat	Insectivore	LC	Native	Cave, man-made structures	Open-space, aerial awking	x	x
Moormops blainvillei	Antillean Ghost-faced Bat	Insectivore	LC	Native	Obligate cave	semi-cluttered space; fluttering hunter		
Noctilio leporinus	Fishing Bat	Piscivore	LC	Native	Cave, crevice, Tree hollow	Slow-moving water surface; along the edge and open fields	x	
Nyctinomops macrotus	Big Free-tailed Bat	Insectivore	LC	Native	Cave, crevices	Open-space, aerial awking	x	
Pteronotus macleayii	MacLeay's Mustached Bat	Insectivore	LC	Native	Obligate cave	Background-cluttered space; fluttering hunter		x
Pteronotus parnellii	Parnell's Mustached Bat	Insectivore	LC	Native	Obligate cave	Highly cluttered space; fluttering hunter	x	

Species	Common name	Diet	IUCN	Range	Roost	Foraging Behaviour	Mangrove	Open Fields
Tadarida brasiliensis	Free-tailed Bat	Insectivore	LC	Native	Cave,man-made structures	Open-space, aerial awking	x	x

Other Fauna

In terms of other fauna, four species were identified in the study (Table 4-36). No species of special conservation status were found in the area.

Table 4-36 Other fauna observed in the study area.

Order	Family	Scientific names	Common names	Status, range Jamaican distribution	Mangroves	Scrubland
Carnivora	Herpestidae	*Herpestes auropunctatus*	Indian Mongoose	native to Iraq and northern South Asia, introduced to the Caribbean		R
Carnivora	Felidae	*Felis catus*	Cats	Domesticated and introduced to the Caribbean		R
Decapoda	Gecarcinidae	*Cardisoma guanhumi*	Blue Land Crab	The native Caribbean and West Atlantic	O	
Coenobitidae	Coenobita	*Coenobita clypeatus*	Hermit crab	The native Caribbean and West Atlantic		O

4.2.3 Benthic Survey

Benthic surveys were conducted in and around the proposed project area. Visibility in the area is generally very poor and this is further complicated by the soft silty sediment which is easily resuspended. Much of the area is composed of a fine, soft and silty sediment with some sandier areas. Seagrass beds identified were dominated by *Thalassia testudinum.* Macro-fauna in these areas was limited to sea cucumbers and starfish. Very few fish were observed, while large numbers of jelly fish (*Aurelia sp.)* were seen throughout the project area.

Sparse *Thalassia*, and even fewer *Syringodium* seagrass beds/blades were observed in several sections of the survey area (*Thalassia* is the dominant species). The visibility in and around the general area was very poor. This reduced the number of species seen and recorded. The list of species seen and anectodical information given by fishermen during the survey is given in (Table 4-37).

Meiofauna, include burrowing species such as crabs, worms and possibly fish are likely present in and around the proposed project area. Evidence of burrowing species was seen during the survey.

Table 4-37 Species seen or known to be in the general survey area

Scientific Name/Class	Common Name
FISH	
Centropomus	Snook
	Sting rays
Pterois sp.	Lionfish
Mugilidae	Mullet
	'Baitfish'
	Mangrove Snapper
	Stingrays
SEAGRASS	
Thalassia testudinum	Turtle grass
Syringodium filiforme	Manatee Grass
INVERTEBRATES	
Strombus gigas	Queen Conch
Holothuria mexicana	Donkey Dung Sea Cucumber
Cassiopeia sp.	Upside Down Jellyfish
Oreaster sp.	Starfish
Aurelia sp.	Moon Jellyfish
Lytechinus	Green urchin
	Shrimp

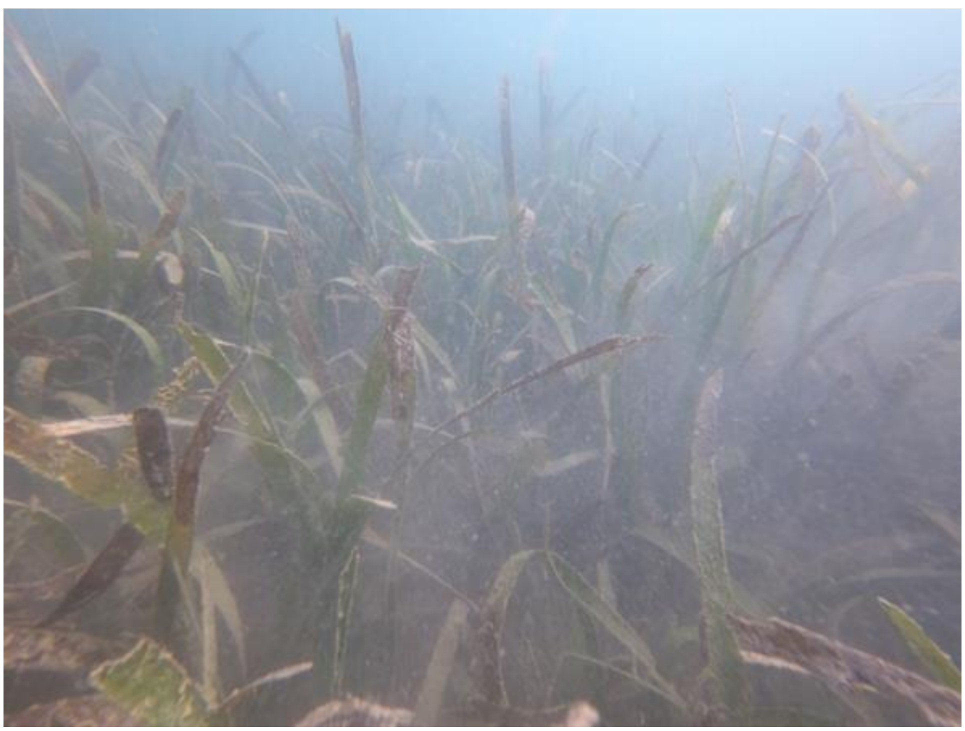


Plate 4-4 *Thalassia* in silt/mud

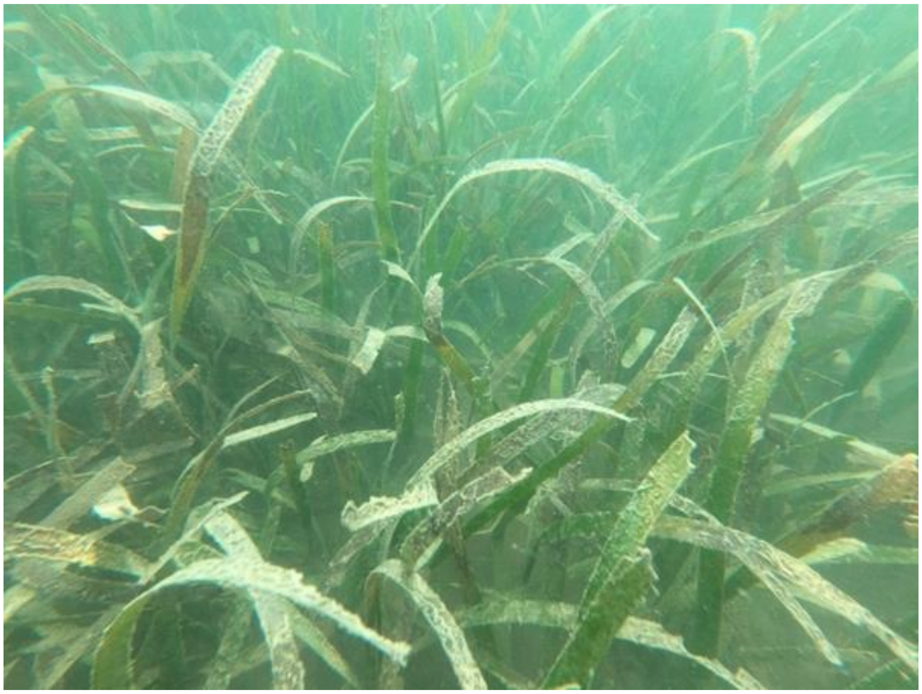


Plate 4-5 *Thalassia* seen during survey

Plate 4-6 *Thalassia* and *Halimeda* in the nearshore

Plate 4-7 Sea cucumber seen during survey

Table 4-38 below gives the coordinates and description of the benthos via probes conducted, while Figure 4-57 illustrates their locations.

Table 4-38 Coordinates and description of the benthos via probes

ID	Biota	Sediment	Other comment	Northing	Easting
1	*Thalassia*	Sand and Mud	sparse *Thalassia*	699611.856	650185.450
2	*Thalassia*	Sand	sparse *Thalassia*	699765.971	650320.567
3	*Thalassia*	Sand and Mud	Sparse *Thalassia*	699887.091	650387.879
4	Macro Algae	Sand and Mud	silty	699644.565	650579.378
5	Macro Algae	Sand and Mud	silty	699846.523	650568.092
6	None	Silt	muddy	699423.252	651204.575

Figure 4-57 Benthos Map via probes conducted

4.2.3.1 Seagrass Density and Distribution

Methodology

A total of two (2), 0.5m^2 quadrats, were placed in seagrass (where possible) within the each of the four (4) survey areas. The locations of each quadrat were marked using a Trimble Geo-7x geographical positioning system (GPS). Shoot density, percentage cover, leaf blade length, leaf blade width, overall health and appearance and other organisms located within the seagrass beds were all recorded. Where possible, seagrass blades were assessed within each quadrat.

Shoot density was recorded within 0.5m x 0.5m square in each quadrat thrown. Percentage cover was recorded by estimating the total area covered within the 0.5m x 0.5m quadrat. Leaf blade length and width were recorded by measuring 10 random lead blades within each quadrat. Example of quadrats are given in Plate 4-8 and Plate 4-9.

Plate 4-8 Example of a quadrat in seagrass

Plate 4-9 Quadrat with less dense seagrass

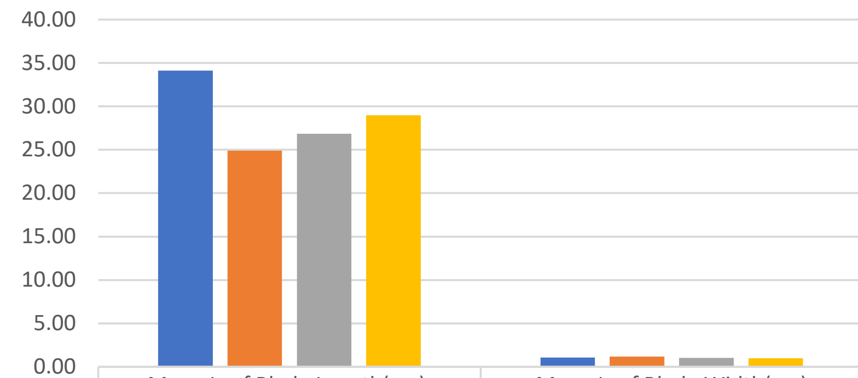
Table 4-39 Quadrat Coordinates in JAD2001

Quadrat	Northing	Easting
Q1a	699584.678	650183.422
Q1b	699587.571	650184.583
Q2a	699844.637	650314.741
Q2b	699846.758	650320.629
Q3a	699888.906	650379.025
Q3b	699893.602	650375.814
Q4a	699641.975	650554.068
Q4b	699634.138	650557.007

Figure 4-58 Map showing quadrat locations

Results

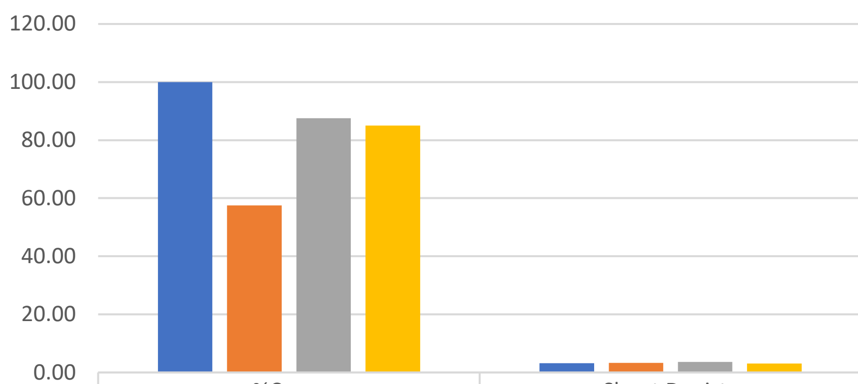
All four stations were similar in mean blade length and mean blade width. Station 1 had an average blade length of 34.14cm and a mean blade width of 1.08 cm while station 2 had the shortest blade length of 24.91 with a width of 1.17 cm (the widest), shown in Figure 4-59.



	Mean Leaf Blade Length(cm)	Mean Leaf Blade Width(cm)
Station 1	34.14	1.08
Station 2	24.91	1.17
Station 3	26.85	1.04
Station 4	28.99	1.01

Figure 4-59 Mean Blade length and width

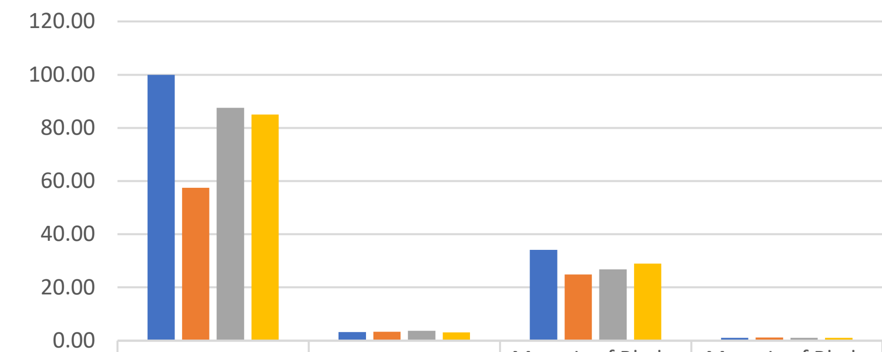
Percentage cover was similar at all stations except for station 2 which had the lowest percent cover. Shoot density was similar at all stations. Figure 4-60 shows the percentage cover and average shoot density at each station.



	%Cover	Shoot Denisty
Station 1	100.00	3.25
Station 2	57.50	3.30
Station 3	87.50	3.70
Station 4	85.00	3.05

Figure 4-60 Percentage Cover and Shoot Density

Seagrass blade density and distribution, as well as bed health was similar at all stations (Figure 4-61)



	%Cover	Shoot Denisty	Mean Leaf Blade Length(cm)	Mean Leaf Blade Width(cm)
Station 1	100.00	3.25	34.14	1.08
Station 2	57.50	3.30	24.91	1.17
Station 3	87.50	3.70	26.85	1.04
Station 4	85.00	3.05	28.99	1.01

Figure 4-61 Comparison; Shoot Density, Percentage Cover and Mean Blade Length and Width

4.2.3.2 Seagrass Status

Methodology

SEAGRASS CORES

Within the project area a total of four (4) cores were extracted. At each site, diving was utilized to extract core data. This was done by carrying a graduated and labelled PVC tube of dimensions 2.5 meters length by 8 centimetres width unto the substrate below. The depth of the water column was then noted and with slow swaying motions (in order to reduce the chances of cropping seagrass blades) the PVC core was used to encircle the seagrass below, ensuring all blades were properly within the core. The core was then forced into the substrate using a sledgehammer until resistance was achieved and depth of core into the substrate noted using the graduation markings. A PVC cap was then placed atop the core tube and pounded until a seal was created. The core tube was then swayed back and forth in order to loosen the surrounding substrate to create space in order to remove and cap the working end of core. GPS locations were then taken at the site of core extraction (Table 4-40). The removed core and contents (vegetative and soil plug) were then carried to the surface and stored for later processing. This process was repeated for each sample taken.

Table 4-40 Coordinates of seagrass cores

Core	Northing	Easting
RP C1	699588.391	650186.816
RP C2	699840.481	650315.404
RP C3	699888.065	650385.599
RP C4	699639.259	650557.7

Plate 4-10 Contents removed from seagrass core

Figure 4-62 Map showing locations of seagrass cores

SEAGRASS PRODUCTIVITY

Four (4) 0.027m2 quadrats were randomly anchored in the seagrass meadow. Quadrats were carefully marked with flagging tape and GPS markers to accurately pinpoint their exact location (Table 4-41). The seagrass blades enclosed by the quadrat were properly fixed to ensure that none of the blades were folded underneath the quadrat boundary. A hole punch was then used to make a hole as close to the base of the blade as possible. This was done for at least 5 blades in each quadrat. The samples were left for a period of 2 weeks following which; the blades were reaped by removing the entire shoot from the quadrats. All shoots were removed from the quadrats and carefully placed in labelled Ziploc bags to be processed at the lab.

Table 4-41 Productivity quadrat coordinates

Productivity Quadrat	Northing	Easting
P1	699586.01	650186.172
P2	699836.517	650315.63
P3	699888.764	650384.894
P4	699643.885	650551.503

Figure 4-63 Map showing locations of seagrass productivity quadrats

LAB ANALYSIS

Vegetative Biomass Separation

Upon the removal of core contents, from PVC cores, seagrass samples were carefully separated into below and above ground sections and placed into separate labelled Ziploc bags for later processing.

Above Ground Biomass Processing

Seagrass samples (each blade from each sample) were then removed and measured individually for length and width. After measuring, samples were then weighed for wet weight and recorded with epiphytes still attached. The prominent epiphytes present on the blades were noted after which they were removed by immersing the samples in ten percent (10%) hydrochloric acid (HCL) for twenty (20) minutes. Blades were then carefully wiped clean of all remaining epiphytes, weighed and recorded once more for weight after epiphyte removal (epiphyte weight). Samples were then packaged in newspaper and placed in the Despatch LDB Lab Oven for seventy-two (72) hours at sixty degrees (60^o) for drying (Plate 4-11).

Below Ground Biomass Processing

Below ground seagrass biomass was determined using a 5KW Digital Scale which was used to record wet and dry weights. Here, seagrass roots and rhizomes were washed free of sediments, blotted with a paper towel and weighed for wet weight. Samples were then placed in newspaper and left in a Despatch LDB Lab Oven for seventy-two (72) hours at sixty (60^o) degrees, removed and allowed to cool before being weighed for dry weight.

Productivity Processing

The seagrass shoots were removed from labelled bags and all the individual blades were removed from the shoot. All blades were examined to see if the hole could be found. The area of the seagrass blade above the hole was cut with a scissors and removed. The region below the hole to the white subsurface area was also cut at the interface area and removed. If no holes were found, all the blades that were short with rounded tips were grouped together as new growth blades while the long blades with jagged tips were grouped together as old blades. The freshly cut blades or the grouped blades were now weighed and recorded. After which they were placed in a 10% HCl solution for approximately twenty (20) minutes. After the blades were removed and carefully wiped with a paper towel, there were reweighed and recorded. The blades were carefully packaged in newspaper, labelled and placed in the Despatch LDB lab oven to be dried for approximately seventy-two (72) hours. After the samples were dried, they were re-weighed for dry weight. The productivity data was obtained by transposing the weighted results into the formula:

Dry weight (g) x 0.027258 x 1/14

Plate 4-11 Labelled above and below ground vegetative components per site in Despatch LDB Lab Oven

Substrate and Peat Analysis

The remaining soil collected in the core was allowed to settle. Upon settling, the remaining water is poured through a 64 μm filter in order to collect any remaining suspended sediment particles. Once the majority of this water is removed, the remaining soil samples are collected and placed into plastic containers being sure to add the filtered particles. Once settled excess water is removed using a syringe with tubing attached. Samples are then split into two replicates, placed into labelled aluminium containers and weighed for wet weight. Samples were then placed into the Despatch LDB Lab Oven for seventy-two (72) hours and dried at sixty degrees (60^{o}) (Plate 4-12).

Plate 4-12 Substrate replicates per site in Despatch LDB Lab Oven

Samples were then allowed to cool for one (1) hour after which they were weighed for dry weight and placed into a Thermolyne B1 TableTop Muffle Furnace for five (5) hours at four hundred and fifty degrees (450^{o}) (Plate 4-13). Samples are then removed after cooling and ash free dry weights recorded and analysed.

Plate 4-13 Muffle Furnace containing soil samples recovered from core samples within the Reading Pen peninsula

Results

PHYSIOCHEMICAL COMPONENT

Of the water quality stations in which samples were collected within the Reading Pen peninsula, the following stations were selected and used to describe cores taken within this area (Table 4-42).

Table 4-42 Water quality stations for corresponding core sample

Core Site	WQ Station
RP 1	WQ 2
RP 2	WQ 10
RP 3	WQ 4
RP 4	WQ 6

According to Table 4-43 below, average physiochemical results across sites are seen to vary across each parameter. Within the area sampled, depth is seen to remain constant across sites with RP 2, 3 and 4 having a depth of 5 feet while RP 1 possesses a depth of 4 feet. Average temperature readings per site indicate highest temperatures at RP 1 (most shallow site) though values are seen to remain at a constant around 27o Celsius. Photosynthetically active radiation (PAR) within the seagrass area sampled indicated highest values at RP 1 with a value of 554.50 uE/cm/s while lowest PAR values are seen at RP 4. Average turbidity across sites indicated that RP 1 has the highest value. This may occur as RP 1 may receive dislodged sediments from RP 2 and 3 which are transported by wave activity and deposited in RP 1. Average temperature, salinity and pH were seen to remain relatively stable and statistically insignificant throughout the sites which were sampled. Average dissolved oxygen (mg/l) is seen to decrease at RP 2 and 3 (5.15mg/l) while highest dissolved oxygen readings were recorded at RP 4 with a value of 5.55 mg/l.

Table 4-43 Average values for physiochemical water results per core

WQ Station	Core site	Avg. TEMP. °C	Avg. COND (mS/cm)	Avg. SAL (ppt)	Avg. pH	Avg. D.O. (mg/l)	Avg. Turb (NTU)	Avg. TDS (g/l)	Avg. PAR (uE/cm/s)
2	RP 1	27.638	54.03	35.79	8.06	5.32	2.40	34.59	554.50
4	RP 2	27.590	53.90	35.67	8.04	5.15	0.23	34.46	469.83
4	RP 3	27.590	53.90	35.67	8.04	5.15	0.23	34.46	469.83
6	RP 4	27.635	53.99	35.76	8.07	5.55	0.47	34.56	305.25

SHOOT COMPONENT

Blade density (numbers/m2)

Of the four stations assessed, RP 4 had the highest blade density with a total of 19 blades retrieved within the corer. The least number of blades per square meter was found at RP 2 (3 blades) (Figure 4-64).

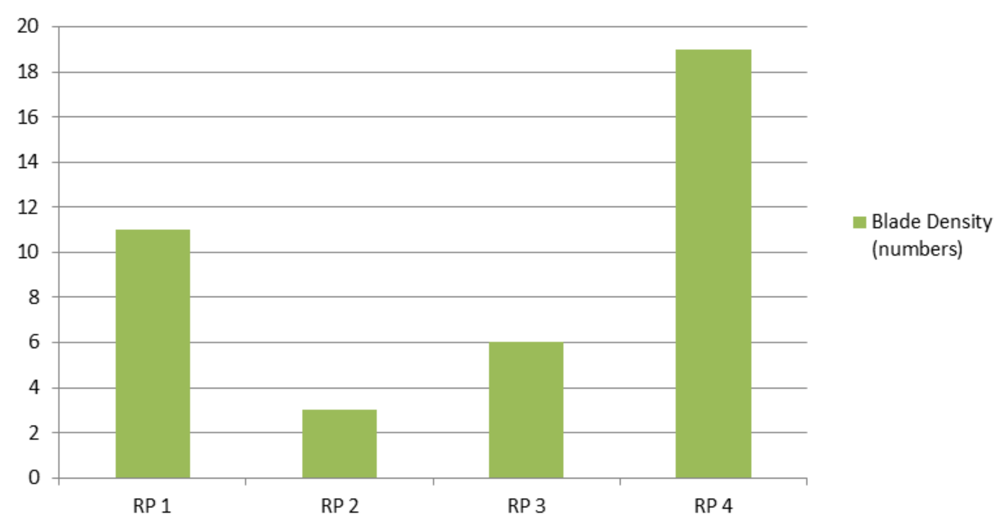


Figure 4-64 Blade density (numbers) of seagrasses collected in core samples per site within the Bogue Lagoon

Mean blade length (cm)

According to Figure 4-65 below, mean blade lengths between sites ranged from 33.1 cm to 26.5cm with the highest blade length being recorded at RP 2 followed by RP1, RP4 and RP3 respectively.

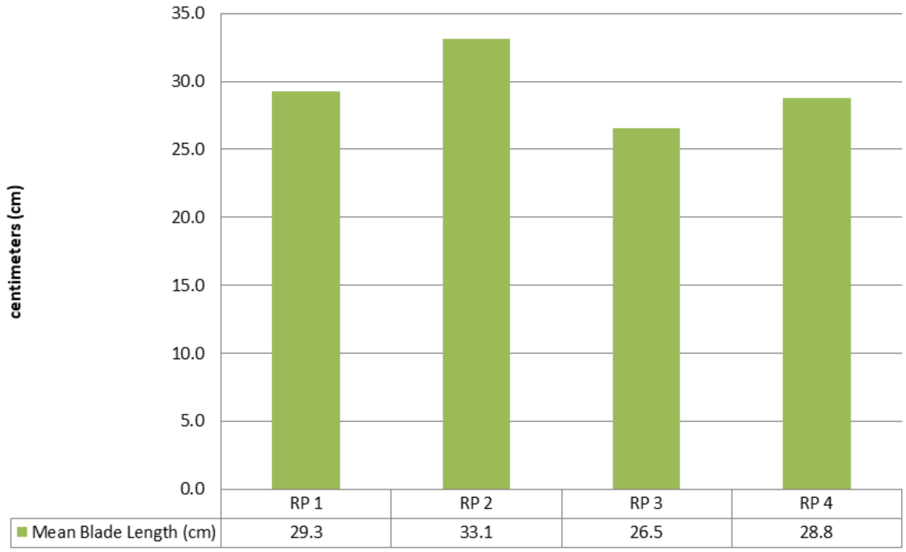


Figure 4-65 Mean blade length (cm) of seagrasses collected in core samples per site within the Bogue Lagoon

Mean blade width (cm)

Mean blade width values ranged from 0.9cm to 1.3cm with the highest width being found in RP2 and lowest at RP4 (Figure 4-66).

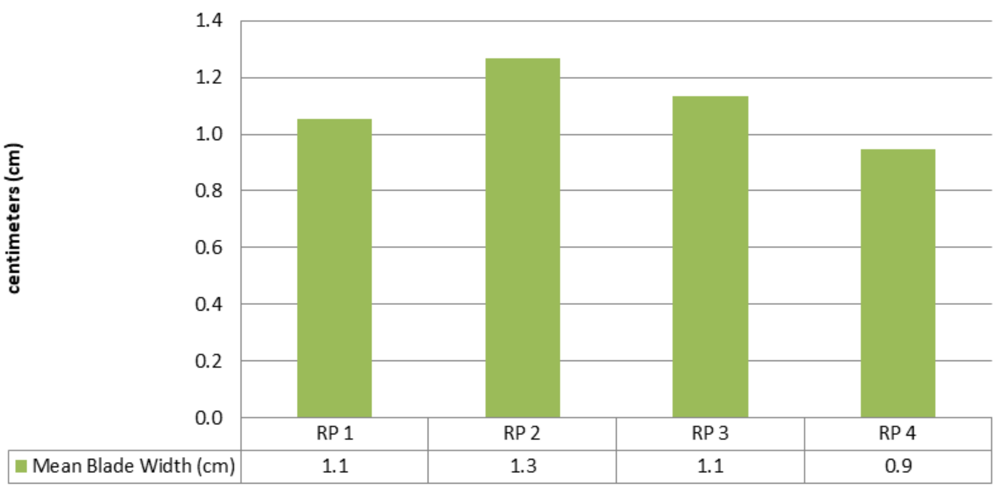


Figure 4-66 Mean blade width (cm) of seagrasses collected in core samples per site within the Bogue Lagoon

Mean above ground wet weight (g)

Mean above ground wet weight between sites varied between RP4 (23.7 g) and RP 2 (6.5 g) (Figure 4-67). Values were seen to initially decrease then increase from RP1 to RP4 (deeper within the bay).

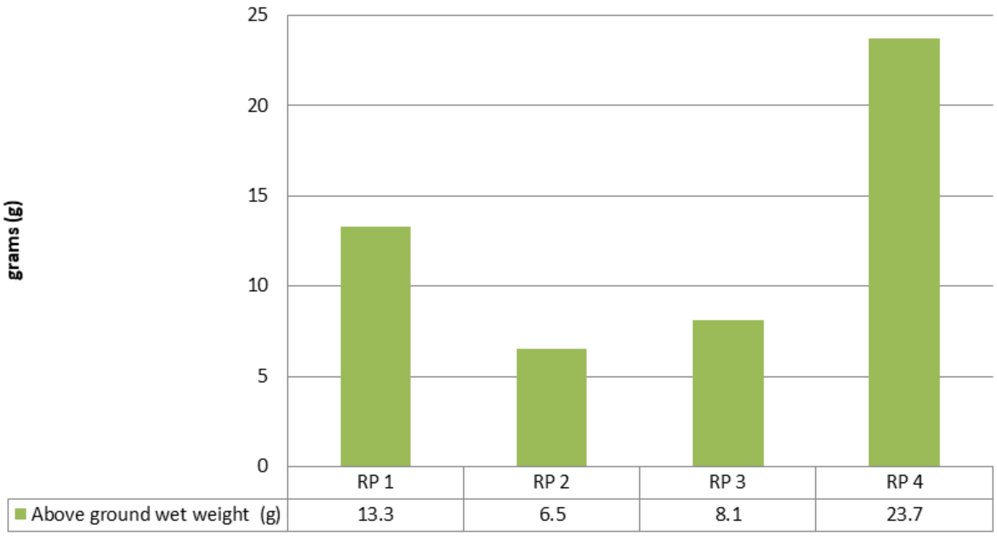


Figure 4-67 Above ground wet weight (g) of seagrasses collected in core samples per site within the Bogue Lagoon

Epiphyte weight (g)

Epiphytes observed were a mixture of calcareous and filamentous epiphytic types. Based on the data gathered, RP 4 had the highest epiphytic weight among seagrasses collected with a total weight of 5 grams. This was followed by RP 1, 3 and 2 (Figure 4-68).

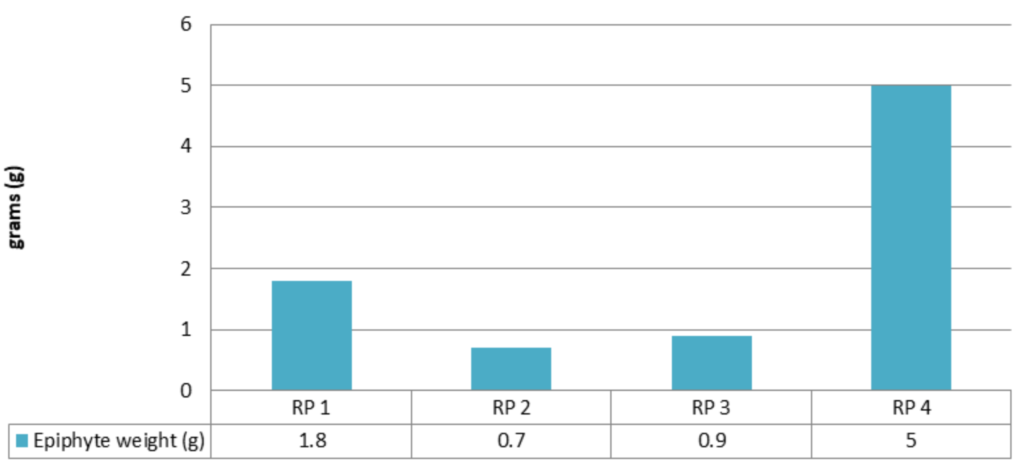


Figure 4-68 Epiphyte weight (g) of seagrasses collected in core samples per site within the Bogue Lagoon

Mean above ground dry weight (g)

Of the mean above ground dry weights, RP 4 was found to have the highest weight of 1.8 grams this was followed by RP1, RP3 and RP2 respectively (Figure 4-69).

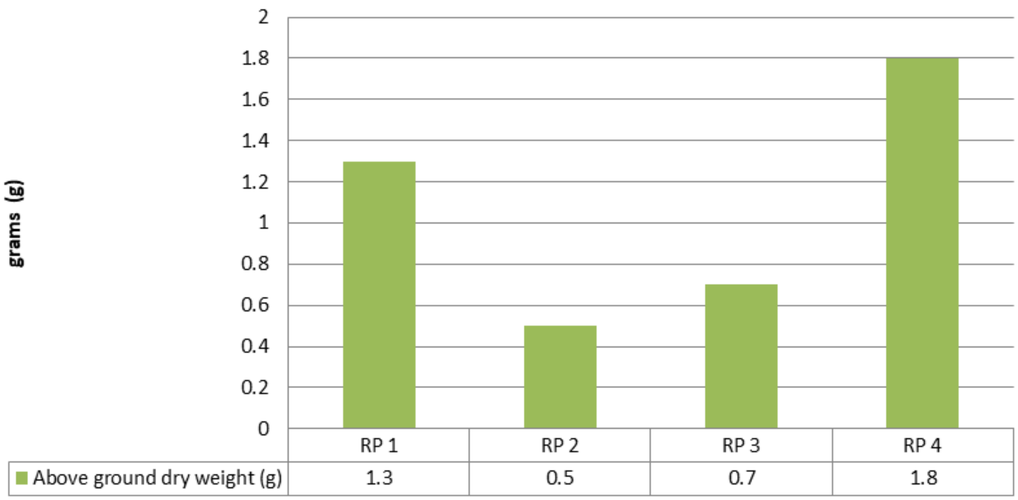


Figure 4-69 Above ground dry weight (g) collected in core samples per site within the Reading Pen peninsula

Mean below ground wet weight (g)

As seen in Figure 4-70, mean below ground wet weight refers to the weight of the root and rhizome layer collected within each core before the drying process. This was seen to vary between sites with the highest weight being present at RP1 with a total weight of 43.6 grams. This was followed by RP3, RP4 and RP2.

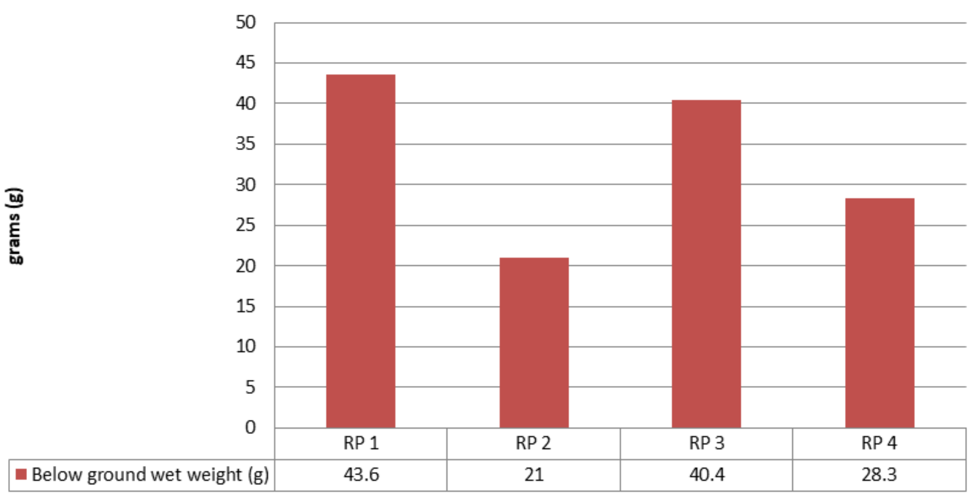


Figure 4-70 Below ground wet weight (g) collected in core samples per site within the Bogue Lagoon

Mean below ground dry weight (g)

According to the data below ground dry weight, much like below ground wet weight was highest at RP 1 and lowest at RP2. The trend seen within the above ground component of the samples collected within each core and their belowground component represented in Figure 4-71 below indicate a similar trend in biomass seen between weights per site.

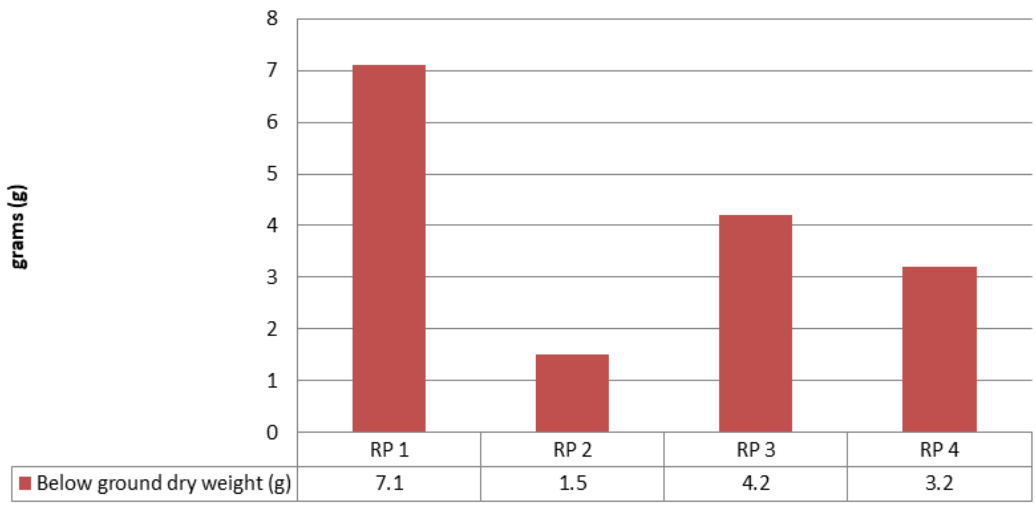


Figure 4-71 Below ground dry weight (g) collected in core samples per site within Bogue Lagoon

Productivity

Productivity quadrats set within each plot which was sampled indicated highest growth rates within RP 1 and RP 3. RP 4 indicated the lowest productivity over a fourteen-day period indicating that some factor is limiting photosynthetic performance (Figure 4-72).

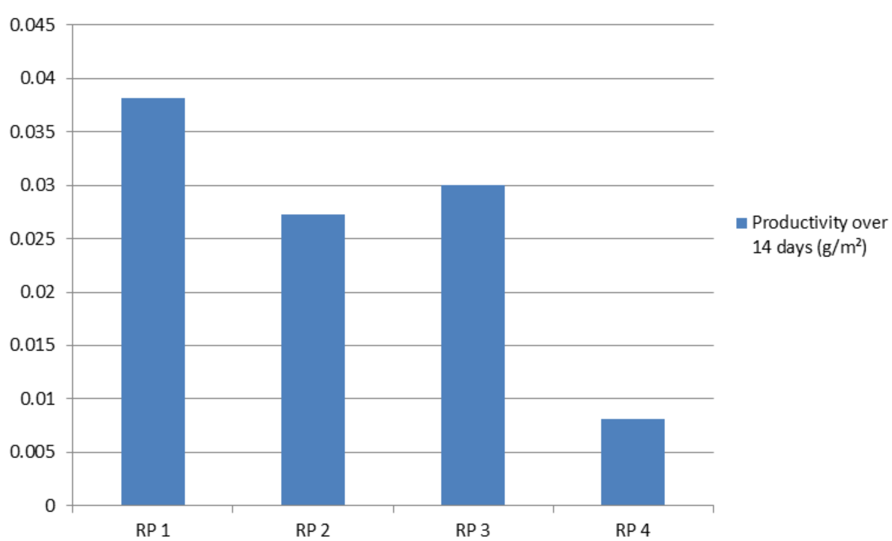
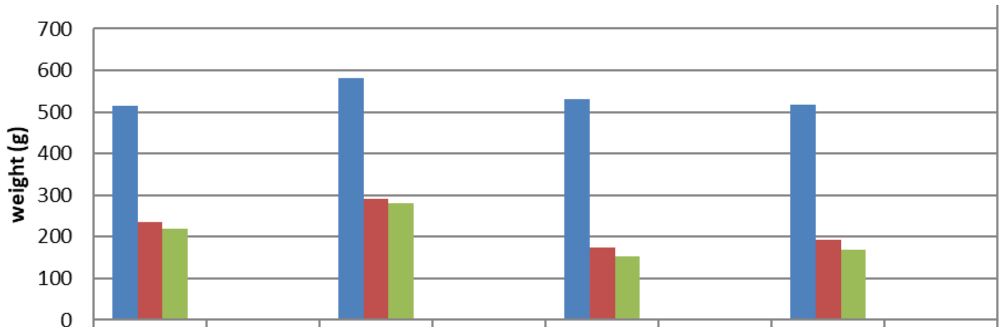


Figure 4-72 Seagrass productivity per site taken within the Bogue Lagoon

SOIL COMPONENT

Mean soil wet, dry and ash free dry weight (g)

Substrate analysis within the project area indicated that the sites with the highest organic content were RP 4 and RP 3. This was indicated through the difference between dry weight and ash free dry weights at each site (Figure 4-73).

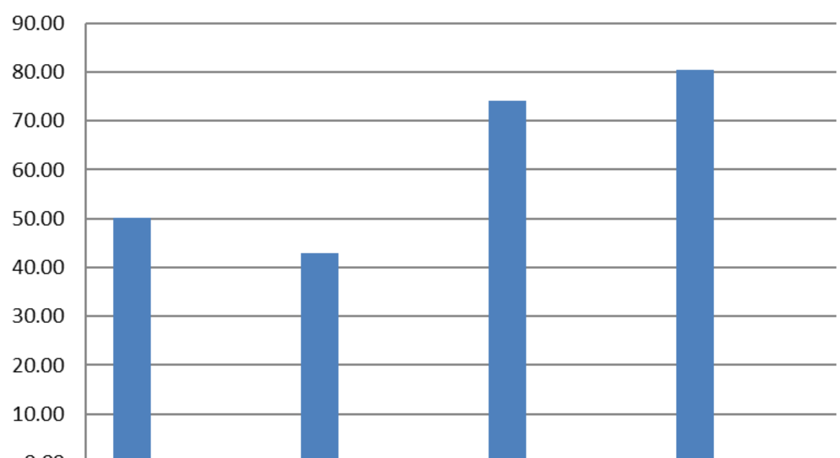


	RP 1	RP 2	RP 3	RP 4
Average Soil Wet wt. (g)	514.7	582.05	530.65	517.35
Average Soil Dry wt. (g)	234.45	292.1	174.65	191.6
Avg Ash Free wt.(g)	220.25	279.9	153.85	169

Figure 4-73 Average soil wet, dry and ash free dry weights (g) per site within the Bogue Lagoon

Mean soil carbon content (g)

According to the data which was analyzed, RP 3 and 4 had the highest soil carbon content of the sites which were sampled with values of 74.01Mg and 80.43 Mg respectively (Figure 4-74).



	RP 1	RP 2	RP 3	RP 4
Total Soil Carbon Content in core (Mg/ha)	50.13	42.96	74.01	80.43

Figure 4-74 Total soil carbon content per site (MgC/ha) collected in core samples within the Bogue Lagoon

Total soil carbon content (g)

Of the four (4) sites which were sampled, total carbon content per site was seen to be highest at RP 4 (80.43MgC) followed by RP 3, RP 1 and RP 3. Overall soil carbon content within the sampled area was calculated to be 247.536 MgC/ha (Figure 4-75).

CARBON RESULTS

Carbon in grass component (Mg/C)

According to analysis conducted on the samples for each site, the highest carbon within the shoot component of the seagrasses collected was seen at RP 1. This was followed by RP 3, 2 and 4 respectively (Figure 4-75).

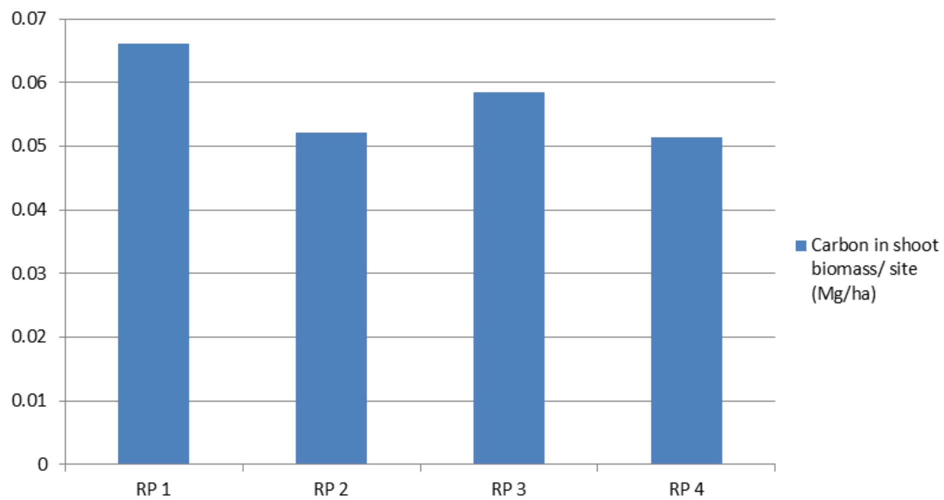


Figure 4-75 Carbon in shoot biomass (MgC/ha) per site within the Bogue Lagoon

Mean carbon in root/rhizome component (Mg/C)

Within the root and rhizome matrix, it was seen that carbon values are highest at RP 1 followed by RP 4, 2 and 2. Carbon values were seen to increase west of RP 2 and deeper within the Reading Pen peninsula bay (Figure 4-76).

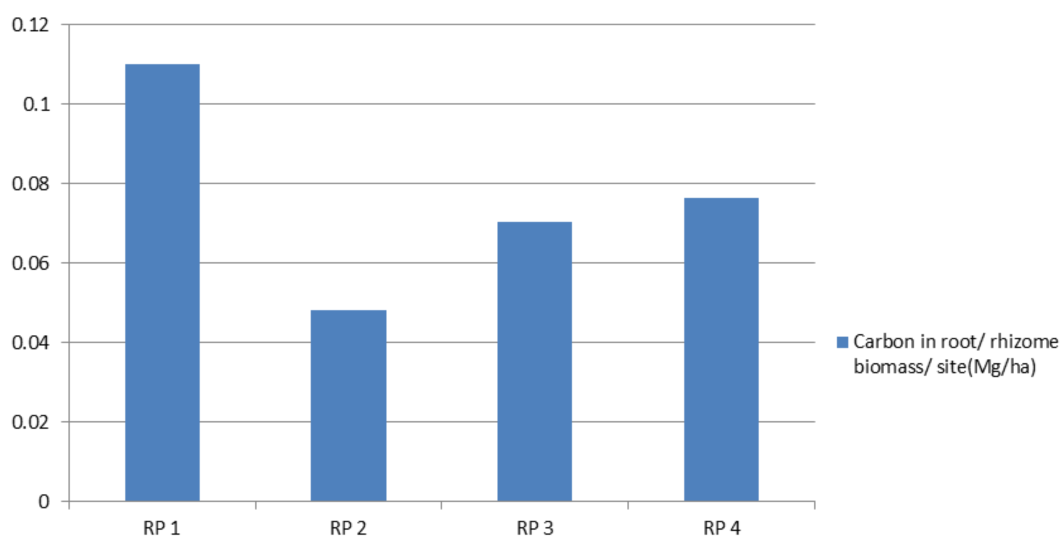


Figure 4-76 Carbon in root/rhizome biomass (MgC/ha) collected in core samples per site within the Bogue Lagoon

Discussion

BLADE DENSITY

According to Jackson, 2019 blade density gives an accurate representation of seagrass abundance and distribution compared to methods such as percentage cover. Data collected on this parameter indicated highest shoot biomass at RP 4 followed by RP 1, RP 3 and RP 2. High blade densities present at RP 4 may be due to its location in a relatively sheltered area. As a result, RP 4 receives reduced wave activity and therefore is the least disturbed of the areas sampled; allowing the meadow to have a lessened likelihood of uprooting due to wave activity and therefore a more dense bed. Water quality analysis conducted at this site indicated low average turbidity levels. Here, due to the dense bed present, there is a greater surface area of seagrass blades to efficiently trap and filter sediments from the water column. RP 2 was seen to have the lowest blade density of the sites sampled. Being located at the tip of the Reading Pen peninsula, this area receives high wave energies, resulting in increased disturbance which will lead to the continuous breakage of seagrass blades and a less dense meadow.

SHOOT BIOMASS

Seagrass biomass is the weight (measured as fresh weight, dry weight or ash-free dry weight) of seagrasses per meter squared and thereby provides a measure of seagrass abundance along depth gradients. This measure refers to either the total biomass or the aboveground biomass of the seagrasses (Borum et al., 2004). Seagrass blades, being above ground and exposed are the most vulnerable portion of the plant. These blades are often subject to breakage as a result of high wave energies, anthropogenic activities and grazing by a number of marine fauna (Short et al., 2016). As a result, shoot biomass of seagrasses ecosystems constantly changes depending on the physical and biological factors within their environment.

From samples collected, the highest shoot biomass was found at RP 1 (0.00195 g) while the lowest biomass was seen at RP 4 (0.00151g). Within RP 1, high shoot biomass may be due to low epiphytic colonization of seagrass blades, shallow depths and high photosynthetically active radiation (PAR) present as seagrass biomass is related to water clarity and light penetration (Borum et al., 2004).

Epiphytic colonization on seagrass blades within shallow and waters are known to do more good than harm to seagrasses as these colonies are seen to protect shoots from harmful UV B rays and reduce desiccation. According to Aho et al., 2011, epiphytes are seen to increase the growth rate of Thalassia testudinum within shallow zones and only begin to be disadvantageous when grasses have no need for the protective effects of epiphyte colonization from UV rays.

Where epiphytic colonization is high, seagrass blades are unable to absorb sunlight efficiently. Heavy epiphyte loads can also have detrimental effects on seagrass plants as hydrodynamic drag may increase the risk of leaf loss from wave or current activity (Hogarth, 2015).

Blades recovered from core samples taken at RP 4 possessed high amounts of these epiphytic colonies. This information coupled with the location of this meadow adjacent to mangrove forests may explain shoot biomass further. Among sites sampled, RP 4 is located in closest proximity to the adjacent mangrove forest. Mangroves here will shade portions of the seagrass bed reducing the amount of light which is able to penetrate through the water column. This is further confirmed by water quality data collected which indicates low average PAR values.

PRODUCTIVITY

According to Koopmans et al., 2020, seagrass productivity for a given meadow is determined by the balance of photosynthesis and respiration. This balance is determined by the response to environmental factors such as nutrient availability, temperature, water velocity, carbon dioxide availability and irradiance; with response to irradiance being the most fundamental. Among the sites sampled, RP 1 had the highest productivity (0.381g m2 d-14) followed by RP 3, RP 2 and RP 4.

The rate of productivity seen at RP 1 may be due to shallow depths, increased PAR and increased TDS compared to the other sites which were sampled. Shallow depths allow for the increased absorption of light by shoots as well as nutrients present within the water column leading to higher productivity rates. Low productivity at RP 4 may be a result of the high epiphytic colonization of seagrass blades as seen in Figure 11. Though epiphytic algae may have beneficial effects on seagrasses (Orth & van Montfrans 1984, Brandt & Koch 2003), negative impacts such as the reduction of light available for photosynthesis, reduction in the rate of diffusion of materials such as CO2 across the seagrass blade surface and increased physical drag (resulting in increased loss of leaves or plants) are seen to predominate (Nelson, 2017). Epiphytic biofilms often benefit in less than optimal conditions due to their capacity to tolerate reduced water qualities as well as their positioning further up in the water column (being located on seagrass blades) allowing them to absorb light at shallower depths.

SHOOT CARBON

Carbon values within shoot components varied between 0.0661MgC at RP 1 to 0.0514 MgC at RP 4. As discussed earlier, the role of disturbances, epiphytes and productivity has a significant influence on seagrass biomass. This also translated into the efficiency at which carbon is stored within seagrass blades.

In addition, the possible exchange of fauna at RP 4 between the nearby mangrove ecosystem and seagrass meadow may influence shoot carbon values. High biodiversity may result in increased stress on seagrass meadows as feeding relationships (grazing) may be increased, shading by mangroves and increased epiphyte colonization may also result in low carbon values. These stressors will result in low overall productivity and explain the decreased biomass seen here.

According to Dawes, 1998, under the influence of shading; seagrasses such as Thalassia testudinum which have undergone prolonged blade damage or removal but has an intact rhizome matrix will support lower blade growth in that area. Plants here will therefore promote colonization in areas of high light availability rather than vertical growth in shaded regions. Therefore, shaded areas within seagrass beds will have a relatively low blade length and higher numbers of shoots, in an effort to increase surface area for light capture. Blade densities seen at RP 4 may therefore result due resource allocation strategies being implemented by seagrasses. As a result, more energy may be put toward horizontal spread of the bed present rather than vertical growth of blades; leading to reduced shoot carbon.

ROOT BIOMASS

Like most plants, a significant portion of effort is placed into the development of root systems. Within seagrasses this is particularly important as these plants are under constant environmental pressures from wave activity. As a result, seagrasses possess a vast root/rhizome matrix which not only helps the plant holdfast to its substrate, but is also beneficial to the ecosystem as it prevents this substrate from being removed by wave activity.

Of the sampled sites, the site with the highest root biomass was RP 1(0.0032g) while the site with the lowest root biomass was RP 2 (0.0014g). RP 1 is situated west of the Reading Pen peninsula and is a relatively sheltered site in close proximity to mangrove forests. Grasses here may have a high root biomass due to the substrate having a fine, silty consistency. Grasses within this area may have a hard time holding fast to the substrate and so will invest a significant portion of their energy into staying grounded.

The more exposed sites to wave activity, RP 2 and RP 3 are seen to have the lowest biomass of the sites sampled with RP 2 possessing the lowest biomass of all four sites. Root biomass at RP 2 may be a result of the substrate containing large amounts of shells which were also found interlocked within root systems recovered from the core sample. At high densities, shells may prevent root systems from successful lateral spread.

ROOT CARBON

A characteristic of most plants, carbon is typically found in higher densities within root systems due to the carbon fixation process. Carbon stores within root systems tend to be much higher than within leafy above ground portions due to their above ground nature and thus continuous loss of carbon stored in the above ground vegetation. It is less likely that these stores are released unless major disturbances which impact the benthos occur such as mining or dredging.

Within the below ground vegetative component of the seagrass meadow which was sampled surrounding the Reading Penn peninsula, an estimated sampled area carbon pool value of 0.3054 MgC/ha was determined. Of these estimates, the site with the highest carbon stored within the root component was RP 1 (0.1102MgC). Data for this parameter was consistent with trends seen in root biomass as highest values were seen in RP 1 followed by RP 4, RP 3 and RP 2 respectively. Sites RP 1 and RP 4 are situated in close proximity to mangrove ecosystems. As discussed earlier, the proximity to mangrove forests has a significant impact on carbon values seen within seagrass ecosystems as organic carbon inputs are high among mangrove ecosystems. The root and rhizome matrix are therefore expected to have a high capacity to sequester and store carbon once it is allowed to spread effectively.

SUBSTRATE ANALYSIS – DRY BULK DENSITY

Determined by the mass of a fully dried sample and its original volume, dry bulk density often indicates prominent soil components including the differences between organic and inorganic components. This is often determined by texture, colour, weight and the contents of these dried samples. Among the samples taken, there was an observable difference in colour and texture between at RP 2 and those taken at RP 3 and RP 4. Substrate recovered at RP 2 had similarities to silty anoxic sediment and had large amounts of uninhabited intact shells.

SUBSTRATE CARBON

Based on the results gathered, blue carbon storage within the substrate was greatest at RP 4 (80MgC) while RP 2 had the lowest carbon storage (42.96 MgC). Storage of carbon among sediments is dependent upon a number of factors including the stability of the sediment, associated root components of seagrasses present within the area, proximity to mangrove ecosystems and the nature and level of disturbances which an area possesses. At RP 4 and RP3 specifically, substrate recovered appeared brown/red and was peat-like in nature with visible portions of matted dead mangrove root materials; making this sample high in organic content. This is consistent with the data gathered as soil carbon values between sites had little variation (±5MgC). Supporting data for this parameter at RP 4 include blade density and root biomass of which high values present are able to further support substrate carbon seen. High blade densities will lead to increases in sediment trapping by seagrasses leading to greater soil carbon as the sediment layer will continuously receive input as fallout occurs from the water column.

Sites which were located in the more sheltered sections within the project area are seen to have a greater soil carbon value. This is due to decreased effect which wave activity may play east of the peninsula.

4.2.4 Mangrove Community

4.2.4.1 Overview

Investigations of the proposed development site at Reading Pen revealed that the site has a significant mangrove forest community found at the tidal areas of the property, boasting a Rhizophora mangle (red mangrove) dominated inter-tidal zone, which surround the property. However, this band of mangrove forest varies in thickness around the periphery of the development site, having a wider band of mangroves to the East where a stream emerges, travelling north towards the Bogue lagoon. The band of mangroves gets narrower moving North towards the properties northern tip, where the band gets very wide, and again narrowing towards the property's Western boundary. The property's western edge is characterized by a relatively steep slope, seemingly the result of fill material historically deposited at the site (based on rubble, debris, and limestone material evident in many sections of the sloping shoreline) in previous years. *Laguncularia racemosa* (white mangroves) dominate this shoreline. However, a very dense band of red mangroves is found West of the development sites' Western fringes, separated by a narrow and very small stream/storm drain.

4.2.4.2 Mangrove Survey

Figure 4-77 and Table 4-46 show the ten (10) sample plot locations used to examine the mangrove community.

Table 4-44 Coordinates, seedling density, salinity, and water depth for quadrats 1 to 10

Quadrat	Coordinates	Water Depth (cm)	Salinity (ppt)
1	18.445026, -77.940945	5	0
2	18.446000, -77.941454	60	24
3	18.446866, -77.941913	40	30
4	18.447456, -77.942325	40	30
5	18.447760, -77.942965	20	30

Quadrat	Coordinates	Water Depth (cm)	Salinity (ppt)
6	18.447453, -77.943426	30	34
7	18.447106, -77.943295	40	30
8	18.446686, -77.943210	> 60	5
9	18.446020, -77.943130		24
10	18.445220, -77.942755	~ 60	0

Figure 4-77 Mangrove footprint and plots

Red mangrove trees were found in varying densities ranging from 9 to 22 per plot (100m^2) around the property's fringes (Table 4-45, Plate 4-14). Mangrove tree heights reached a maximum of 11.1 m at the Eastern edge (plot #1), which also boasted greater species diversity having both red and white mangrove trees, which was not very commonly seen in most sample plots. Red mangrove tree heights became progressively taller with larger DBH values moving north.

Table 4-45 Mangrove tree density, average height and average DBH in 10m x 10m quadrats across the survey site

Quadrats	*Rhizophora Mangle (*Red Mangrove)			*Laguncularia racemosa* (White Mangrove)			Seedling Density (per m^2)
	Tree Density	Average Tree Height (m)	Average DBH (cm)	Tree Density	Average Tree Height (m)	Average DBH (cm)	
1	9	6.4	9.2	4	11.1	24	6 - red mangrove
2	12	6.3	14.4				60 - red mangrove
3	17	10.5	16.6				17 - red mangrove
4	13	10.7	15.8				18 - red mangrove
5	13	10.9	12.3				28 - red mangrove
6	6	10.3	6.5				9 - red mangrove
7	9	7.4	15				
8	12	8	15				
9	22	7.6	12	1	2.2	1	
10	13	7.8	7.6				

Plate 4-14 Red mangrove trees within sample plot #3

Plate 4-15 Red mangroves in sample plot #5-East

The red mangrove trees on the Eastern edges also boasted comparatively greater animal diversity found on the prop roots submerged into the lagoon's waters, indicating that this section is the most stable and possible "older" and undisturbed section of the property.

The heights attained by the white mangroves in plot 1 may be explained by the presence of fresh water in this location (see visible hydrology section below). White mangrove trees also attained the widest girth (DBH), boasting an average 24cm in this location. This DBH and height value for white mangroves was very contrasting to the trees found on the Western edges (plot 9), where trees had mean heights of 2.2 m and were very shrubby (1cm DBH). The vegetative characteristics of the Western mangroves may support a theory of historic reclamation and persistent disturbance, as despite the low salinity that white mangroves normally thrive in (as seen in plot #1), the trees here have not attained significant growth compared to their Eastern counterparts.

It is noteworthy that the sediment found at the Western fringe was extremely soft and fine, with a very deep channel (Plate 4-16) separating the Reading Pen development site from the neighbouring mangrove Cay/lands immediately West. This Western stream "may" have relatively frequent and perhaps strong outflows which is preventing normal mangrove land accretion and mangrove seedling recruitment. Plate 4-17 shows a 2011 aerial (Google Earth) image, where the Western stream can be clearly seen separating the respective land parcels. Recent images show an overgrowth of the channel with mangrove vegetation on the West and other vegetation on the Reading pen development site.

Plate 4-16 Narrow creek (northern end) separating proposed development site from Western mangroves- with historically placed rubble and fill material evident

Plate 4-17 Google earth image (2011) showing the very visible western stream/creek, water level logger locations and freshwater flow directions observed for the eastern and western channel

Table 4-46 Other non- mangrove wetland vegetation observed throughout survey area

Flora Observed	DAFOR Index
Lantana sp.	F
Mimosa pudica (Shame 'ole' lady)	F
leucaena sp. (Lead tree)	F
Solanum torvum (Susumber)	O
Sedge	F
Albizia saman (Guango)	O
Coconut	O
Ricinus communis (Castor oil plant)	F
Eleocharis sp.	O
Acrostichum aureum (Mangrove fern)	A
Typha	F
Wild tobacco	R
Dalbergia sp. (coin vine)	F
Guazuma ulmifolia (Baceda)	F
Clitoria sp.	O
Bidens alba (Spanish needle)	O

4.2.4.3 Mangrove Hydrology

The interior of the proposed development site is raised, and no visible sources of water were observed in this location. The entire periphery of the site has mangrove forest vegetation, supported by tidal and estuarine water, ranging in salinity from 0-34 parts per thousand (ppt). The property has 2 main riverine sources at the east and west, which allows mixing of sea and fresh water in most tidal locations. The salinity is noticeably reduced at the "mouth" of the streams and increases to near normal seawater at the Reading Pen point. Therefore, the hydrology of the property is unremarkable, with persistent freshwater flows moving north towards the Bogue lagoon, and not rising unto the interior of the development footprint. The fringes of the mangrove forest are tidally influenced, but the interior is 1-3m higher than the inter-tidal zone, preventing any wetting in normal weather conditions.

Water level loggers deployed (logger #1 placed at Station R1 and logger #2 placed at Station R5) at the site (Dec 23rd, 2021 to Jan 8th, 2022) showed normal tidal fluctuations with a mean tidal fluctuation of 30-31 cm over the 2-week period for both loggers placed at the East and North locations (Figure 4-78 and Figure 4-79). The Eastern River showed constant water flow while the Western creek showed no net movement during survey days.

However, logger #2 (North placement) showed a spike in temperature between Dec 27-29, 2021, which coincided with the lowest water level measurements. The area likely experienced very low tides that period, and the logger was exposed to excess sunlight in the gaps of the forest, or the logger was sitting in a small pool of water which became heated (40-41 °C) due to lack of tidal movement.

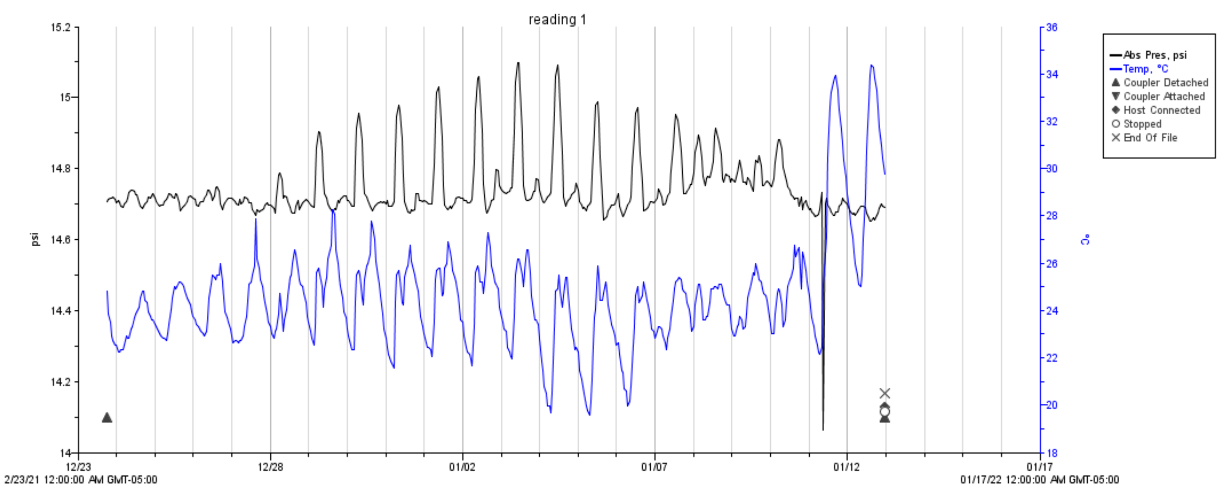


Figure 4-78 Water level logger #1-placed at plot R1 (Eastern boundary)

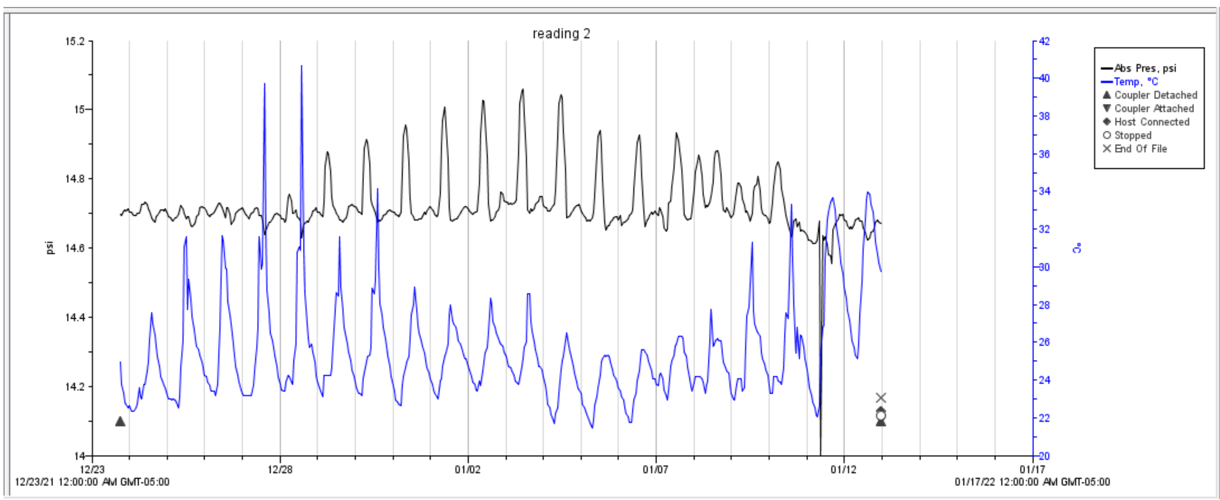


Figure 4-79 Water level Logger #2 placed at plot R5 (northern property)

4.2.4.4 Mangrove Productivity

The rate at which organic matter per unit area is created as a result of photosynthesis is known as productivity, and leaf litter production has been used widely as a substitute to determine the net primary production within a mangrove forest (Hogarth, 2007). A highly productive mangrove forest produces around 10,000 grams of organic matter m^{-2} per year, which is a superior rate to other coastal communities (Osborne, 2000).

Six (6) locations were studied for leaf productivity at the Reading Pen site and Bogue mangrove forest environs (Figure 4-80). Within four (4) selected quadrats and two (2) other adjacent control sites, leaf litter was caught in 0.25m^2 wooden frames traps with fine mesh. Two traps were placed within each quadrat for 21 days. Traps were positioned level below the branches of the trees in the closed canopy, away from excess wind or human disturbance.

The leaf litter collected was placed in a bag, air-dried for 72 hours, and weighed. The productivity was then calculated using the formula below:

$$\textbf{Productivity}\ (\textbf{gm}-^{2}\textbf{d}-^{2}) = \textbf{4}\ \left[\frac{\textbf{weight (g) of litter over 0.25m}^{2}\textbf{area}}{\textbf{Time (d)}}\right]$$

Plate 4-18 Leaf litter trap at Mangrove Cay-East

Plate 4-19 Leaf letter trap at R8(b)

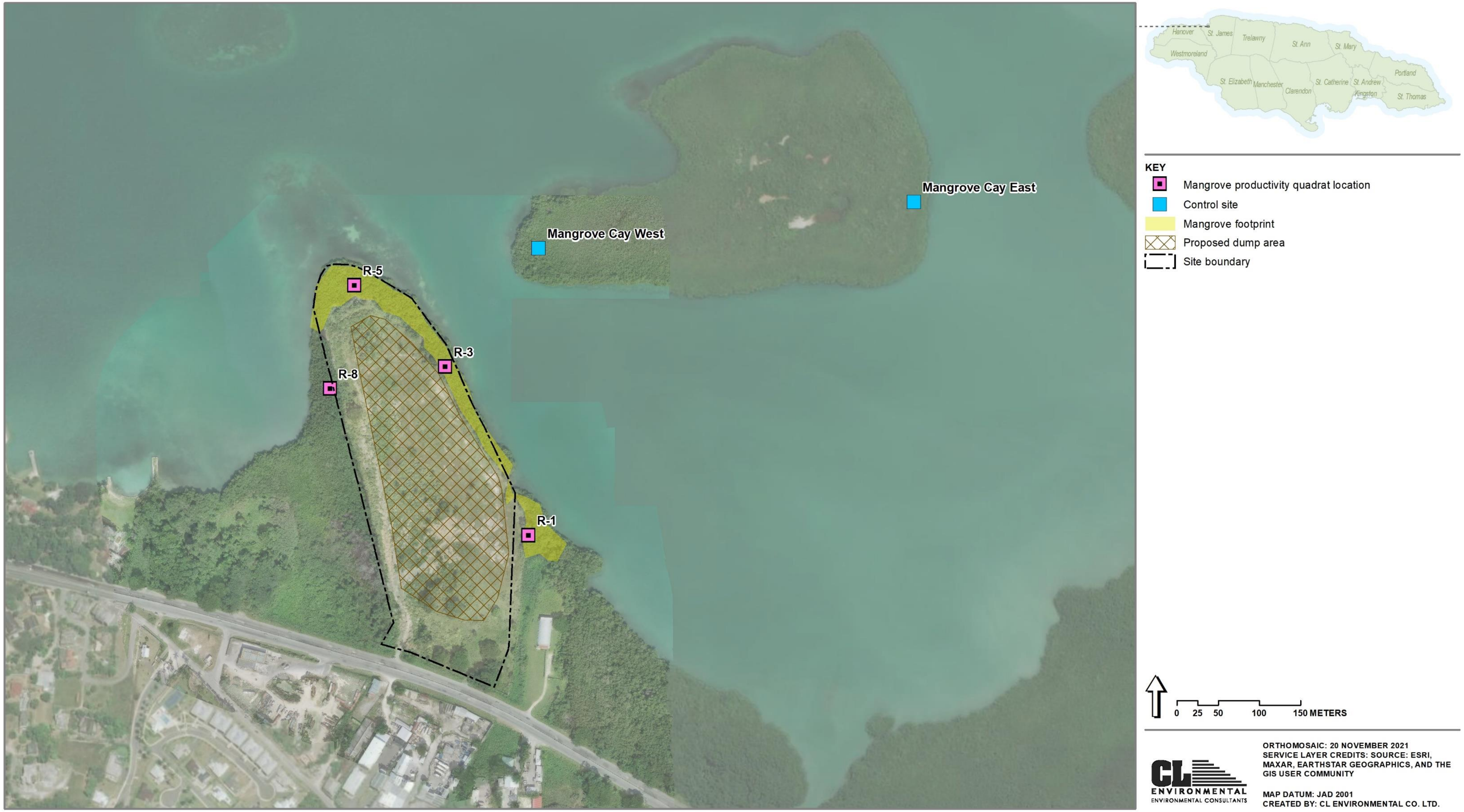


Figure 4-80 Leaf litter trap locations

As seen in Table 4-47, quadrats R3B and R8B had comparatively higher leaf production than the other sites (higher than 5g), while the other locations showed productivity between 2- 4.98 g/m²/day. The derived productivity figures for all sites were consistent with expectations based on previous studies. The most recent comparison can be drawn from McFarlane (2021) where sites in Falmouth, Jamaica had productivity vales ranging from 2-9 g/m²/day. McFarlane (2021) showed that sites relatively free of human impact, in fresh water and having trees taller than 11m, had productivity values over 9g/m²/day. Estuarine sites with shorter trees had values ranging from 2-4g/m²/day, very similar to these Bogue/Reading Pen sites. Other relevant studies include Chin (2014), who highlighted mean forest productivity values of the North Coast Sites ranging from 2.058 g/m²/day to 6.907 g/m²/day.

Table 4-47 Leaf litter weight and calculated productivity at each sample site

Sample	Weight (g)	Productivity (g/m²/day)
Mangrove Cay East 1A	15.74	3.00
Mangrove Cay East 1b	12.09	2.30
Mangrove Cay West 1A	11.7	2.23
Mangrove Cay West 1B	14.34	2.73
R1A	17.41	3.32
R1b	15.02	2.86
R3A	12.46	2.37
R3B	30.35	**5.78**
R5A	11.62	2.21
R5B	26.16	4.98
R8A	21.43	4.08
R8B	29.63	**5.64**

4.2.4.5 Prop Roots

Various species of sea-sponges, hydroids, oysters, anemones and other benthic fauna were observed on these red mangrove prop roots (Plate 4-20 to Plate 4-22). These sessile mangrove fauna were noticeably missing from plot 1 and plots 8-10 on the Eastern and Western edges respectively, where higher freshwater quantities were recorded (indicated by salinity as seen in Table 4-44). This was expected as there is a well-accepted correlation between mangrove fauna and salinity, where these sessile organisms favour a saline/normal seawater (36 ppt) habitat.

Plate 4-20 Sponges and ascidians observed on Red mangrove roots in Bogue lagoon

Plate 4-21 Oysters, Sponges and ascidians observed on Red mangrove roots in Bogue lagoon

Plate 4-22 Oysters and sponges amongst red mangrove roots

4.2.4.6 Ecological Services

The proposed project area occurs within a Coastal Ecosystem with a combination of wetland and terrestrial habitats. The mangrove forest portions of the property utilize the fresh water sources that travel North from 2 streams found East and West of the property, which mix with the tidal waters from the Bogue lagoon.

It is evident that the properties support a few life systems and provides habitat for several organisms. The project area has a comparatively moderate amount of mangrove forest which has varying no clear zonation based on the narrow nature of the mangroves. There were varying degrees of historic human modification and influences (East and West) as well as areas with little to no human interference (north).

Mangrove forests are known to provide over 200 functions globally. The observed services of the Ecosystems found on the proposed development site includes (not in order of importance):

1. Water retention
2. Nutrient filtration
3. Nutrient cycling
4. Carbon sequestration
5. Coastal protection from wind, storm events and surges
6. Erosion prevention and shoreline stabilization
7. Solid waste trapping
8. Sediment trapping

9. Land accretion
10. Habitat provision for numerous fauna (birds, reptiles, molluscs, arthropods, annelids etc)
11. Provision of food for wild fauna and livestock
12. Nesting and spawning grounds for fauna
13. Provision of wood for humans (fuel, construction, fishing)
14. Agricultural uses for humans
15. Fishing grounds for humans

The list provided is not exhaustive but based solely on field observations and anecdotal conversations over a 3-day field study.

4.3 NATURAL HAZARD VULNERABILITY

4.3.1 Wind Assessment

Wind hazards relate to the potential damage that high-velocity winds can generate, which are likely to cause damage. Damage is caused by force exerted directly by the wind on the physical structures or is caused by the impact of objects that become projectiles due to the high velocity of the winds. While spontaneous weather systems such as thunderstorms or cold frontal systems may produce higher than normal wind speeds, hurricanes are responsible for most wind hazard situations.

A hurricane is an intense tropical weather system with a well-defined anti-clockwise circulation of sustained winds of 74 mph (33 m/s) or higher. As high-velocity winds move perpendicular to high mountain ridges, significant wind speed variation occurs (Davenport (1985); Figure 4-81). The project area is mountainous and susceptible to accelerated wind speeds. The wind hazard phenomena took these topographic features into account to accurately estimate the possible effects.

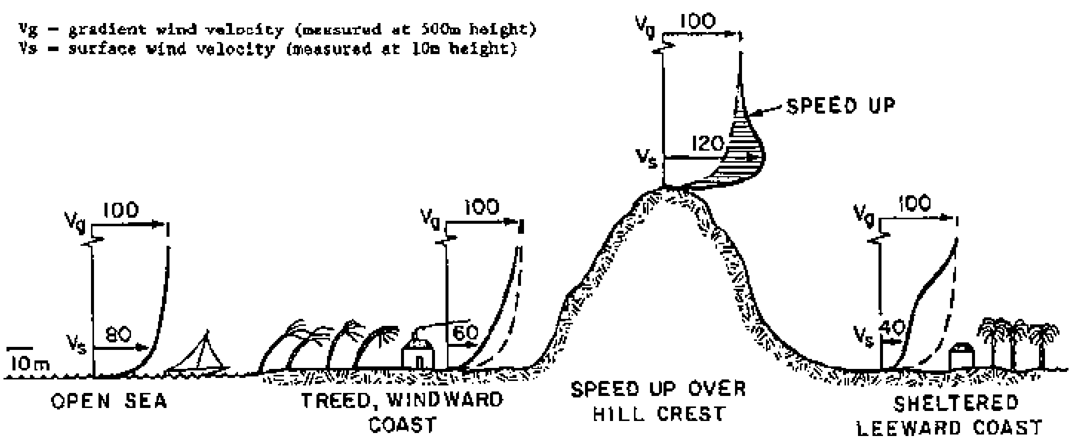


Figure 4-81 Diagram showing effects of topography on hurricane wind speeds. Source: (Davenport, et al., 1985)

4.3.1.1 Approach

The general approach taken to determine the wind hazard is to use the winds generated by a hurricane since this would be the primary source of high winds in the region. Given the correlation between storm surge and winds generated by a hurricane, a hindcast hurricane model was used to determine the wind and other conditions at a selected offshore location because of passing hurricanes. The National Hurricane Centre (NOAA) database of hurricane track data was utilised to carry out this hindcast, followed by a statistical analysis to determine the hurricane waves, wind, and setup. In this section, we are more concerned about the wind output.

Wind speeds were then projected by WindNinja, which computes spatially varying wind fields. It requires elevation data for the modelling area, a domain-mean initial wind speed and direction, and specification of the dominant vegetation in the area. The model then outputs grids of wind speed and direction presented on maps.

The methodology used includes:

1. Extraction of Storms and Storm Parameters from the historical database. A historical database of storms was searched for all storms passing within a search radius of 100km radius of the site.
2. Application of Extremal Analysis. Here the predicted maximum wind speed from each hurricane was arranged in descending order, and each assigned an exceedance probability by Weibull's distribution. The future return period was be derived based on the historical data. The addition of 24% increase in category 4 & 5 hurricanes was then applied projected to mid-century (2040–2060) under radiative forcing scenario RCP8.5 according to Emanuel (2013)2.
3. Use elevation data along with the winds generated by the storm surge model to compute spatially varying wind fields over land.
4. Produce maps of wind speed and direction for different return periods for the various sites.

4.3.1.2 Results

A sensitivity analysis was done to determine the worst-case hurricane, and results showed that the most extreme wind speed will be generated from a Northerly direction, closely followed by the South.

Table 4-48 Summary of Hindcast Hurricane Model for 2 to 100-year return periods.

RP	Wind Speed (m/s)
2	53.5
5	62.8
10	68.1
25	71.7
50	72.0
100	75.0

[2] Emanuel, Kerry A. "Downscaling CMIP5 climate models shows increased tropical cyclone activity over the 21st century." *Proceedings of the National Academy of Sciences* 110, no. 30 (2013): 12219-12224.

The projected wind speeds generated for 2014 to 2060 show increases of 20.7% for the 100yr wind speeds to 25.7% for 10yr wind speeds; this means that in some instances, wind speeds are likely to increase by up to 17.5m/s more the present climate. Further, the wind field model revealed that the project area will likely experience large fields of high winds during extreme weather events ranging between 70-90 m/s for future 100-yr RP events (Figure 4-82).

Table 4-49 Summary of Projected maximum wind speeds for 2-to-100-year return period hurricanes.

RP	Wind Speed (m/s)	Percentage Increase
2	65.4	22.2%
5	76.1	21.2%
10	85.6	25.7%
25	88.6	23.6%
50	88.7	23.2%
100	90.5	20.7%

Future Climate 100-yr Return Period Wind Speeds

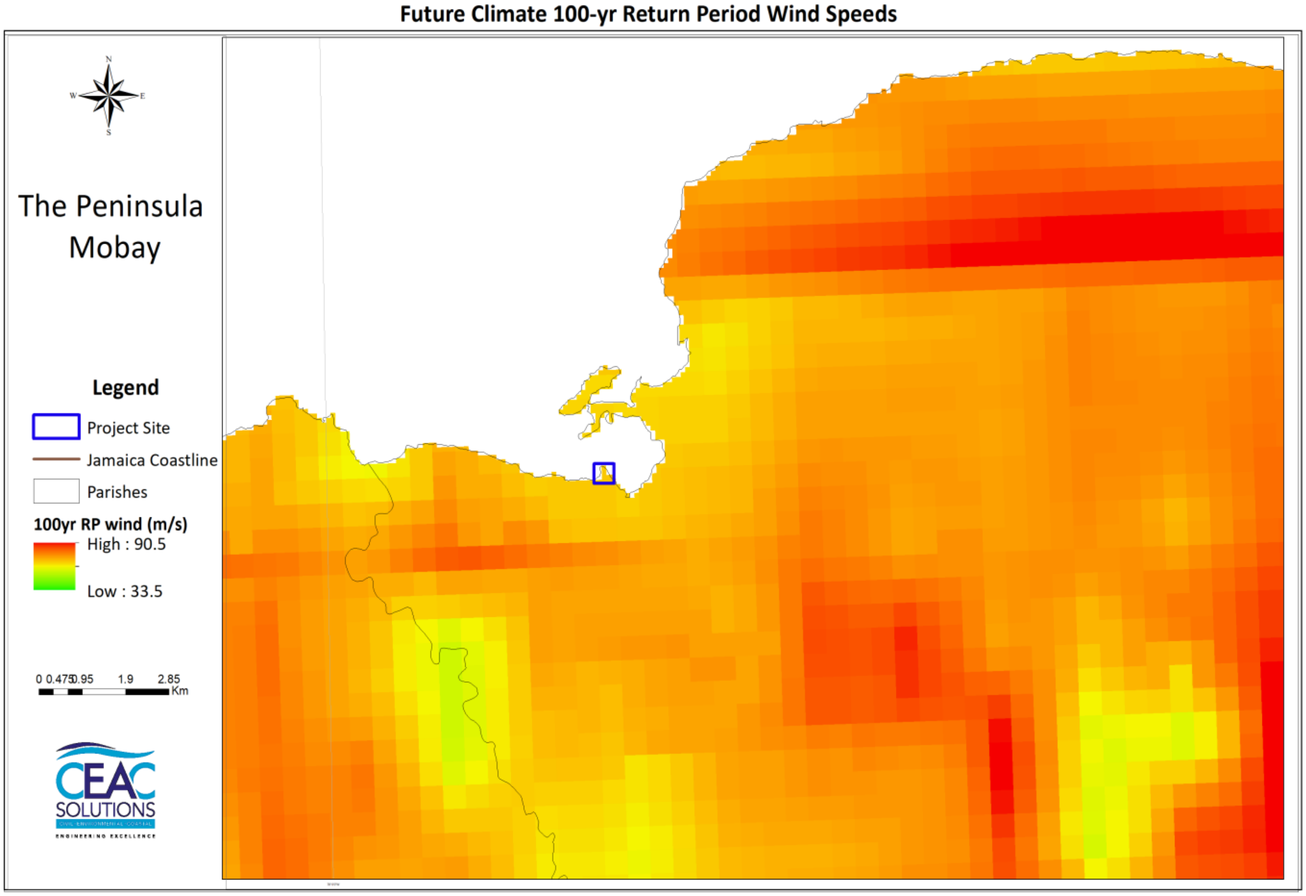


Figure 4-82 100-year RP Wind speeds with winds varying directions (driving wind speeds of 165 mph or 90.5 m/s)

4.3.2 Climate Change Considerations

Recent global and regional climate change models have been predicting changes in the climate conditions that may increase the impacts of the coastal hazards. Jamaica's Second National Communication (SNC) on Climate Change (Government of Jamaica, 2011) lists the main climate change hazards as follows:

- Sea level rise
- Increase in extreme events – precipitation and drought
- More intense storms and increased storm surge levels
- Increased temperature

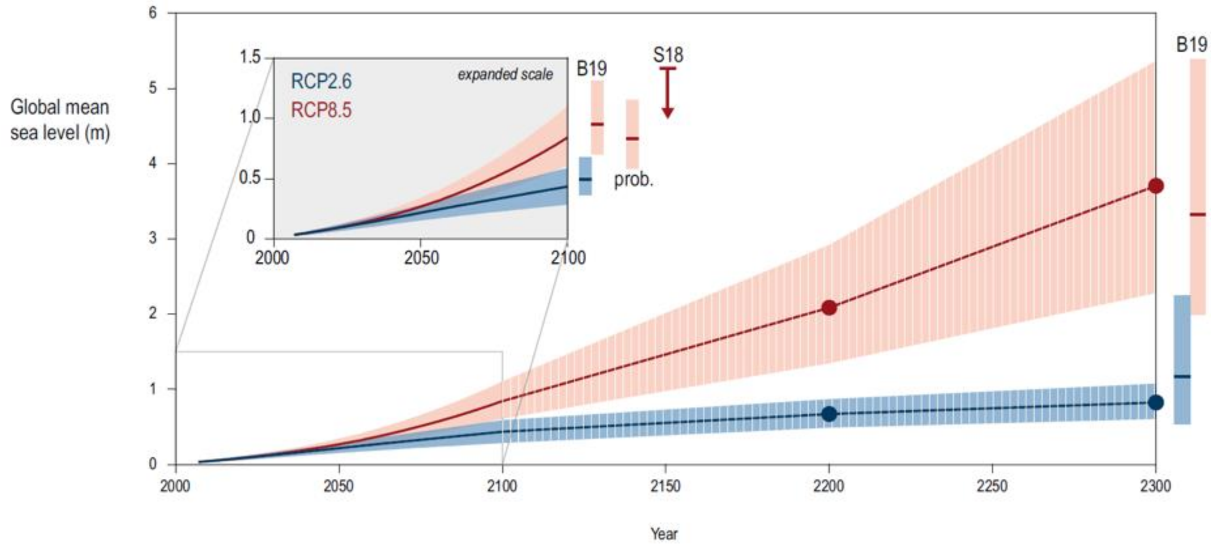
4.3.2.1 Sea Level Rise

Rises in localized sea levels are based on thermal expansion and salinity, both affected by increases in temperature. An increase in temperature naturally warms the oceans and contributes to salinity by adding fresh water to the ocean through the melting of glaciers and ice sheets, thus causing sea-level rise (SLR). Sea level rates are increasing across the globe at an accelerating pace, especially in the 20th century. Globally SLR trends are estimated to have doubled from 1.7 mm/year to 3.1 mm/year. It was noted that the SLR trends within the Caribbean are closely assimilated with the global trends. Caribbean trends are approximately 2.5 ± 1.3 mm/year which is marginally close to the global trend. The Caribbean region is known to have experienced higher SLR due to more intense (warmer) El Niño effects (CEAC Solutions Co. Ltd., 2022).

The following procedure was carried out to determine the sea-level rise:

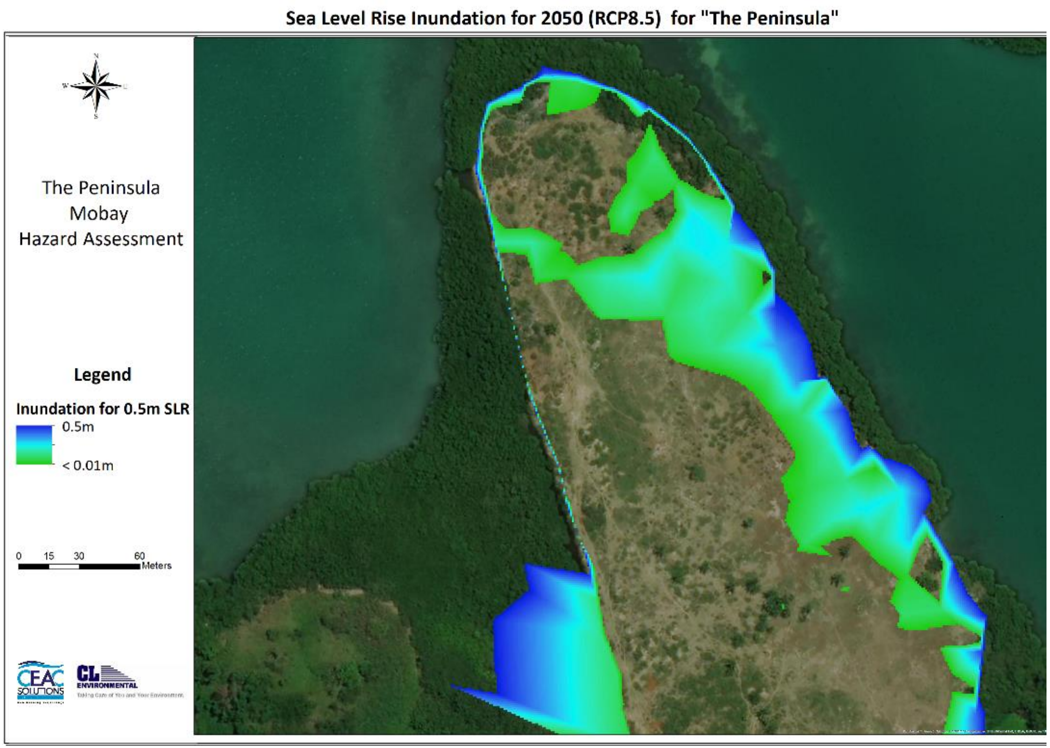
- Application of the RCP 8.5 SLR scenario based on the IPCC AR5 report. Here it was chosen because it represents the worst case of all the emissions scenarios regarding the concentration of GHGs in the atmosphere associated with future global development patterns to the end of the century.
- Produce maps of SLR for different return periods at the project site.

From the available body of literature examined, the following changes related to sea-level rise was noted, there is medium confidence that GMSL is projected to rise between 0.29–0.59 m (likely range) globally under RCP 2.6 and 0.61–1.10 m (likely range) under RCP 8.5 by 2100 (Oppenheimer, 2019) (CEAC Solutions Co. Ltd., 2022).

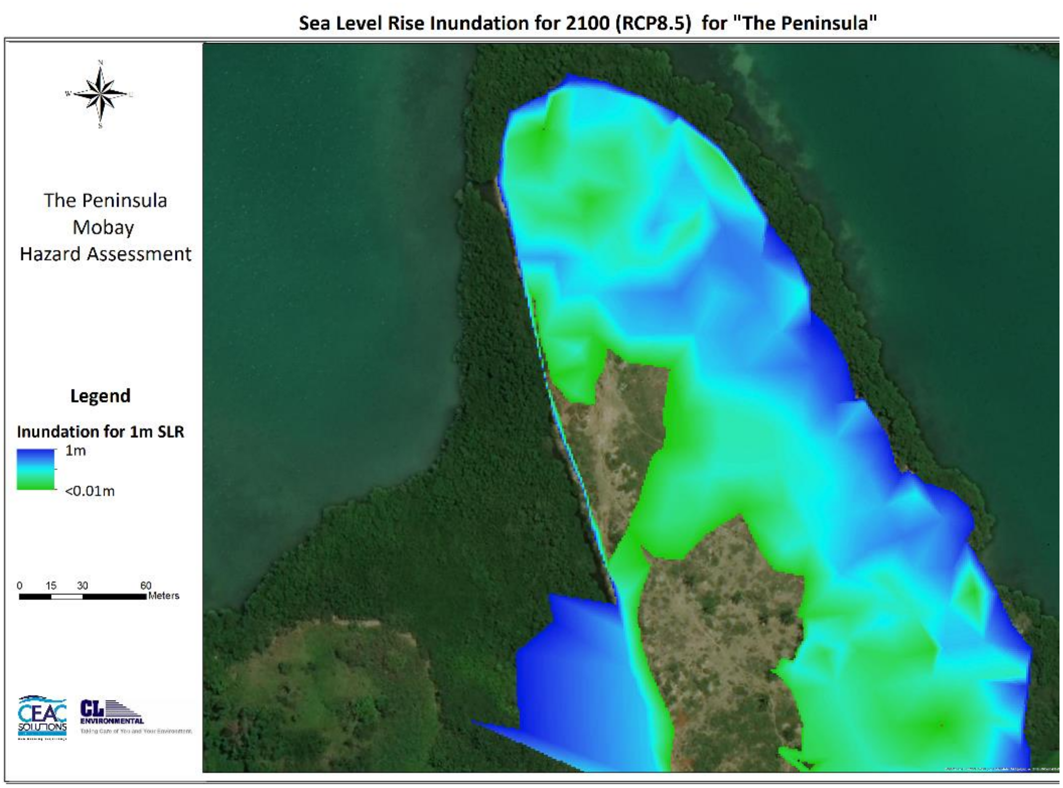


Projections for longer time scales are highly uncertain but a range is provided (4.2.3.6; low confidence). The two sets of two bars labelled B19 are from an expert elicitation for the Antarctic component (Bamber et al., 2019), and reflect the likely range for a 2ºC and 5ºC temperature warming (low confidence. The bar labelled "prob." indicates the likely range of a set of probabilistic projections. Source: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Community.

Figure 4-83 Projected Sea level rise (SLR) until 2300 for RCP2.6 and RCP8.5 up to 2100 (medium confidence)



(a)



(b)

Figure 4-84 Sea level rise elevations depicted within the project area in the year: (a) 2050; (b) 2100

4.3.2.2 Storm Frequency and Intensities

Historical Studies

The AR5 (fifth assessment report) notes that evidence suggests a virtually certain increase in the frequency and intensity of the strongest cyclones in the Atlantic since the 1970s. It is further noted that the average lifetime of North Atlantic tropical cyclones shows an increasing trend of 0.07 day/yr. for the same period which is statistically significant (Villarini & Vecchi, 2012).

Other recent studies (Jones, 2016) focused on the North Atlantic region highlighted several documentary evidence of trends in the North Atlantic cyclone frequencies over the past century. The trends show higher North Atlantic Tropical Storm (TC) activity (+60%°C_1) since 1995 [Goldenberg et al., 2001] and increased frequency of very intense TCs (~ + 17%°C_1) within the North Atlantic region since the 1990s [Emanuel, 2007; Holland and Webster, 2007; Bender et al., 2010]. The studies further indicate the trends have been observed in association with long term changes in tropical Atlantic oceanic and atmospheric conditions important to North Atlantic TC development including increased mean surface temperatures (0.12 ± 0.04°C per decade for 1951–2010), increased tropospheric water vapour (7%°C_1 since 1970s), and fluctuations in vertical wind shear within 6ms_1 since 1995. Changes in some of these local factors as well as the influence of other remote factors such as the variability of sea surface temperatures (SSTs) in the central and eastern equatorial Pacific associated with El Niño–Southern Oscillation and/or multi-decadal North Atlantic variations have also been shown to influence TC variability on inter-annual and decadal timescales [Gray, 1984a; Goldenberg and Shapiro, 1996; Bell and Chelliah, 2006. Global climate Models (GCM's) utilising SST and near-surface wind predictors suggest significant increases in mean annual frequency by 2-8 TCs by 2070-2090, compared to a single surface wind predictor model, indicating that positive trends in SSTs under global warming have a larger relative influence on projections than changes in the variability of the surface winds. Even though similar research (Murakami, n.d.) show an overall decrease in Global and hemispheric TC genesis numbers (13%–25%) under the IPCC A1B global warming scenario. This must not be confused with the 2-8 increase per year noted by others which is Caribbean region specific. Additionally, it was also shown through use of high-resolution models that when the instantaneous maximum surface wind velocities for TCs are averaged, all coastal regions show an increasing intensity by 1%-7%.

Future Climate Projections

The Intergovernmental panel on Climate Change (IPCC) have made projections based on numerical models which indicate tropical storms are far more intense storms than in previous years. The (2007) IPCC report (Solomon, 2007) stated the following:

> *"There is evidence from modelling studies that future tropical cyclones could become more severe, with greater wind speeds and more intense precipitation. Studies suggest that such changes may already be underway; there are indications that the average number of Category 4 and 5 hurricanes per year has increased over the past 30 years."*

Others have isolated the influence of increasing temperatures on the frequency of hurricanes and have suggested that a 0.5°C increase will result in a 40% increase in hurricane activities (Saunders & Lea, 2008). The predictions of the IPCC are consistent with the number of category 4 and 5 storms that have tracked within 400 kilometres Jamaica in the past 130 years (Figure 4-85) the number of category 4 and 5 storms has increased from 10 to 15 storms per twenty-year intervals up to 1950 to 30 to 35 storms per twenty years after 1950. This doubling of storm occurrences coupled with increased sea level rise can result in shoreline retreat as beach profiles adjust to a more intense wave climate.

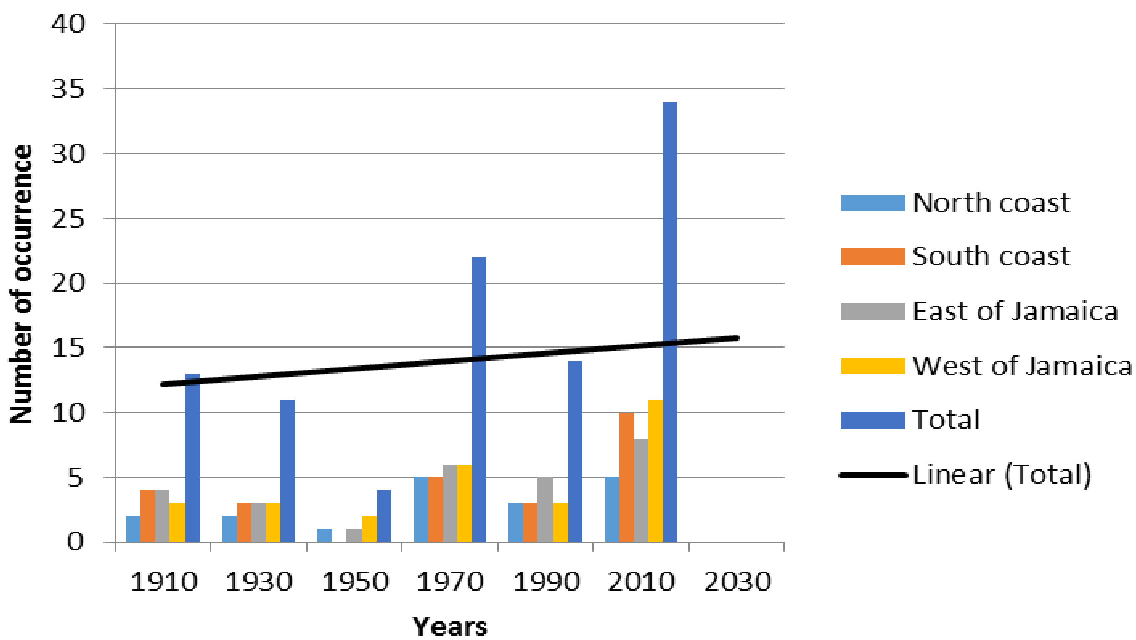
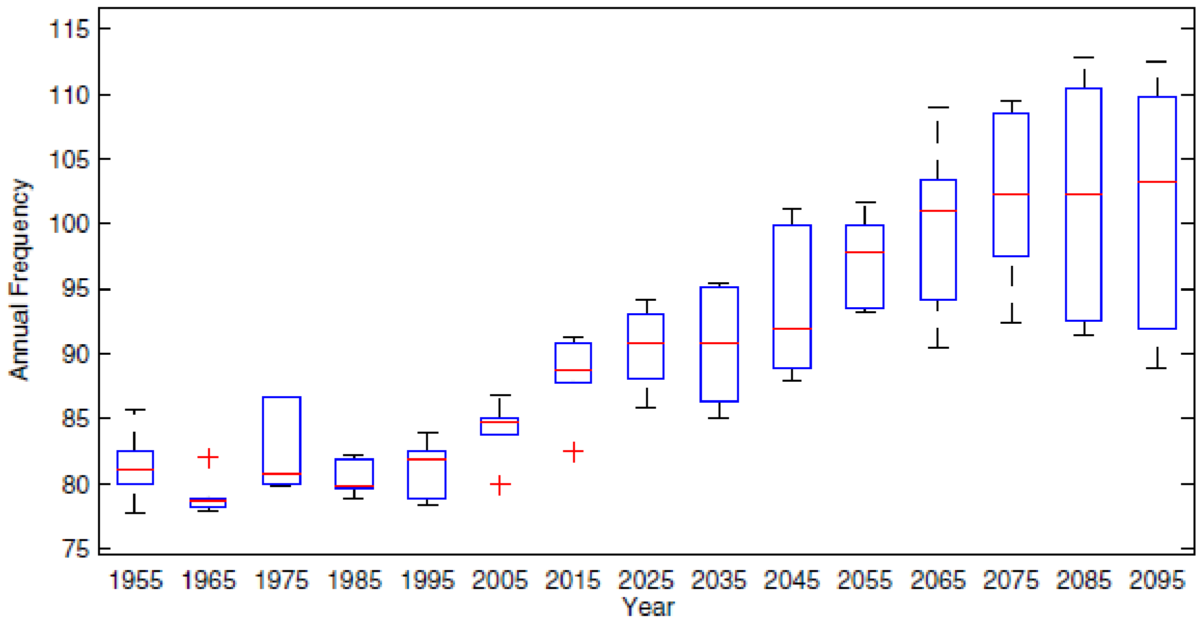


Figure 4-85 Occurrences of Category 4 and 5 hurricanes that have passed within 300 kilometres of Jamaica's shoreline since 1890 to 2014, in twenty years intervals

A study carried out by Emanuel (2013) projected that the frequency and intensity of tropical cyclones are expected to increase from 1981-2000 to 2100 under radiative forcing scenario RCP8.5. It was projected that noticeable increases in tropical cyclones will occur in the North Atlantic and South Indian Ocean. Especially during the first three quarters of the 21st century is indicated, with a total increase in the range of 10–40% (Figure 4-86). Along, with an increase of 40% globally in hurricanes of Saffir-Simpson Category 3 and higher.



Source: Emanuel (2013)

In each box, the red line represents the median among the six models, and the bottom and tops of the boxes represent the 25th and 75th percentiles, respectively. The whiskers extend to the most extreme points not considered outliers, which are represented by the red + signs. Points are considered outliers if they lie more than 1.5 times the box height above or below the box

Figure 4-86 Global annual frequency of tropical cyclones averaged in 10-y blocks for the period 1950–2100, using historical simulations for the period 1950–2005 and the RCP8.5 scenario for the period 2006–2100

Knutson (2013) stated that with warming occurring in the Atlantic Ocean over the twenty-first century there will be less tropical storms and hurricanes overall; there will also be an increase in the frequency of very intense (categories 4 and 5) hurricanes under the representative concentration pathway 4.5. The author stated that this increase is similar with those of Murakami et al. (2012), who used a high-resolution global model, which projected a nonsignificant increase in category 4 and 5 storm days in the Atlantic basin (+15%) and globally (+4%).

4.3.3 Wave Climate, Storm Surge and Hydrodynamics

Hurricanes produce heavy rainfall, high winds, and storm surge, all of which have the potential to cause damage and dislocation. Extreme rainfalls and sea levels are typically associated with hurricanes and tropical storms and depressions. Hurricanes can form almost anywhere in the Tropical Atlantic Basin from the West Coast of Africa near the Cape Verde Islands, to the Gulf of Mexico and the Caribbean Sea which are the main development areas. Jamaica lies in the Atlantic hurricane belt west of one of the Main Development Area, Cape Verde Islands. Over the past twenty years, at least five major hurricanes have impacted the Caribbean region (Figure 4-87).

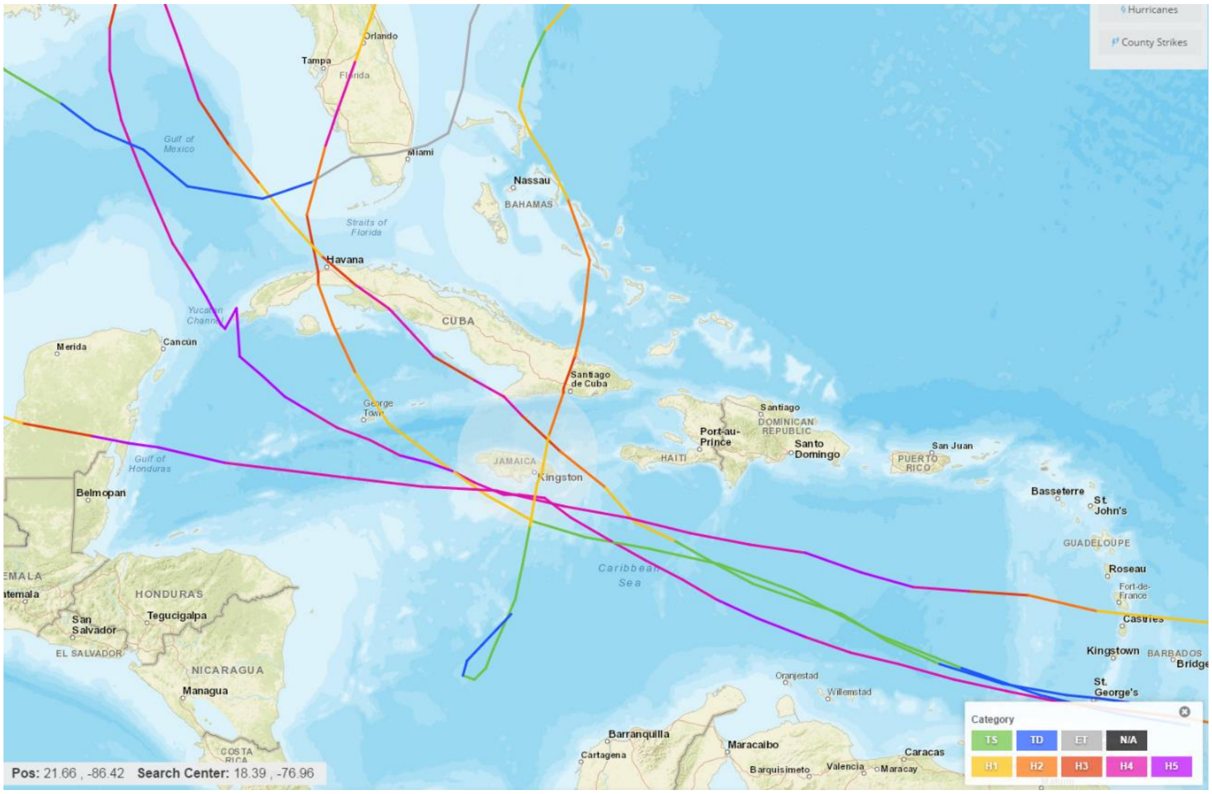


Figure 4-87 Tropical storms/Hurricanes passing through the Caribbean over the past fifteen (15) years

4.3.3.1 Hurricane Wave Hindcast

Methodology

It was necessary to define the deep-water hurricane wave climate at a point offshore the project area, to establish safe floor levels above the anticipated storm surge. The offshore point from which hurricane track data within a 300 km radius passed is shown below:

- Latitude: 18.48 degrees North
- Longitude: -77.98 degrees West

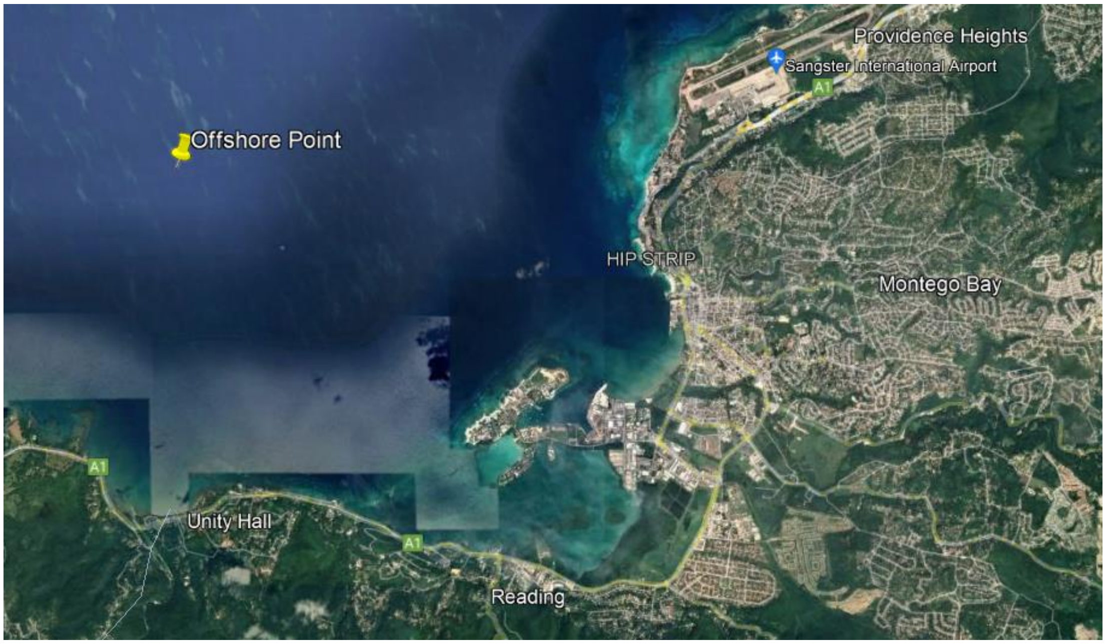


Figure 4-88 Location of offshore point used for Extremal analysis, showing the track used in the analysis

The National Hurricane Centre (NOAA) database of hurricane track data in the Caribbean Sea was utilised to carry out a hindcast, followed by a statistical analysis to determine the hurricane waves and wind setup conditions. The database of hurricanes, dating back to 1886, was searched for storms that passed within a 300km radius from the site (CEAC Solutions Co. Ltd., 2022). The following procedure was carried out.

1. Extraction of storms and storm parameters from the historical database. A database of storms was searched for all storms passing within a search radius of 300km radius of the site.
2. Application of the JONSWAP Wind-Wave Model. A wave model was used to determine the wave conditions generated at the site due to the rotating hurricane wind field. This is a widely applied model and has been used for numerous engineering problems. The model computes the wave height from a parametric formulation of the hurricane wind field.
3. Application of Extremal Statistics. Here the predicted maximum wave height from each hurricane was arranged in descending order and each assigned an exceedance probability by Weibull's distribution.
4. A bathymetric profile from deep-water to the site was then defined and each hurricane wave transformed along the profile. The wave height at the nearshore end of the profile was then extracted from the model and stored in a database. All the returned nearshore values were then subjected to an Extremal Statistical analysis and assigned exceedance probabilities with a Weibull distribution.

Results

OCCURRENCES AND DIRECTIONS

The results of the search clearly indicate the sites overall vulnerability, in summary:

- 107 hurricane systems came within 300 kilometres of the project area

- 4 were classified as catastrophic (Category 5)
- 18 were classified as extreme (Category 4)

The bi-variant table analysis indicates that the waves generated offshore the site have approached from all seaward possible. However, the most frequent hurricane waves have been noted to come from a **westerly** direction. In summary, there are:

- 84 (x6 hours) occurrences from the West
- 76 (x6 hours) occurrences from the Northwest
- 48 (x6 hours) occurrences from the Northeast
- 31 (x6 hours) occurrences from the East
- 25 (x6 hours) occurrences from the Southwest
- 3 (x6 hours) occurrences from the South-East

The directions mentioned above are more prevalent for the node considered because of the unobstructed path (fetch) for waves to propagate and reach shore. The site becomes more exposed as soon as the passing hurricane systems are more to the north of the island.

EXTREME WAVE HEIGHTS

For coastal areas, it is important to understand the probable conditions that a proposed coastal structure will be subjected to, to adequately and appropriately design the structure to provide maximum protection against extreme events (CEAC Solutions Co. Ltd., 2022).

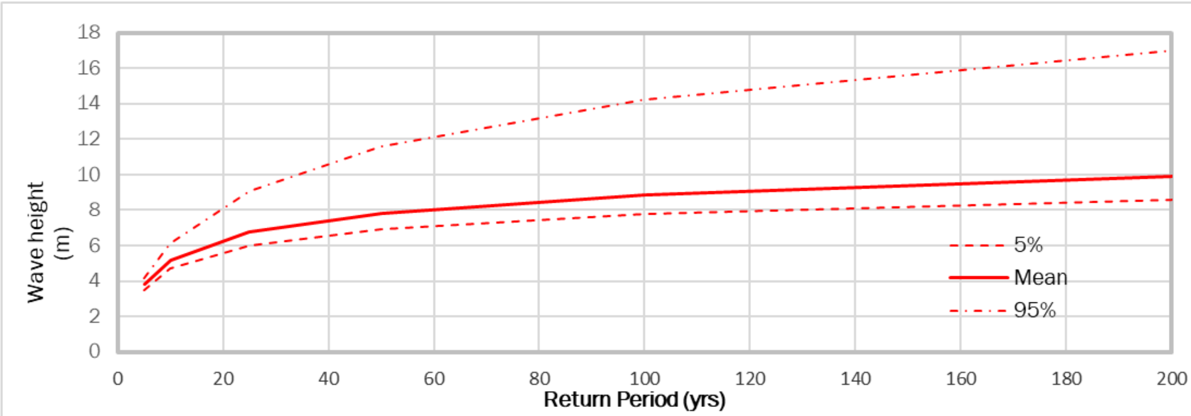
Wave heights were analysed in a similar manner as the storm surge levels above. The annual maximum values of extreme wave heights were fitted to a Generalised type III Extreme Value (GEV) distribution to determine the wave heights. Boot resampling was employed to improve the estimates of standard errors and confidence intervals. This was a necessity because the sample size of the dataset, created by the 300 km criteria, reduced the original dataset. The climate change considerations, the number of intense storms events (Cat IV and IV) will increase by 24%, were also applied to the statistical model.

The extremal analysis results indicated that the 10, 25, 50 and 100-year return period events resulted in mean wave heights of 5.15 m, 7.55 m, 10.43 m, and 12.68 m, respectively (CEAC Solutions Co. Ltd., 2022). Overall, these are relatively large waves with the potential of causing severe damage along the shoreline. They are, however, deep-water waves that will be impacted by the bathymetry as they approach the shoreline. Therefore, their potential for nearshore wave climates was investigated using a wave refraction and diffraction model.

Table 4-50 Summary of present and future Wave Height predictions at the site

Source: (CEAC Solutions Co. Ltd., 2022)

Return period (year)	Wave height, HS (m) Present	Wave height, HS (m) Future	Period (seconds)
10	5.12	5.15	11.5
25	6.69	7.55	12.5
50	7.86	10.43	13.0
100	8.98	12.68	13.4



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-89 Significant Wave Heights for return periods under the future climate

4.3.3.2 Deepwater Operational and Swells Hindcast

The operational and swell wave climate was also necessary to define the impact of the nearshore waves on the project site's shoreline. The deep-water wave heights and periods were extracted from a global wave projection model that ran wave climate simulations using a 1-degree global implementation of WaveWatch III (v3.14). Results of the simulations were published as network common data form (NetCDF) files by The Commonwealth Scientific and Industrial Research Organisation (CSIRO) based in Australia. For the purposes of this project, the data was extracted for the Representative Concentration Pathway (RCP) 8.5 trajectory for the mid-century period (2026 – 2045). The trajectory was chosen as it best simulates our current trajectory of increased gas emissions and population growth through the end of the century with nominal policies to reduce emissions (CEAC Solutions Co. Ltd., 2022). An offshore point was selected approximately 50 km from the shoreline at:

- Latitude: 18.46 degrees North
- Longitude: -78.3 degrees West

The deep-water wave data was then used to generate bi-variant tables for the mean wave heights versus periods. The operational wave was then determined as the 50 percent exceedance wave occurring at the site, whereas the swell waves were estimated by taking the highest 99 percent exceedance waves from the bi-variant table (CEAC Solutions Co. Ltd., 2022).

The analysis determined that operational wave heights are 0.9 m and has a period of 5.5 secs. The swell wave heights are of a magnitude of 2.75m and have a period of 9.3 secs (Table 4-51).

Table 4-51 Wave height (meters) and corresponding wave period (seconds) for the future operational and swell waves determined from the bivariate table

Source: (CEAC Solutions Co. Ltd., 2022)

	Operational	Swell
Wave Height (m)	0.9	2.75
Period (seconds)	5.5	9.3
Direction	E	E

4.3.3.3 Nearshore Wave Climate and Hydrodynamics

Nearshore wave climate is crucial for assessing coastal processes and their effects on the natural and man-made structures along a shoreline. This wave condition is derived from deep-water wave parameters since offshore waves translate to nearshore waves as they approach the shore. The direct transformation of such a large amount of wave observations is not feasible; thus advanced techniques using numerical wave models are used to quickly drive nearshore wave conditions from offshore wave data. Current and future wave climate scenarios were simulated in Mike for 50 return period for deep-water waves (CEAC Solutions Co. Ltd., 2022).

Model Description

The MIKE 21/3 Coupled FM Module suite of computer programs was used to calculate the corresponding distribution of surface water elevation and waves in the area. MIKE 21/3 Coupled Model FM is a truly dynamic modelling system for application within coastal, estuaries, and river environments. When using the suite, it is possible to simulate the mutual interaction between waves and currents using a dynamic coupling between the Hydrodynamic Module and the Spectral Wave Module. The two (2) modules are employed as (CEAC Solutions Co. Ltd., 2022):

- The hydrodynamic module to calculate the solution for the surface elevation and velocity field at each point in the domain as a function of time with a critical Courant–Friedrichs–Levy (CFL) number.
- The spectral wave module to model the wave propagation and transformation from offshore up to the shoreline was calculated using the spectral wave component

Modelling Scenarios

The following scenarios were executed to evaluate the vulnerability of the shoreline within the project area. The scenarios are described below:

1. Hydrodynamic (Ocean Currents): It was necessary to establish a basis to describe the ocean currents under operational conditions (day to day) and to calibrate the model.
2. Operational waves: It was necessary to establish a basis to describe the daily conditions to understand the present climate and predict potential future changes to come.
3. Swell waves: The scenario was necessary to describe the damage the infrequent, high-energy waves would have on the beach. Swell wave conditions are generally infrequent and occur a few days out of the year. The waves are fairly large (>1.6m wave heights) and have long periods which enables them to cause significant damage to beaches and other structures near the

shoreline. It was, therefore, important to look at the swell wave climate to understand the impact on the existing and proposed shoreline and also to design shoreline protective structures, which can withstand these scenarios. The model was used to simulate swell wave conditions from offshore to nearshore for waves approaching the site from the South-East, South-West, West, and East directions.

4. Future Hurricane, Swells and Operational climate (2050): The rate of climate change globally within the next century is expected to be significantly higher than it was in the past. Trends observed in historical and current climate data are analyzed used to project future climate. Scientists have predicted that there will be fewer storm events but with greater intensities. This scenario is needed to evaluate how resilient the shoreline is and what changes are needed to make it more resilient to future climate change.
5. Storm Surge: It was necessary to establish a basis to describe the storm surge conditions to understand the present climate, as well as, to predict potential future changes to come.

4.3.3.4 Ocean Currents

The hydrodynamic (HD) module utilised in MIKE 21/3 solves the equations for the conservation of mass and momentum as well as for salinity and temperature in response to a variety of forcing functions. The hydrodynamic module of MIKE 3 Flow Models HD FM provides the basis for computations of processes performed in many other modules such as sediment and mud transport, transport of heat and suspended matter, oil spill, agent-based modelling, and ecology but can also be used as a stand-alone application.

Model Inputs

WIND DATA

Wind data was gathered from predictive models and suggested relatively calm wind speeds (8m/s) from the dominant Eastern direction (CEAC Solutions Co. Ltd., 2022). Wind data was retrieved from Hedonism II Station (IJAMAICA3) for the dates of the survey December 6th- 8th, 2021. This data was used to facilitate the calibration of the HD model.

ASTRONOMICAL TIDES

Tides have to do with the rise and fall of the sea level because of the gravitational forces of the Sun and the Moon and the rotation of the Earth. The Mike 21 software was introduced to produce acceptable and accurate tidal height data for an appropriate solution to tidal analysis and predictions. The average tidal range for the project area was determined to be approximately 0.2m (CEAC Solutions Co. Ltd., 2022).

OPERATIONAL WAVES

The current speeds were investigated for operational and swell waves to deduce their potential impacts on the nearshore marine environment. The present operational and swell wave conditions were extracted from the National Oceanic and Atmospheric Administration (NOAA) Wave Watch III model. The future climate operational and swell waves were extracted from the Commonwealth Scientific and Industrial Research Organization (CSIRO), based in Australia, to execute the model. See Table 4-52 below for the swells and operational wave heights and periods used. These parameters were put on the boundary of the model.

Table 4-52 Swell and operational conditions used on the model boundary

Source: (CEAC Solutions Co. Ltd., 2022)

	Operational Height (m)	Period (s)
Present Climate	0.8	11
Future Climate	0.9	5.5

Results

CALIBRATION OF MODEL

Calibration was a necessary step employed in the hydrodynamic modelling exercise to reduce predictive error is subsequently suspended sediment transport modelling (CEAC Solutions Co. Ltd., 2022). The model was calibrated by systematically adjusting model parameters such as turbulence and viscosity. The correlation between the current speeds observed in the field and results taken from the model on average were within a reasonable tolerance (CEAC Solutions Co. Ltd., 2022). The observational data and simulation deviated a maximum of 0.1786m/s with an average difference of 0.0650m/s. The mean error generated was 0.060, therefore gives good confidence to the results of the simulation and were used for modelling present and future operational and swell conditions.

OPERATIONAL CONDITIONS

Sub-surface currents are generally slower than surface current in the model results. Bottom current speed ranged from 0.02 – 0.09m/s in a westerly direction. While the surface currents speeds varied between 0.06 - 0.08 m/s. The speeds modelled are generally comparable to those measured during the data collection exercise (CEAC Solutions Co. Ltd., 2022).

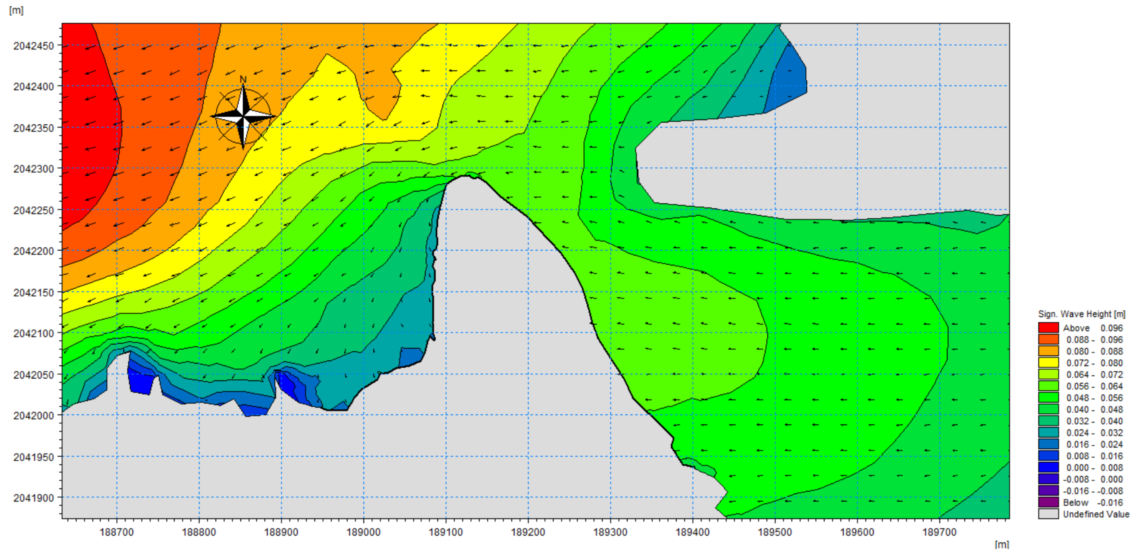
Table 4-53 Model results of currents for Present and Future Climate under Operational Conditions

Source: (CEAC Solutions Co. Ltd., 2022)

Scenario	Current Speed (m/s)
Bottom Currents	0.02 – 0.09
Surface Currents	0.04 – 0.16

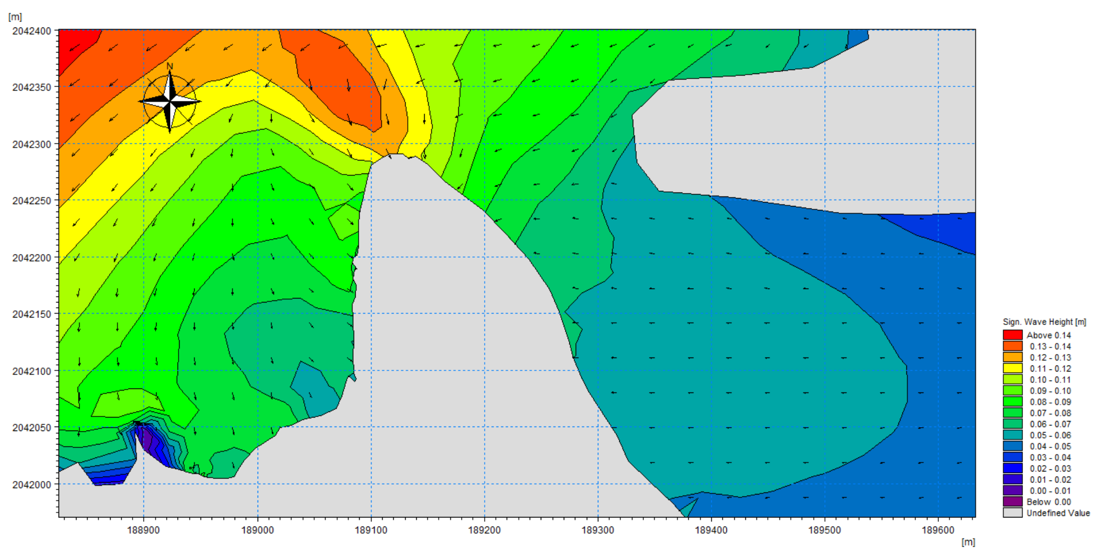
4.3.3.5 Operational Waves

Day-to-day or operational waves were modelled using data from the NOAA Wave Watch weather service database for the period 1999 to 2012 at 6-hour intervals for an offshore node. The model was calibrated to run operational waves for the easterly direction (dominant Wind direction). Based on the wave predictions, the existing shoreline was modelled to understand the most vulnerable areas better and estimate the magnitude of wave heights reaching the shoreline. The model showed that under operational conditions, the shoreline may experience average wave heights of 0.02- 0.04m. In the future climate, the wave heights were predicted to range between 0.05m – 0.14m in the nearshore area (CEAC Solutions Co. Ltd., 2022).



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-90 Present operational wave plot (East)



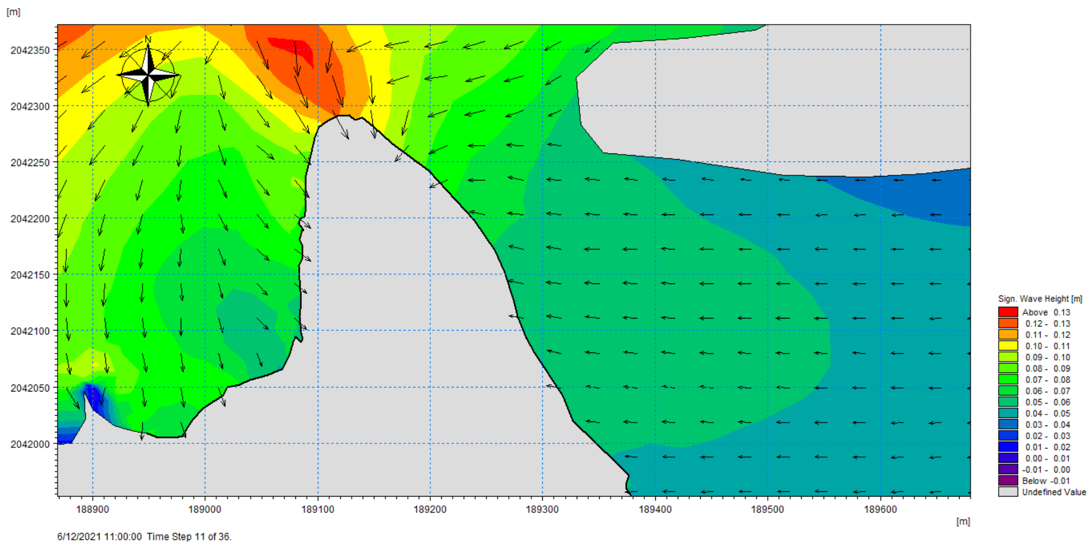
Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-91 Future operational wave plot (East)

4.3.3.6 Swell Waves

Present Climate

The model showed that under swell wave conditions, the nearshore area may experience wave heights ranging between 0.07- 0.12m from an Easterly (E) direction. These are relatively small waves and should pose small erosion risks. See Figure 4-92 which shows the waves generated due to swells.

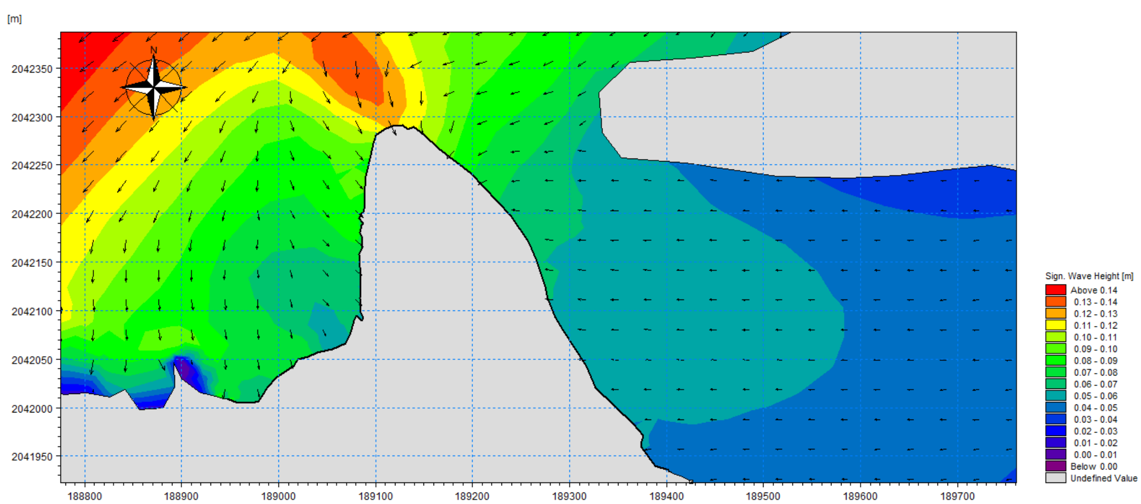


Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-92 Present Climate Swell Waves Plot (East)

Future Climate

The model shows that for the future climate, swell wave heights in the nearshore ranged between 0.04m – 0.15m from an Easterly (E) direction, as seen in Figure 4-93. Again, these are relatively small waves and should pose small erosion risks.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-93 Future Climate Swell Waves Plot (East)

Summary and Discussion

The modelling results showed that operational and swell waves in the present climate are of an average height of approximately 0.04m and 0.12m, respectively, in the nearshore area. Whereas, under future climate, the operational wave averages increase to 0.1m while swell wave averages increase to 0.15m. It must be noted that wave heights are more significant at the northern-most section of the Peninsula, therefore, greater caution should be taken in this area.

Table 4-54 Summary of Operational wave heights arriving at the shoreline based on deep-water wave transformation modelling

Source: (CEAC Solutions Co. Ltd., 2022)

Operational Waves	Present Climate	Future Climate
Directions	E	E
Significant wave height (m)	0.02 - 0.04	0.05 - 0.12

Table 4-55 Swell wave heights (m) at the existing shoreline

Source: (CEAC Solutions Co. Ltd., 2022)

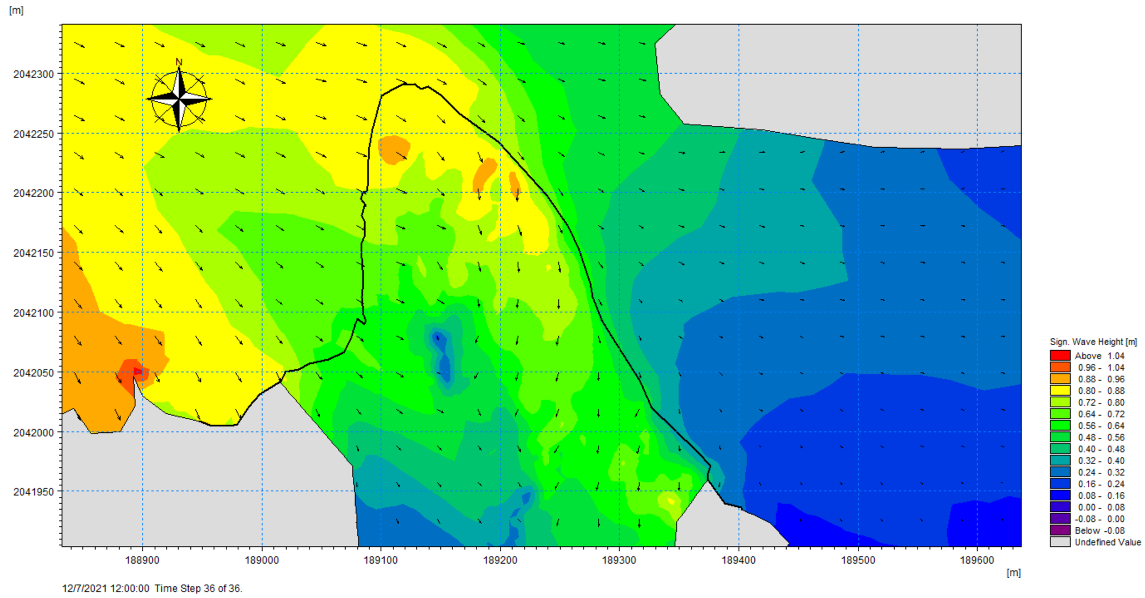
Swell Waves	Present Climate	Future Climate
Directions	E	E
Significant wave height (m)	0.05 - 0.13	0.04 - 0.15

4.3.3.7 Hurricane Waves

A wave transformation analysis was done to observe how the wave changes as it moves from deep-water to the shoreline. The nearshore wave heights were identified, arriving from three (3) dominant directions namely: westerly (W), north-westerly (NW), and south-westerly directions, for a 10-, 25-, 50- and 100-year return period storm. The models were simulated using both the current and future climate scenarios to better understand the worst-case impact of the waves on the study area as it relates to climate change.

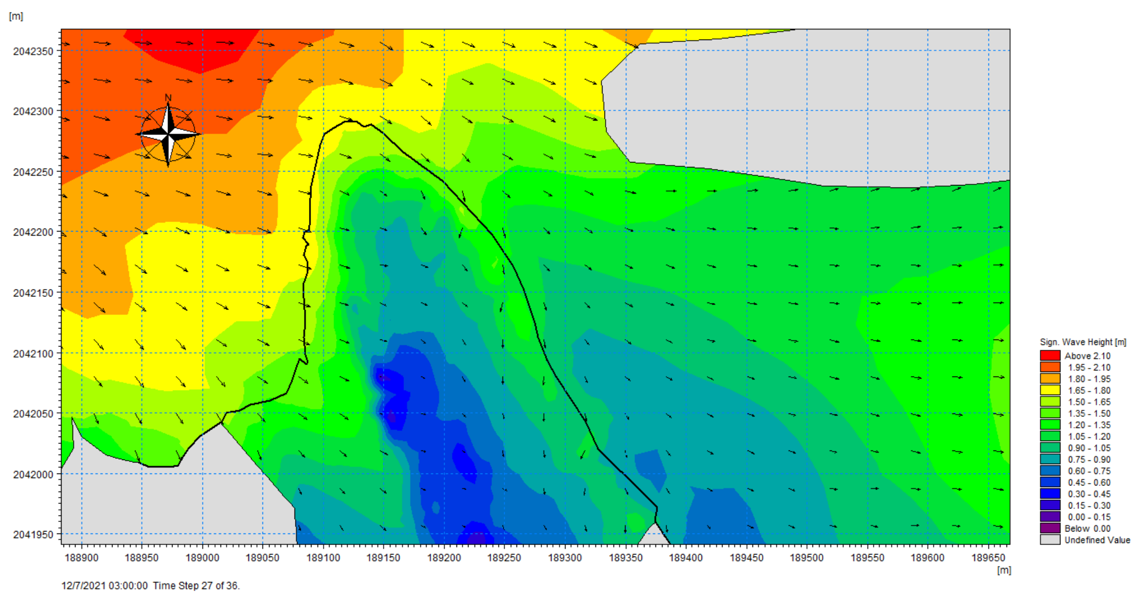
Present Climate

The analysis revealed that under the present climate for the 50yr RP the wave heights were 0.96m, 0.8m and 1m from the NW, W and SW respectively. However, for the 100-year Return Period the wave heights were 1.96m, 1.8m and 1.35m for the NW, W and SW respectively.



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-94 50 Yr. Return Period- Present Climate Extreme Waves Plot (North-West)

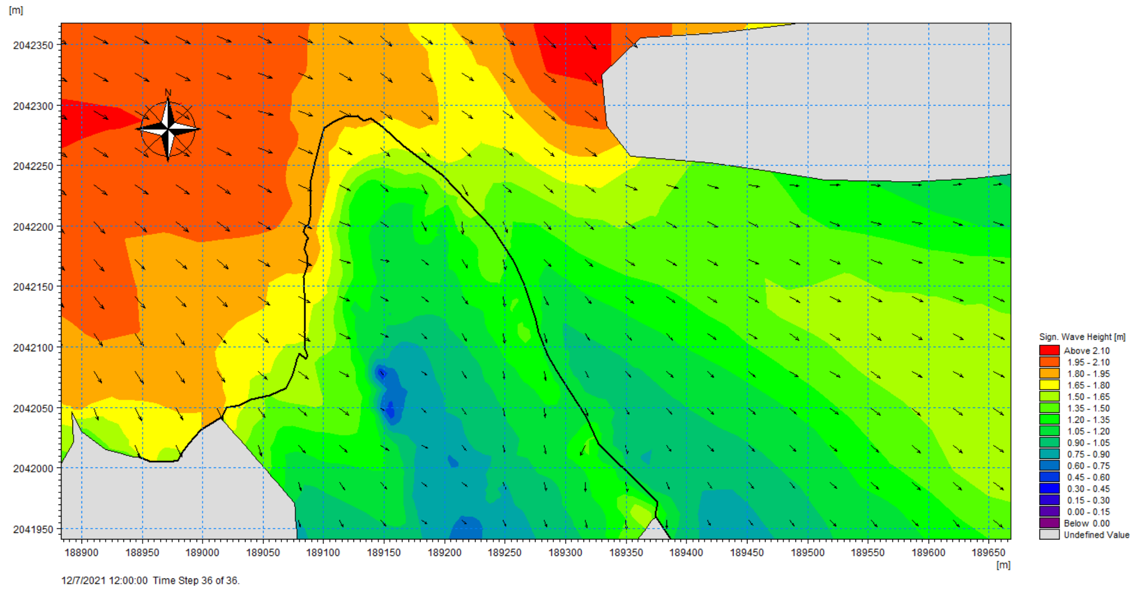


Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-95 100 Yr. Return Period- Present Climate Extreme Waves Plot (NorthWest)

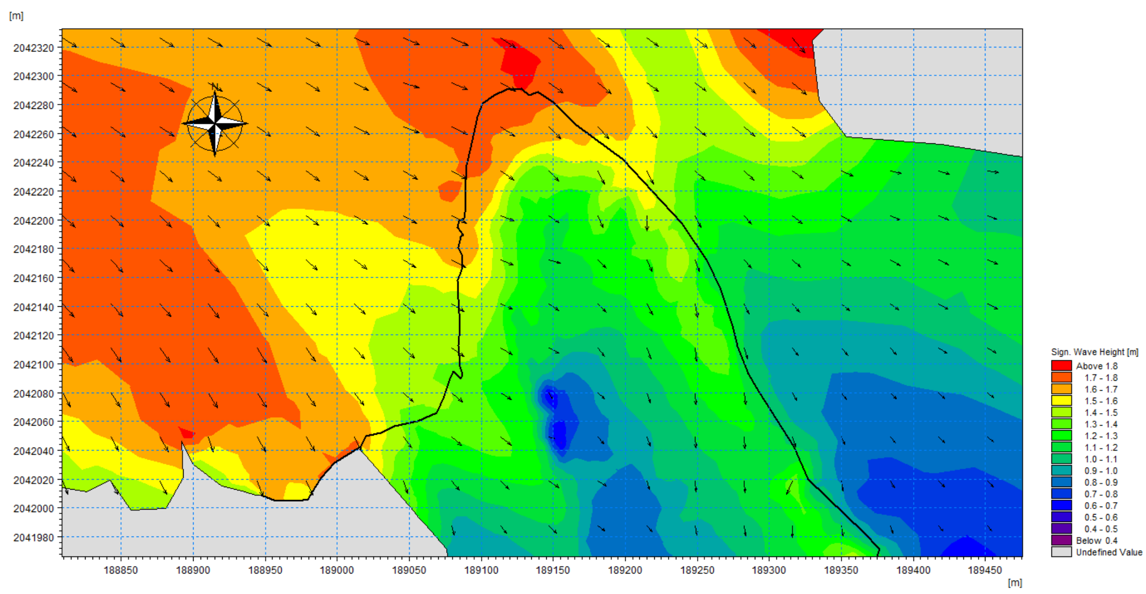
Future Climate

It was concluded from the future climate models, that the nearshore wave heights were 1.8m, 1.6m and 1.2m for the NW, W and SW respectively. Whereas, for the 100yr RP the wave heights were 2.2m, 2m and 1.5m for the NW, W and SW respectively. Therefore, extreme precaution should be taken at the project area as it would be exposed to hazardous wave conditions during a storm.



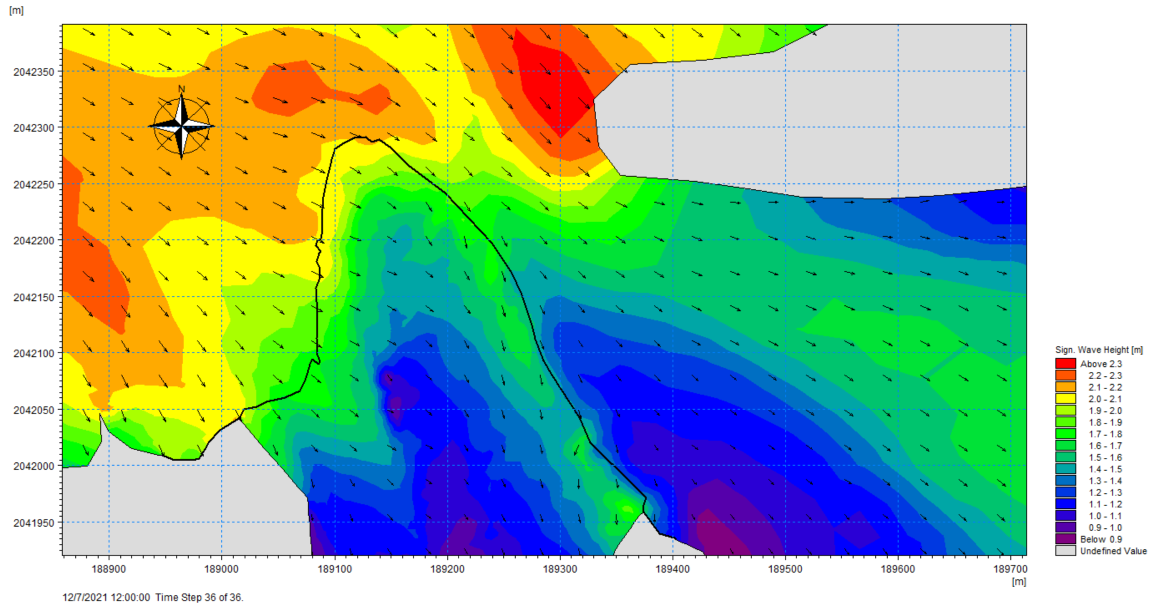
Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-96 100 Yr. Return Period- Future Climate Extreme Waves Plot (North-West)



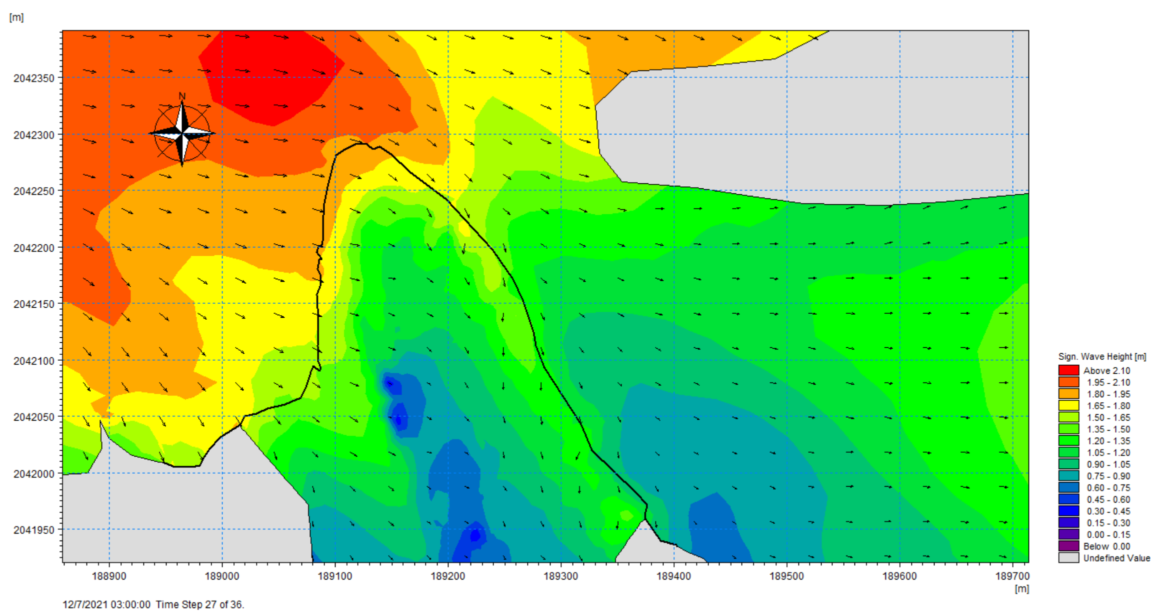
Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-97 50 Yr. Return Period- Future Climate Extreme Waves Plot (Northwest)



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-98 100 Yr. Return Period- Future Climate Extreme Waves Plot (Northwest)



Source: (CEAC Solutions Co. Ltd., 2022)

Figure 4-99 100 Yr. Return Period- Future Climate Extreme Waves Plot (North-west)

Table 4-56 Summary of 100yr return period Hurricane wave heights arriving at the shoreline based on deep water wave transformation modelling

Source: (CEAC Solutions Co. Ltd., 2022)

Hurricane Waves (Present)			
Direction	NW	W	SW
Hurricane Waves (50 - year)	0.96	0.8	1
Hurricane Waves (100 - year)	1.96	1.8	1.35
Hurricane Waves (Future)			
Direction	NW	W	SW
Hurricane Waves (50 - year)	1.8	1.6	1.2
Hurricane Waves (100 - year)	2.2	2.0	1.50

Summary and Discussion

The results of the modelling showed that present extreme waves for 100 Yr. Return Period ranged between 1.36-1.96m arriving at the shoreline from varying direction. While for the future 100 Yr. the heights of the waves ranged between 1.5 - 2.2 m. During the hurricane conditions, the southwest (SW) direction pose the least threat to the shoreline while the northwest (NW) and west (W) direction pose a greater threat. It was observed that the project area would be completely inundated due to it low lying nature therefore it would be recommended that protection measures be undertaken.

4.3.3.8 Storm Surge

Two models were used to estimate the storm surge and the results were compared to the USAID TAOS model and a worst-case direct hit track.

CEAC Storm Surge Model

Static storm surge was investigated in the analysis for all major components of storm surge. The phenomena considered were: Sea Level Rise, Wave Breaking and Shoaling, Wind setup, Refraction, Tides and Inverse Barometric Pressure Rises. A total of 107 storms passed within 300km of the site from 1864 to 2016 (152 years). The annual maximum values of storm surges were then fitted to a generalised type III extreme value (GEV) distribution to determine the return period storm surge values. Boot resampling was employed to improve the estimates of standard errors and confidence intervals.

As aforementioned, climate change considerations predicted that the total number of intense storms events (Cat IV and IV) will increase by 24%. The climate change considerations were then applied to the frequency analysis which reflected an increment of mean storm surge heights in the future.

The extremal analysis results indicated that the 10, 25, 50 and 100-year return period for the present climate resulted in mean storm inundation depths of 0.34m, 0.65 m, 0.98m and 1.32m respectively. While for the future climate, the results indicated for the 10, 25, 50 and 100-year return period, storm surge inundation depths of 0.37m, 0.69m, 1 m and 1.35 m respectively. Overall, the mean storm surge levels predicted were relatively high and would potentially cause significant inundation along the project area. Storm surges are a meteorological phenomenon, mostly windstorms that pose a geophysical risk which abruptly inundated low-lying coastal regions. Over the past decades, the direct impact of such hazards as storm surges and extreme waves has resulted in grave environmental degradation and socioeconomic disturbances along Jamaica's coast. These hazards are expected to become more severe in the future because of present and projected sea-level rise and more intense hurricanes.

Table 4-57 Summary of present and future Storm Surge predictions at the site (with run-up)

Return period (year)	Storm surge (m) Present	Storm surge (m) Future
10	0.34	0.37
25	0.65	0.69
50	0.98	1.00
100	1.32	1.35

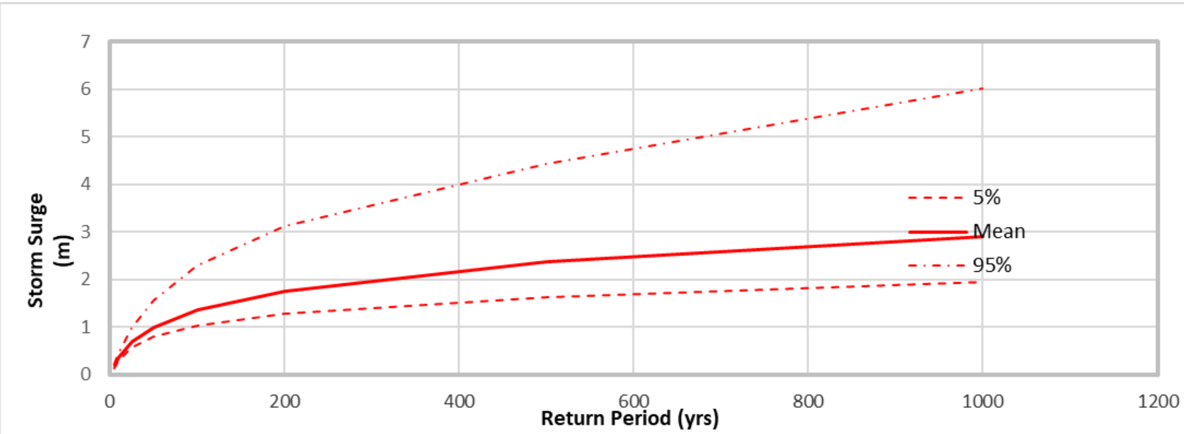


Figure 4-100 Storm Surge for return periods under the future climate (With Runup)

Mike 21/3 Couple Model: Storm Surge Climate Analysis

Storm surges are a meteorological phenomenon, mostly windstorms that pose a geophysical risk which abruptly inundated low-lying coastal regions. Over the past decades, the direct impact of such hazards as storm surges and extreme waves has resulted in grave environmental degradation and socioeconomic disturbances along Jamaica's coast. These hazards are expected to become more severe in the future because of present and projected sea-level rise and more intense hurricanes.

This section aims to examine the inundation risk of extreme water levels in project areas under climate change. A storm surge analysis was done to observe the rise in the seawater level from the change in the meteorological process such as wind and atmospheric pressure, at the shoreline. The storm surge heights were identified for 10-, 25-, 50- and 100-year return period storm. The models were simulated using both the current and future climate scenarios to better understand the waves' impact on the study area related to climate change.

RESULTS

Present Climate

Under present climate, for the 50- year return period the storm surge ranged between 1.2- 2.1 m while for the 100 Yr. Return Period storm surge ranged between 1.68m- 2.2m, as shown in Figure 4-101.

Whereas the future climate scenario, the analysis revealed storm surge ranged from 1.96- 2.4m for the 50 Yr. Return Period while for the 100 Yr. Return Period the storm surge range between 2.08-2.5m.

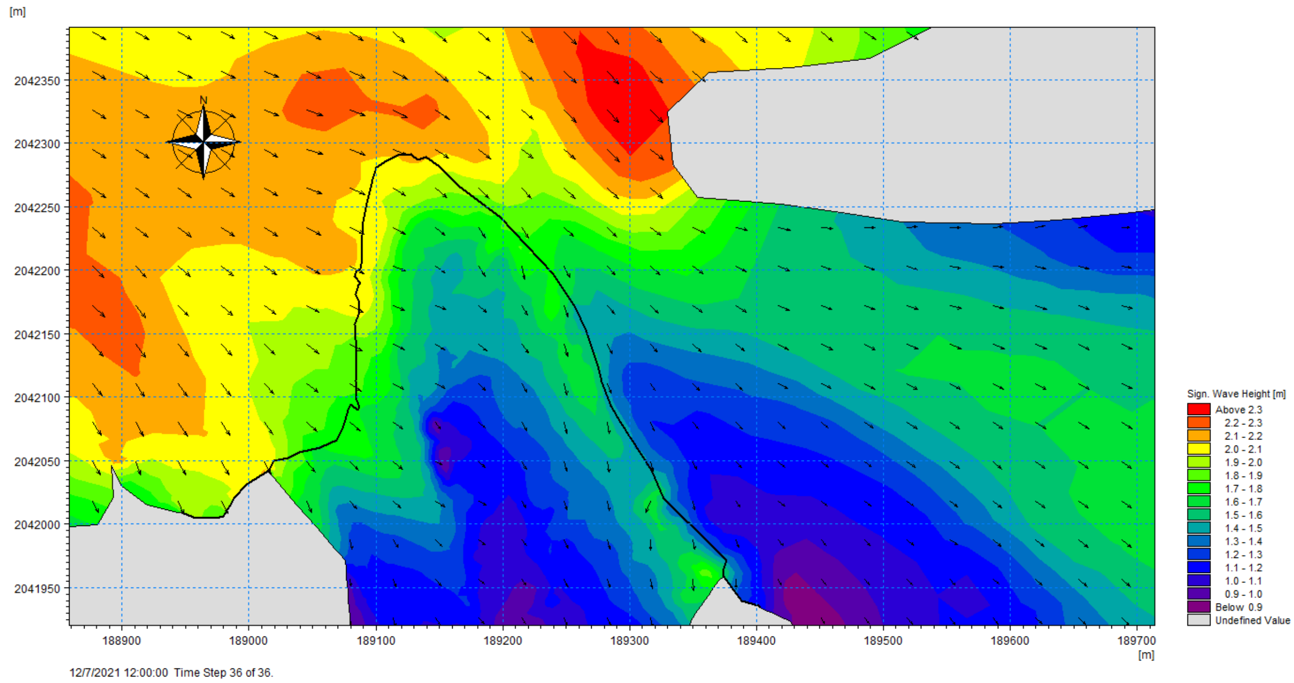


Figure 4-101 50 Yr. Return Period- Present Climate Storm Surge Plot

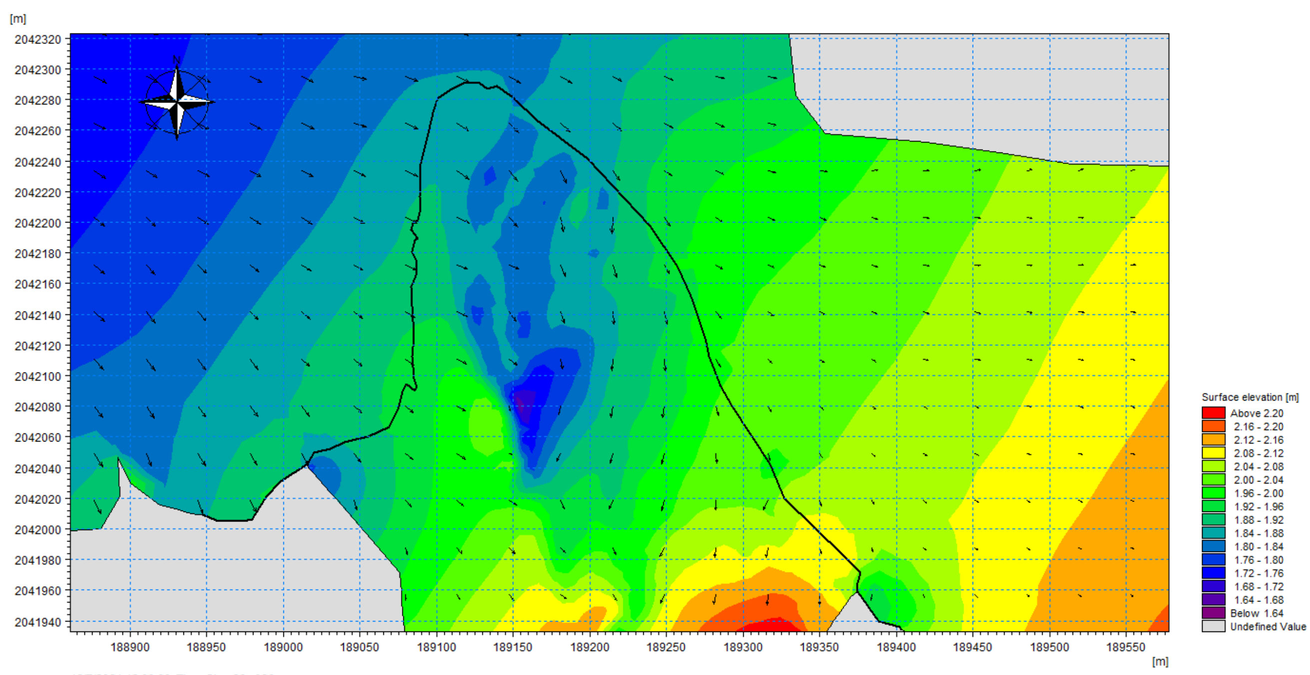


Figure 4-102 100 Yr. Return Period- Present Climate Storm Surge Plot

Future Climate

Under the future climate scenario, the storm surge ranged from 1.96- 2.4m for the 50 Yr. Return Period while for the 100 Yr. Return Period the storm surge range between 2.08- 2.5m.

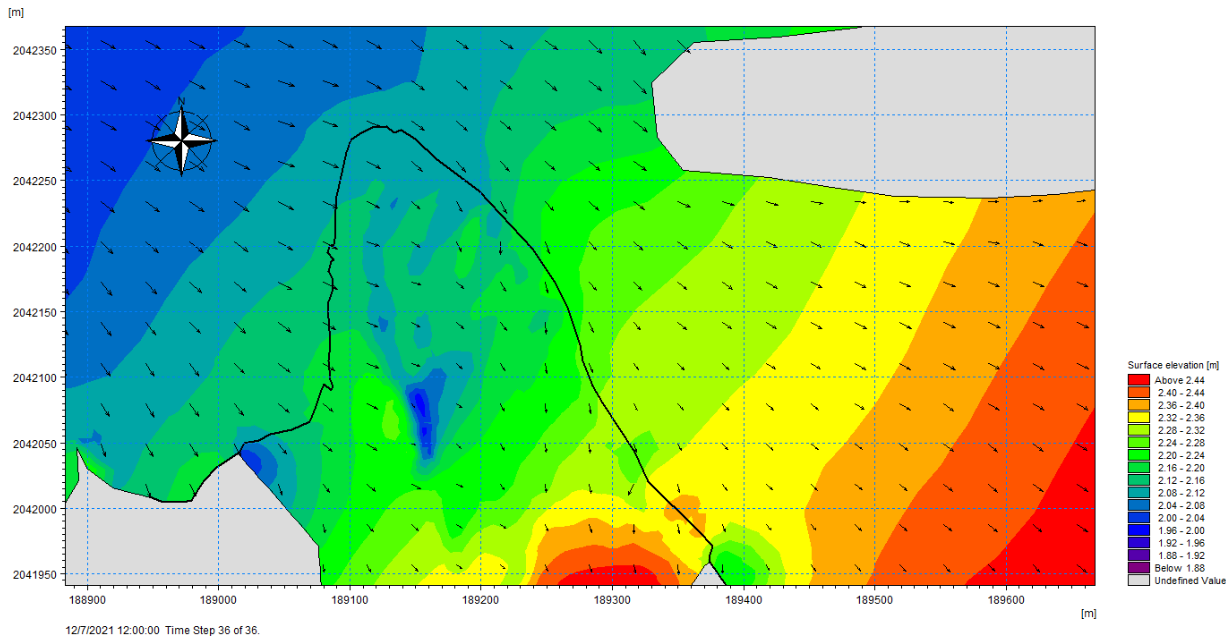


Figure 4-103 50 Yr. Return Period- Future Climate Storm Surge Plot

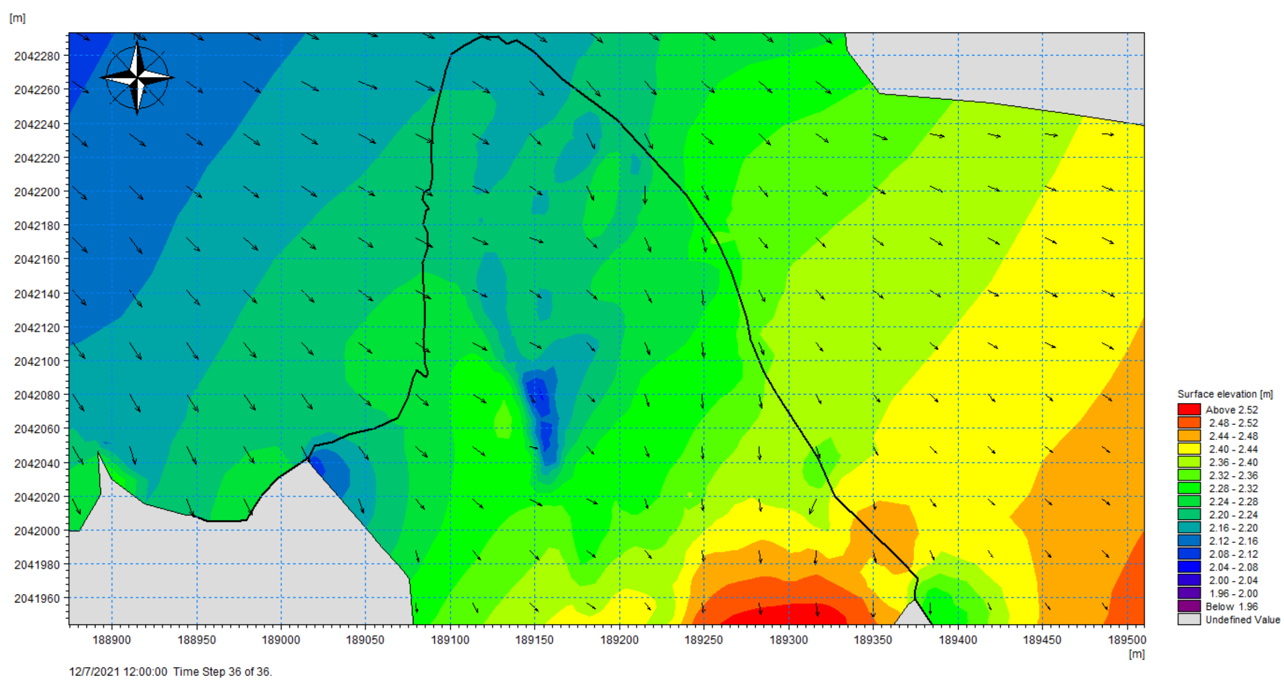


Figure 4-104 100 Yr. Return Period- Future Climate Storm Surge Plot

Comparison to TAOS model and Recommended Minimum Floor and road levels

The analysis deduced that the site would be fully inundated by the storm surge under 50 and 100 Yr Return Period, present and future climate. It was estimated that the worst-case scenario storm surge inundation (100 Yr. Return Period) would cause damage within the project area. The storm surge inundation depth at the shoreline ranged from **1.0- 1.35**m for the 50-yr and 100-yr Return Period Future climate storm for the CEAC/TAOS model while the Mike Coupled model showed inundation depths of **1.3 – 1.66m** for the 50-yr to 100-yr Return Period events. Overall, the Mike Model showed greater inundation depths than the TAOS model with a 30% difference for the 50-yr event and 23% for the 100-yr event. For the purposes of setting floor elevations, we will use the Mike model results. This is because Mike takes into account the entirety of the shoreline and models how waves and currents would traverse around land and through reefs and how these would impact water levels and wave heights in other areas.

The minimum recommended floor level is 3.3m, and the road levels are recommended to be at an elevation of 2.6m above MSL (Table 4-59).

Table 4-58 TAOS Model vs Mike Model results comparison.

Return period (year)	CEAC/TAOS Model SS Inundation Depth		Mike Coupled Model SS Inundation Depth		Percentage Difference	
	Present Climate (m)	Future Climate (m)	Present Climate (m)	Future Climate (m)	Present Climate (m)	Future Climate (m)
10	0.34	0.37	0.39	0.42	15%	14%
25	0.65	0.69	0.64	0.69	-2%	0%
50	0.98	1.00	1.1	1.3	12%	30%
100	1.32	1.35	1.5	1.66	14%	23%

Table 4-59 Recommended Floor and Road levels based on 25-yr to 100-yr RP storm surge.

RP	Future Climate Storm Surge (m)	Freeboard (m)	2050 SLR (m)	Recommended Floor Level (m)	Comments
25	1.8	0.3	0.5	**2.6**	Recommended Road Level
50	2.4	0.3	0.5	3.2	
100	2.5	0.3	0.5	**3.3**	Recommended Floor Level

4.3.4 Long-Term Coastal Erosion

In addition to coastal inundation (storm surge), which was previously discussed, coastal erosion makes the shoreline more susceptible to hazards due to the exposed nature. Coastal erosion is the loss of coastal lands due to the net removal of sediments from the shoreline. It is a natural process that occurs whenever the deposition of new material does not balance the transport of material away from the shoreline. Such processes may lead to the undercutting of cliffs and steep slopes, resulting in the undermining of manmade structures situated near the coastline.

An assessment was conducted using satellite imagery over 19-year period (2002-2021) to investigate long-term erosion trends. This allowed for identifying erosion hot spots and the long-term threats to the project area from retreating shorelines. It was important to identify the actual erosion hotspots that might require stabilization and make recommendations to reduce the vulnerability.

The overall long-term erosion trend was estimated by two methods:

1. Firstly, Observation of actual long-term shoreline positions from dated Google earth imagery. The rates of accretion and or erosion between the time intervals and the overall time interval were determined using the following relationship:

   Equation 4.1 Rate of erosion or accretion between two successive intervals (metres per year)

   $E_y^1 = \frac{D}{N}$, where

   E = the rate of erosion or accretion between two successive intervals (metres per year)

   D = the displacement between two intervals (metres)

   N = the number of years between two successive intervals (years) and

   Equation 4.2 Rate of erosion or accretion from the datum year to the final interval

   $E_y^0 = \frac{D_T}{N_T}$, where

   E_y^0 = the rate of erosion or accretion from the datum year to the final interval

   D_T = the displacement from the datum to the final interval

   N_T = the number of years from datum year to final interval

2. Sea level rise erosion/shoreline recession component was estimated to determine the erosion due to chronic global trends versus event-based erosion events (i.e. hurricanes and swell events). The Brunn model is perhaps the best-known and most commonly used to model shoreline retreat due to sea-level rise. This two-dimensional model assumes an equilibrium profile. Thus, it inherently assumes that the volume of sediment deposited is equal to that eroded from the dunes. Consequently, the rise in the nearshore bottom due to the deposited sediment is equal to the rise in sea level. The original Brunn model is expressed below in Equation 4.3, and this mathematical relationship was the basis for estimating shoreline retreat within the study area. The magnitude of cross-shore sand transport is related to wave energy dissipation per unit water volume in the main portion of the surf zone.

   Equation 4.3 Brunn model

   $$\Delta y = -R = -S\frac{W_*}{(h_* + B)} = -\frac{S}{\tan\theta'}$$

Where:

Parameter	Description	Units
Δy	Dune line erosion	m
R	Horizontal profile recession	m
S	Sea level rise	m
$\tan \boldsymbol{\theta}$	Average slope over the active profile	m
$\boldsymbol{W}_*$	Cross-shore width of the active profile (i.e. cross-shore distance from closure depth to the furthest landward point of sediment transport)	m
$\boldsymbol{h}_*$	is the closure depth (maximum depth of sediment transport)	m
B	the elevation of the beach or dune crest (maximum height of sediment transport)	m

4.3.4.1 Historical Shorelines

The recently obtained satellite image of the project area (February 2021) can be seen Figure 4-105, showing the different states of the shoreline over the past nineteen (19) years. After analysing the historical shoreline positions, it was observed that the shoreline was moderately stable. The main cause of the shoreline change in the project area was cross-shore transport erosion. This created a submerged berm at the mouth of the bay. Upon examining the project shoreline (2021) and comparing it with the others from the previous years, it was concluded that there was a general erosion trend at a rate of approximately < 0.1m yearly.

The western sections of the peninsula eroded quicker than the eastern section due to the exposure to the nearshore wave climate. The overall trend for this period was slight erosion, as the wave climate is mild, and mangroves protect the shoreline, therefore, deeming the shoreline very stable throughout the 19-year period.

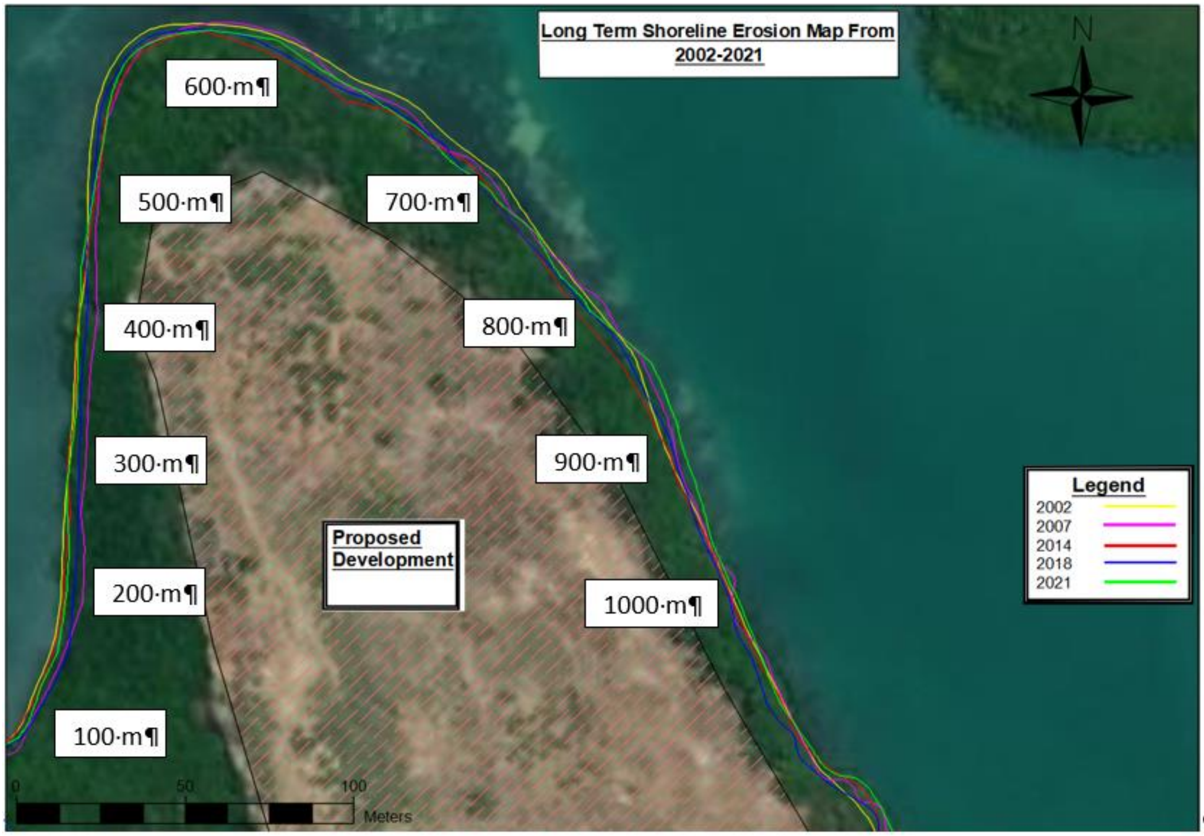


Figure 4-105 Long Term Erosion map showing historic shorelines from 2021 – 2003

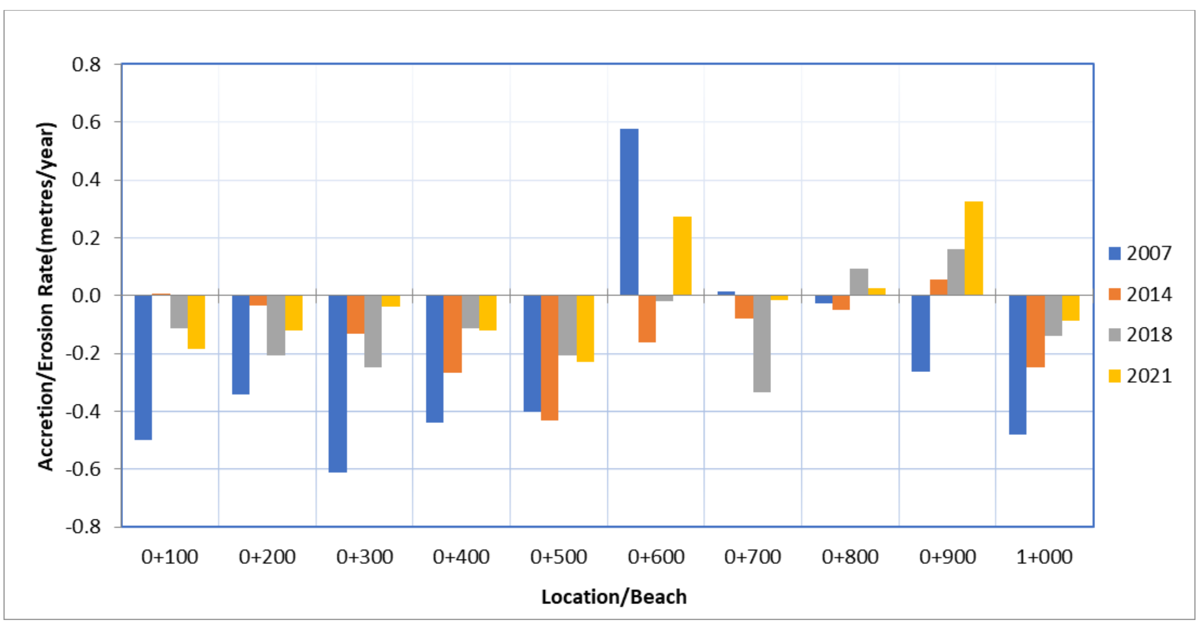


Figure 4-106 Average rate of shoreline changes for the respective years

4.3.4.2 Sea Level Rise Shoreline Recession/Erosion

Sea level rise erosion/shoreline recession component was estimated to determine predicted erosion due to chronic global trends versus event-based erosion. The Brunn Rule estimates shoreline erosion from SLR of up to 0.28m annually. This is relatively slow to national observations, but the proponent should monitor the site for any significant changes. The shoreline change, projected for the next 25 years, indicates erosion ranging from 5.18 m to 7m.

Table 4-60 Predicted Shoreline change and effects of climate change

Parameter	Profile (m)									
	100	200	300	400	500	600	700	800	900	1000
Berm Height, B (m)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Rate of sea level rise, S (mm/yr)	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Offshore profile, W* (m)	300	330	400	340	350	360	405	330	350	400
depth of offshore limit, h* (m)	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70	5.70
Estimated change in 25 years (m)	-5.18	-5.70	-6.91	-5.88	-6.05	-6.22	-7.00	-5.70	-6.05	-6.91
Long term erosion based on Bruun Model (m/year)	-0.21	-0.23	-0.28	-0.24	-0.24	-0.25	-0.28	-0.23	-0.24	-0.28
Background/Historical (m/year)	-0.18	-0.12	-0.04	-0.12	-0.23	0.27	-0.01	0.02	0.33	-0.09
Difference (m)	-0.02	-0.11	-0.24	-0.12	-0.01	0.03	-0.27	-0.20	0.08	-0.19
Difference due to SLR (%)	-113	-88	-73	-96	-106	91	190	92	74	-31

4.3.5 Storm Induced Erosion

It is necessary to determine how the shoreline will respond to the anticipated severe wave climate during hurricane events. The adopted approach was to utilise a cross-shore sediment transport model (SBEACH) to predict the response of the shoreline to waves from design storm events. SBEACH was used to determine the existing shoreline's response to 25-year to 100-year storms from waves approaching the Northwestern (NW) direction.

4.3.5.1 Methodology and Data

One profile from the NW direction was cut from land (project site) to deep water. The wave data from the deep-water hurricane model were utilized for this analysis using a 25, 50 and 100-year return period. Since predicted wave heights were the highest for waves coming from a north-western direction, the profile in the NW direction from the project site was used in SBEACH. Table 4-61 shows the hurricane wave characteristics utilized in the model.

Table 4-61 Input conditions for cross-shore erosion (m) modelling for hurricane wave conditions

Storm	Offshore Wave Height, Hs (m)	Period, Tp (m)	Wind speed (m/s)	Water Elevation + Setup (m)
Hurricane (25- year RP)	7.6	12.5	75	1.5
Hurricane (50- year RP)	10.4	13.0	103	2
Hurricane (100- year RP)	12.7	13.4	136	2.5

4.3.5.2 Results

SBEACH was used to determine the existing shoreline's response to 25, 50 and 100-year storm from waves approaching from a north-western direction. The model was run for three (3) scenarios:

i. Existing profile with future 25-year storm
ii. Existing profile with future 50-year storm
iii. Existing profile with future 100-year storm

It was observed that moderate erosion is expected to occur during a 25yr RP event. The event is anticipated to erode the beach face approximately 25m inland. Erosion along the profile below can be identified where the initial profile line (red) is above the final profile line (brown) (Figure 4-108). Whereas for the 50yr RP event, the erosion is greater than the 25yr RP, approximately 35m of erosion will occur at the project site. Lastly, for the 100yr RP storm the total reach of beach disturbance was approximately 45m inland (see Table 4-62). The general trend of the scenarios is a landward movement of the shore as the heavy waves erode the berm of the beach as shown in Figure 4-107, flattening the beach profile and moving the sediments via cross-shore erosion. It is important to note that the bay is relatively well sheltered, and as such, the extent of erosion will only be experienced during hurricane scenarios producing waves from the northwest.

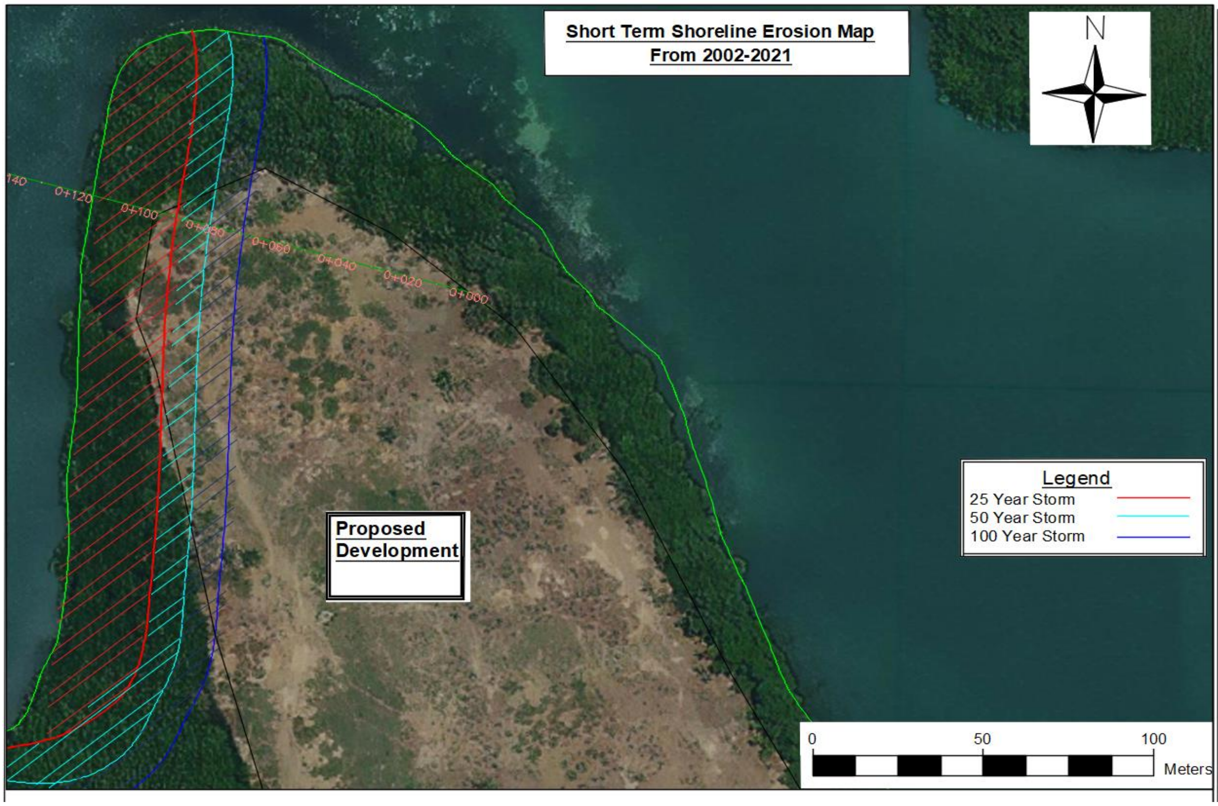
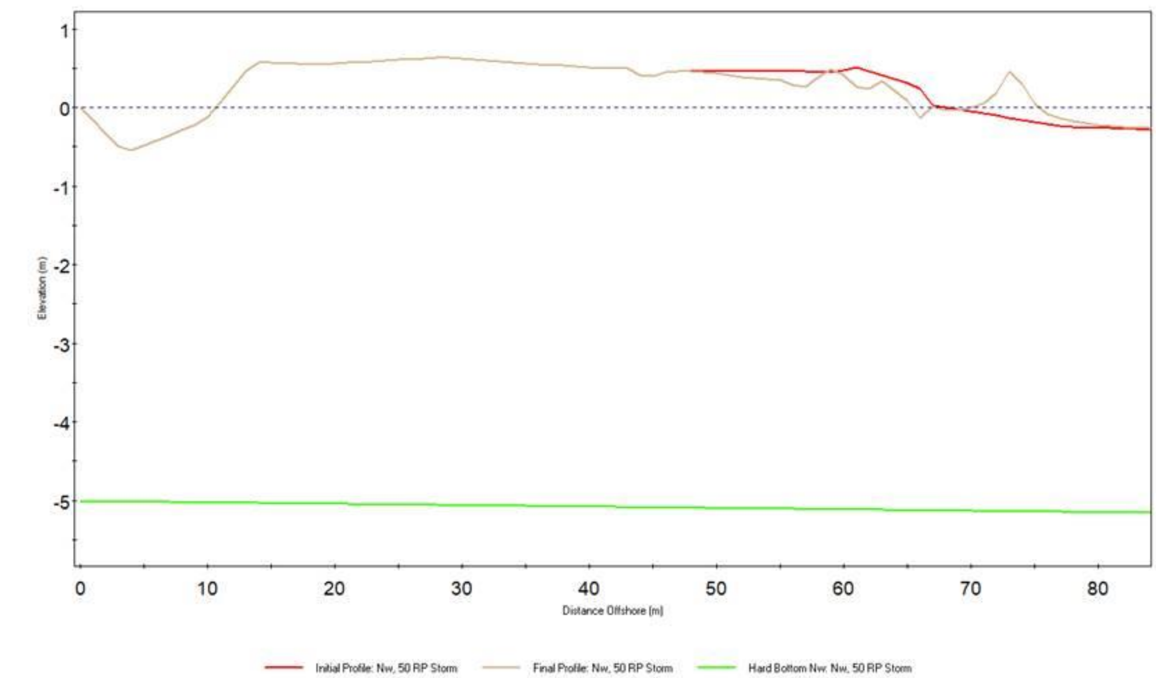


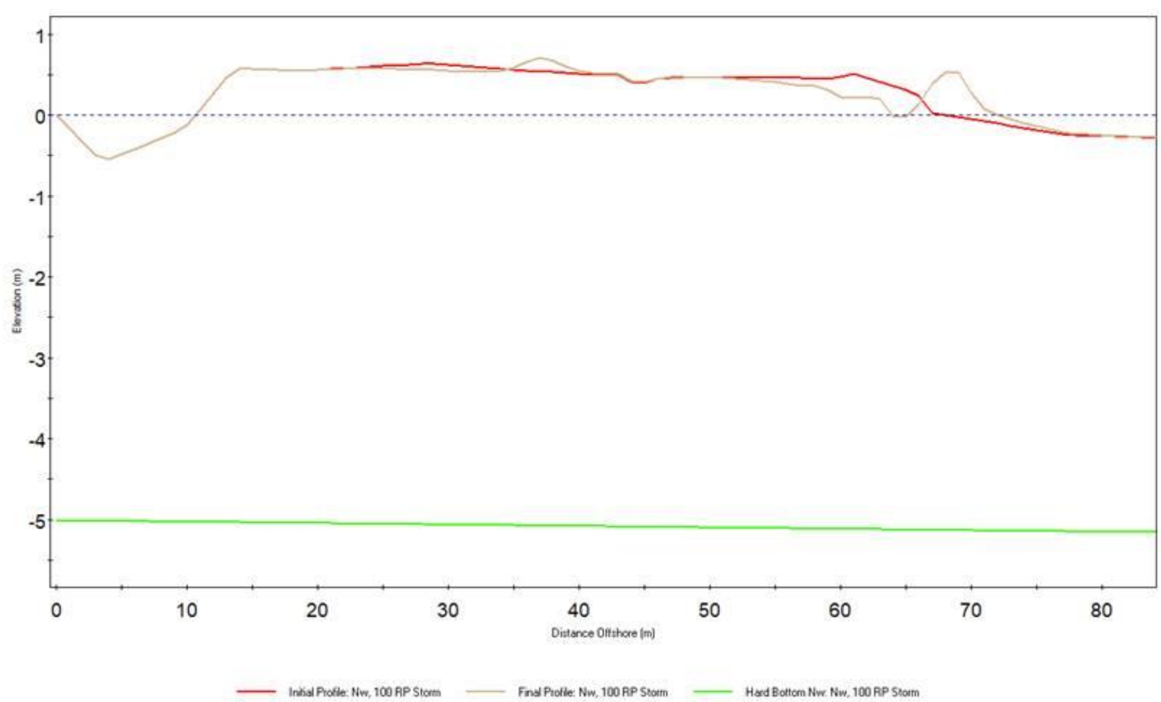
Figure 4-107 Map Showing the short term erosion extents along the project area's shoreline

Table 4-62 showing the Depth and extent of erosion at the project site after swell and storm events.

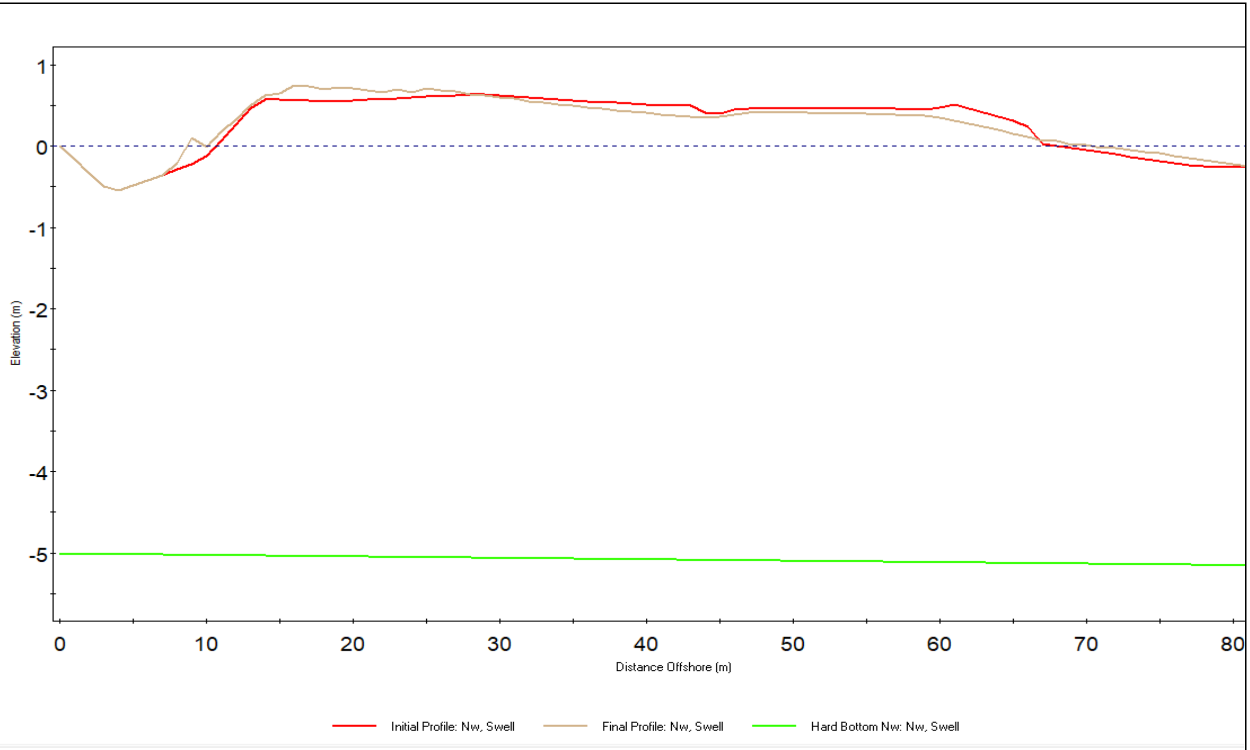
Profile	Return Period	Max Vertical Accretion ΔZ (m)	Max Vertical Erosion ΔZ (m)	Max Horizontal Accretion ΔX (m)	Max Horizontal Erosion ΔX (m)	Extent of beach disturbance (m)
NW	Hurricane (25- year RP)	0.3	0.2	5	15	25
	Hurricane (50- year RP)	0.5	0.2	10	25	35
	Hurricane (100- year RP)	0.5	0.2	10	35	45



25 RP future storm



50 RP future storm



100 RP future storm

Figure 4-108 Beach Profile showing the extent of shoreline movement after respective storms

4.3.6 Earthquake

4.3.6.1 Seismic Events and Epicentres

There was a total of 1,032 seismic events occurring in Jamaica between 2011- 2020 and 94 seismic events being felt by persons in Jamaica over the same time period (Source: Earthquake Unit University of the West Indies, Mona Campus). One local seismic record and one epicentre is located within 5 km of the proposed project site, in May 2017 (Figure 4-109).

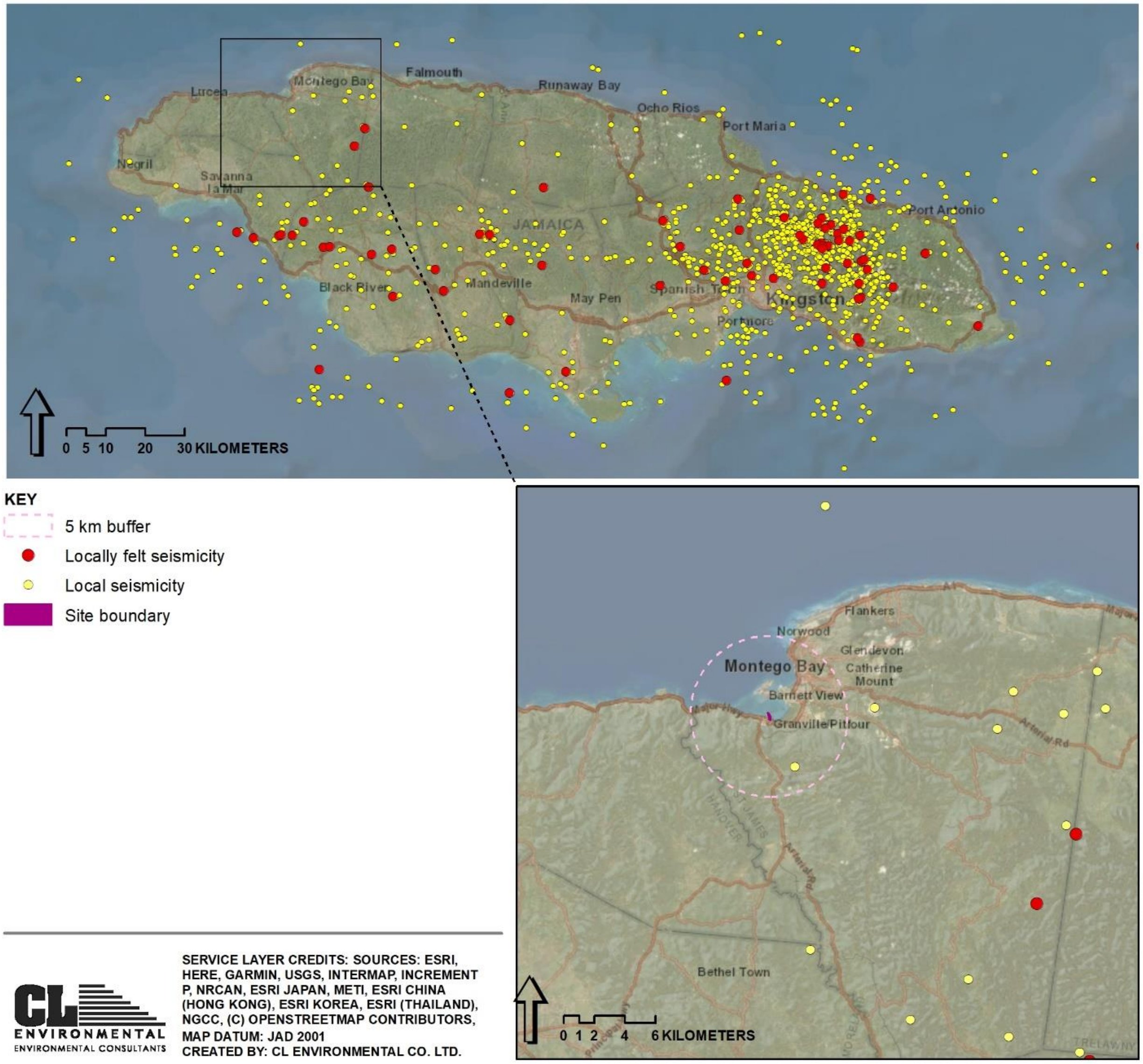


Figure 4-109 Seismic events between 2011 – 2020 for Jamaica

4.3.6.2 Soil Seismicity

The Seismic Site Class was determined using the Standard Penetration Test blow count (SPT-N) for boreholes drilled (Horizon Construction-Jamaica Limited, 2022). For the calculation of the Site Class following this method, the value of SPT-N was limited to 100 blows/foot. Based on the calculations and local geology the site has been classified as SITE CLASS E: Soft Soils.

Sections 4.1.2.2 and 4.1.2.3 summarize the seismic parameters for a probability of exceedance of 10% in 50 years according to the Kingston Metropolitan Area Seismic Hazard Assessment Report, by the Caribbean Disaster Mitigation Project and the Jamaican Standard JS 306.2009_IBC.

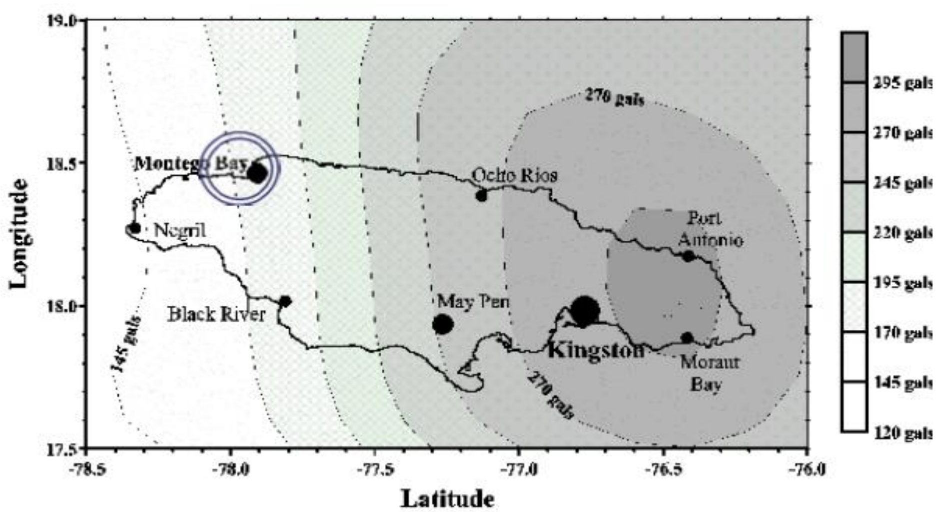
Table 4-63 Seismic parameters and Site Class values

Probability of Exceedance	PGA	S_1 [g]	S_S [g]	Site Class	Fa	Fv
10% in 50 years	0.70	0.20	0.50	E	1.7	3.2

Table 4-64 Response spectrum seismic values

Site Class	S_{DS} [g]	S_{D1} [g]	T_O [sec]	T_S [sec]	Near Field (0/1)
E	0.85	0.64	0.15	0.75	1

Figure 4-110 shows a probability of 10% of experiencing ground accelerations within 50 years. Figure 4-111 and Figure 4-112 shows Ground Earthquake Motion for Jamaica of 0.2 sec Spectral Response Acceleration and Ground Earthquake Motion for Jamaica of 1.0 sec Spectral Response Acceleration, respectively. Figure 4-113 presents a map of the location of the active inland fault zones. This confirms that the project is in the near field of an active fault MNMFZ.



Source: Kingston Metropolitan Area Seismic Hazard Assessment

Figure 4-110 Horizontal Peak Ground Acceleration with probability of exceeding 10% within 50 years

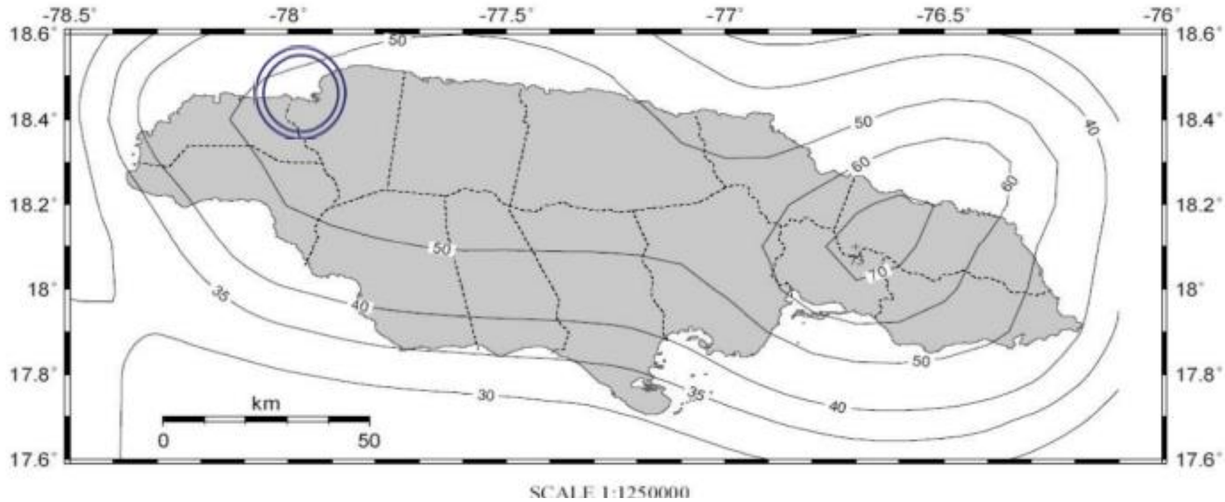


Figure 4-111 Maximum considered Ground Earthquake Motion for Jamaica of 0.2 sec Spectral Response Acceleration Ss (5% of Critical Damping)

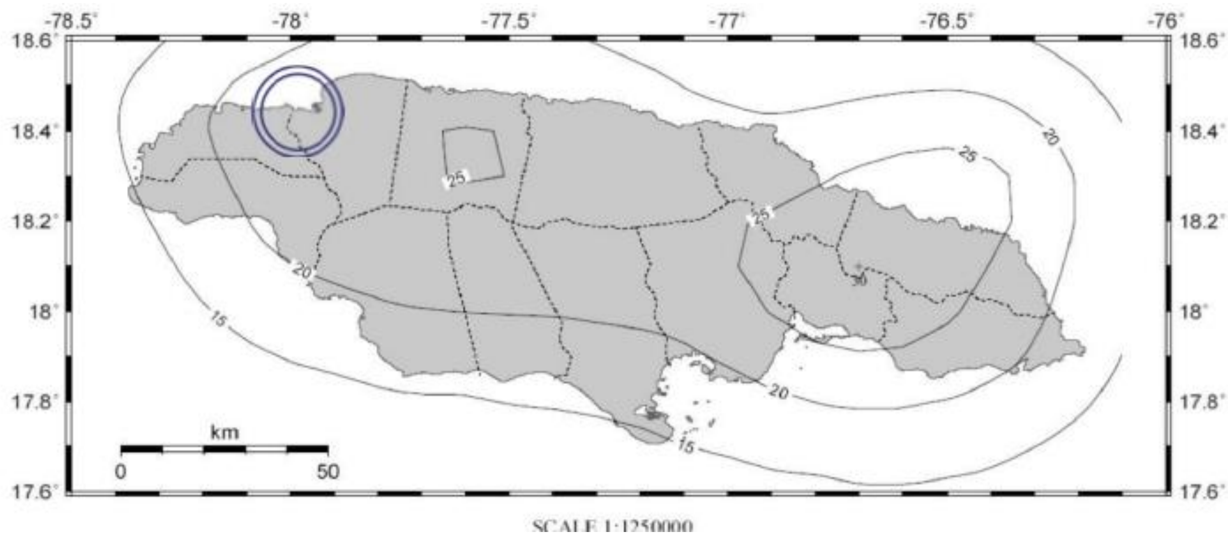
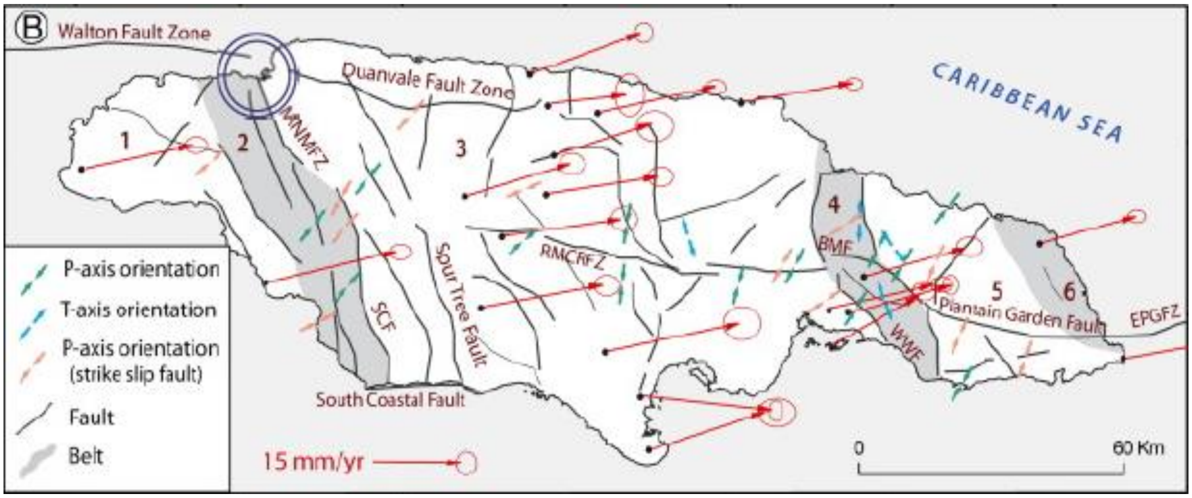


Figure 4-112 Maximum considered Ground Earthquake Motion for Jamaica of 1.0 sec Spectral Response Acceleration S1 (5% of Critical Damping)



Source: Geomorpho-tectonic evolution of the Jamaican restraining bend

Figure 4-113 Location of active on land fault zones and rate of slip

4.3.6.3 Liquefaction Potential

During liquefaction, the soils lose their shear strength therefore losing the bearing capacity to support structures. For the potential effects of liquefaction to be manifested at the ground surface, the soils generally have to be clean sands; silty sands (SM), non-plastic silts (ML), with loose to medium relative density, saturated relatively near the ground surface, and must be subjected to sufficient magnitude duration of shaking. Lateral spreading, differential settlement, loss of bearing capacity, ground tension cracks are results of this phenomenon. With the results of the borings, the potential of liquefaction was evaluated following the simplified SEED and IDRISS procedure a method that is applicable for low-slope terrain (Horizon Construction-Jamaica Limited, 2022).

Liquefaction potential of the subsurface soils was estimated using the N values of the soil samples obtained in the borings and the measured content of fines. Based on our calculations, layers were found of silty sand with potential to liquefaction in all borings at depth between 3 and 11 metres (Horizon Construction-Jamaica Limited, 2022). Table 4-65 presents a summary of the liquefiable layers for all the borings of this project.

Table 4-65 Summary of Liquefaction Analysis

STRUCTURE	BORING NO	DEPTH [FT]	0	5	10	15	20	25	30	35	40	45	50
Villas	PM101		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Restaurant	PM102		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Villas	PM103		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Parking C	PM104		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Tower 4	PM105		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Villas	PM106	LIQUEFACTION [YES/NO]	NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Parking C	PM107		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Parking B	PM108		NO	NO	NO	YES	YES	YES	NO	NO	NO	NO	NO
Tower 3	PM109		NO	NO	NO	YES	YES	YES	NO	NO	NO	NO	NO
Villas	PM110		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Villas	PM111		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Parking B	PM112		NO	NO	NO	YES	YES	YES	NO	NO	NO	NO	NO
Parking A	PM113		NO	NO	YES	YES	YES	NO	NO	NO	NO	NO	NO
Villas	PM114		NO	NO	YES	YES	YES	YES	NO	NO	NO	YES	NO
Tower 2	PM115		NO	NO	NO	YES	YES	YES	YES	NO	NO	NO	NO
Office Building	PM116		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Villas	PM117		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Parking A	PM118		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Parking A	PM119		NO	NO	YES	YES	YES	NO	NO	NO	NO	NO	NO
Villas	PM120	LIQUEFACTION [YES/NO]	NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Supermarket	PM121		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Parking A	PM122		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Tower 1	PM123		NO	NO	YES	YES	YES	NO	NO	NO	NO	NO	NO
Villas	PM124		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Supermarket	PM125		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
Villas	PM126		NO	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO

4.4 SOCIOECONOMIC AND CULTURAL/HERITAGE

4.4.1 Approach

To assess the social elements of the proposed project, a Social Impact Area (SIA) was established. A SIA may be described as the estimated spatial extent of the proposed project's effect on the surrounding communities; for the purposes of this study, it was delineated using a five (5) kilometre buffer around the proposed project area. The SIA comprises 59.12 km^2 of land in the parishes of St. James and Hanover. The project is located in the community of Reading; however, the surrounding communities of Bogue, Anchovy and Unity Hill make up the greatest proportion of land within the SIA (Figure 4-114, Table 4-66).

Table 4-66 Communities located within the SIA, sorted from largest to smallest in area of coverage within the SIA

Community name	Parish	Land area with the SA (km^2)
Bogue	St. James	16.12
Anchovy	St. James	10.92
Unity Hall	St. James	9.72
Comfort Hall	St. James	3.36
Downtown Montego Bay	St. James	3.00
Reading	St. James	2.76
Tower Hill/Moy Hall	St. James	2.18
Mount Salem	St. James	2.05
Fairfield	St. James	1.79
Catherine Mount	St. James	1.70
Mount Carey	St. James	1.12
Albion	St. James	0.74
Granville	St. James	0.57
Roehampton	St. James	0.55
Tucker	St. James	0.43
Brandon Hill	St. James	0.40
West Green	St. James	0.32
Rose Mount Garden	St. James	0.29
Pitfour	St. James	0.26
Catherine Hall	St. James	0.23
Copse	Hanover	0.17
Haddington	Hanover	0.15
Canterbury	St. James	0.11
Woodlands	Hanover	0.10
Rose Heights	St. James	0.04
Cacoon Castle	Hanover	0.02
Paradise	St. James	0.00
Rosemount	St. James	0.00
Retirement	St. James	0.00
Total		**59.12**

Population data were extracted from the Statistical Institute of Jamaica (STATIN) 2011 Population Census database for the extent of the SIA by enumeration district (ED) and processed relative to the ED's percentage coverage within the SIA using Geographic Information Systems (GIS) methodologies. The following computations were made:

- ***Population growth***: [$P_n = P_o (1 + r)^t$]
  Where P_o is the population at the beginning of a period, t is the period of time in years, r is the annual rate of increase, and P_n is the population at the end of the period (United Nations, 1952).
- ***Dependency ratio***: **[child population + aged population /working population X 100]**
  Where the child population is between ages 0-14, the aged population is 65 & over, and the working population is between ages 15-64 years. This ratio is useful for understanding the economic burden being borne by the working population.

- *Male sex ratio:* [male population / female population X 100]

  This in effect denotes the number of males there are to every 100 females and is useful for determining the predominant gender in a particular area.

- *Domestic water consumption*

  Based on the assumption that water usage is 227.12 litres/capita/day and sewage generation at 80% of water consumption. Water consumption for workers in Jamaica is calculated at 19 litres/capita/day and sewage generation at 100% water consumption.

- *Domestic garbage generation*
  Calculated at 4.11 kg/household/day (National Solid Waste Management Authority).

Geospatial data for various services and infrastructure, including schools, health centres, hospitals, police stations, fire stations and post offices were obtained from the Mona GeoInformatics Institute. Other data sources are stated throughout and include organizations such as the Forestry Department, the Planning Institute of Jamaica (PIOJ), Water Resources Authority (WRA) and the National Environmental Planning Agency (NEPA). Additional data were also gleaned from the 1984 national topographic maps (metric series) and satellite imagery available for the project.

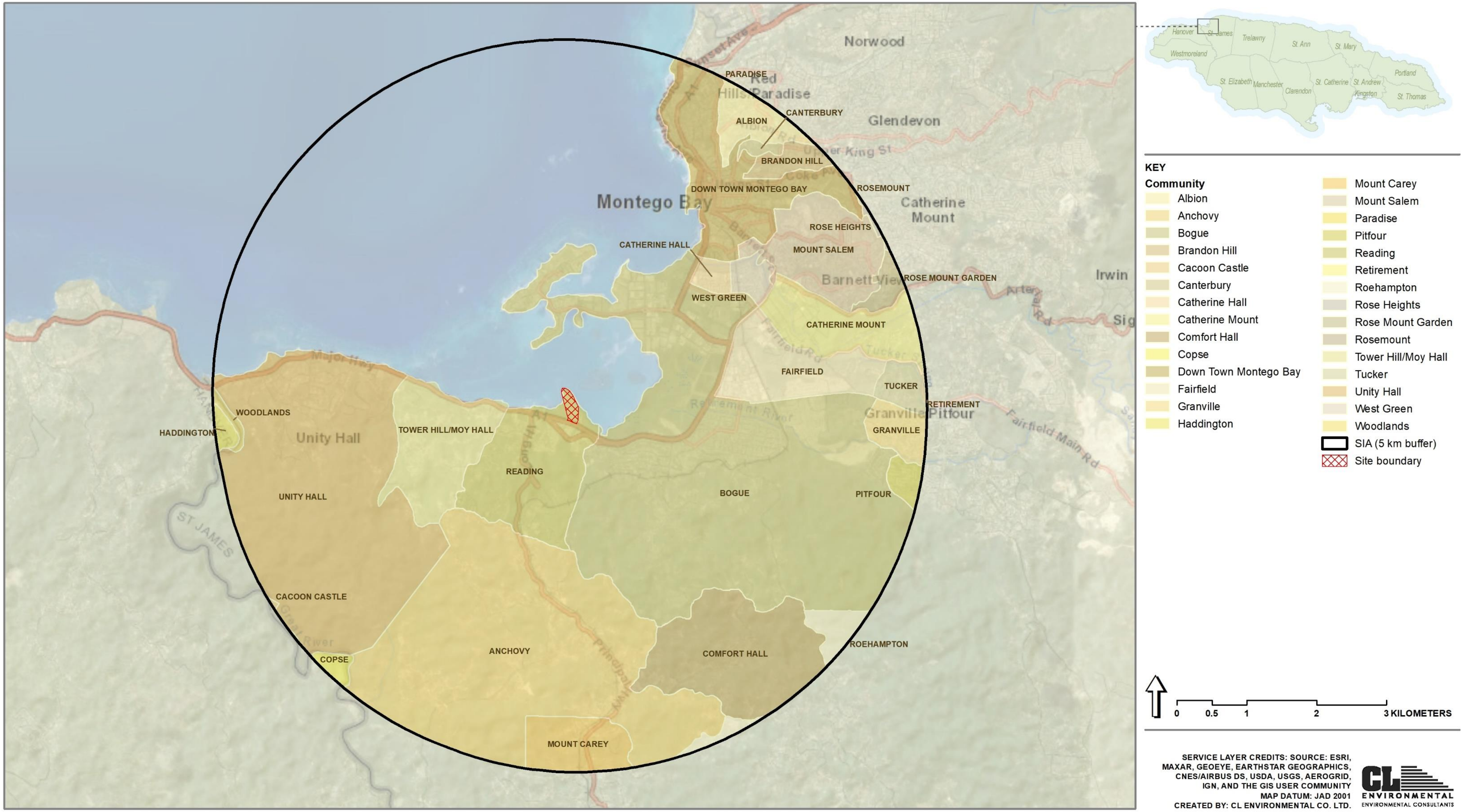


Figure 4-114 Communities within the Social Impact Area (SIA) for the proposed project

4.4.2 Demography

4.4.2.1 Population Density and Growth

The total population within the SIA in 2011 was approximately 46,532 persons (STATIN 2011 Population Census). With a land area within the SIA of approximately 59 km^2, the overall population density for the SIA was calculated to be 783 persons/km^2. This population density is higher than that for Jamaica and the parish of St. James (Table 4-67).

Table 4-67 Comparison of ED population densities for the year 2011

Category	Jamaica	St. James	SA
Total ED area (km2)	10,991.0	591.2	59.4
ED Population	2,697,983	245,103	46,532
ED Population density	245	415	783

Source: STATIN Population Census 2011

In 2001, there were approximately 41,959 persons living in the SIA. The overall growth within the SIA between 2001 and 2011 was approximately 1.04% per annum; however spatial differences in ED population growth are evident throughout the SIA (Figure 4-115). Based on the growth rate of 1.04% per annum, at the time of this study (2022), the population is approximately 52,140 persons and is expected to increase to 67,528 persons over the next twenty-five years if the current population growth rate remains the same. The annual growth rate between 2001 and 2011 for the parish of St. James is 0.51%; using this regional rate, the population in 2022 is estimated to be 49,210 persons, and in 2047, 55,884 persons.

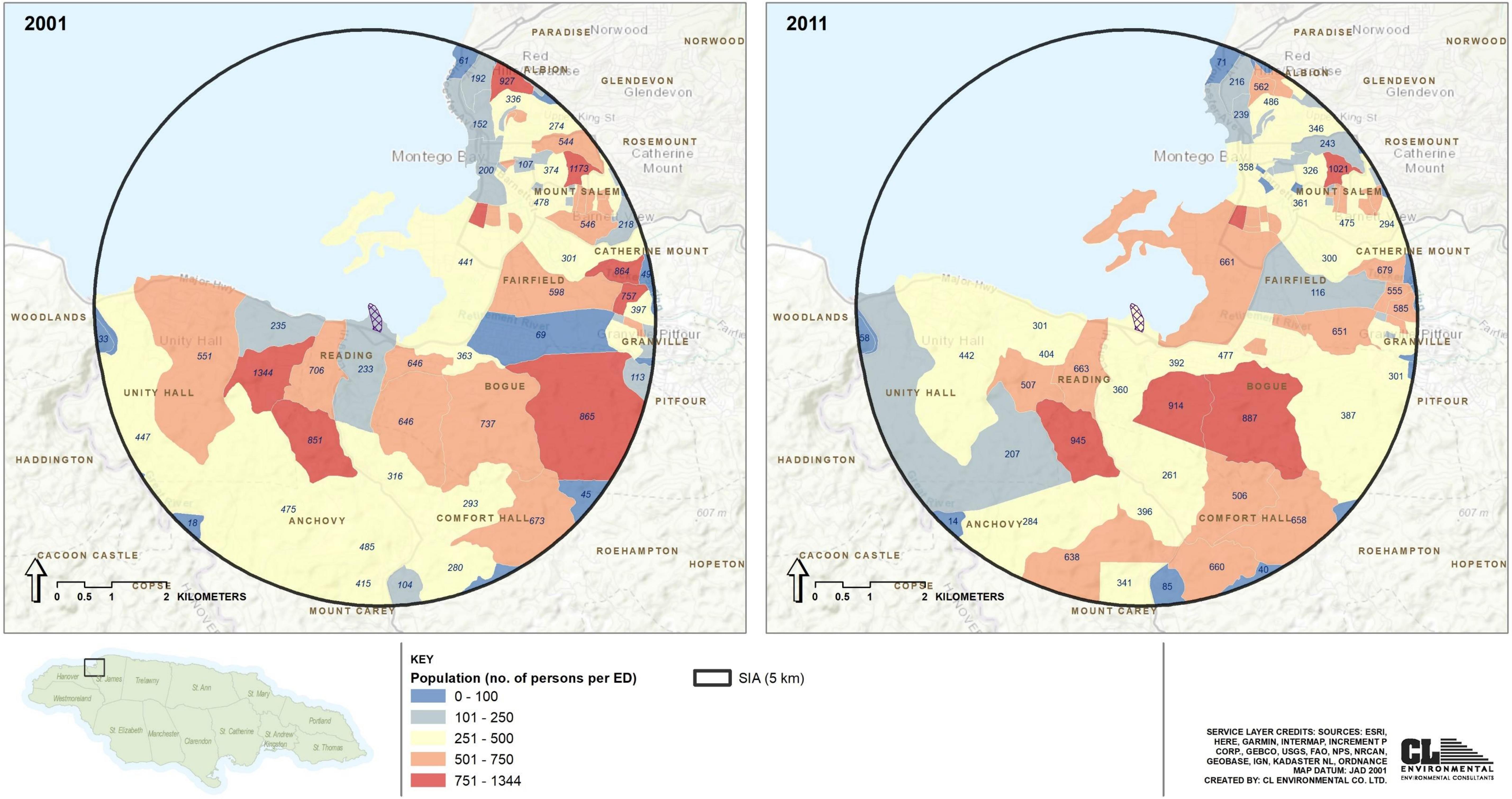


Figure 4-115 SIA 2001 and 2011 population represented by enumeration districts

4.4.2.2 Age, Sex and Dependency Ratios

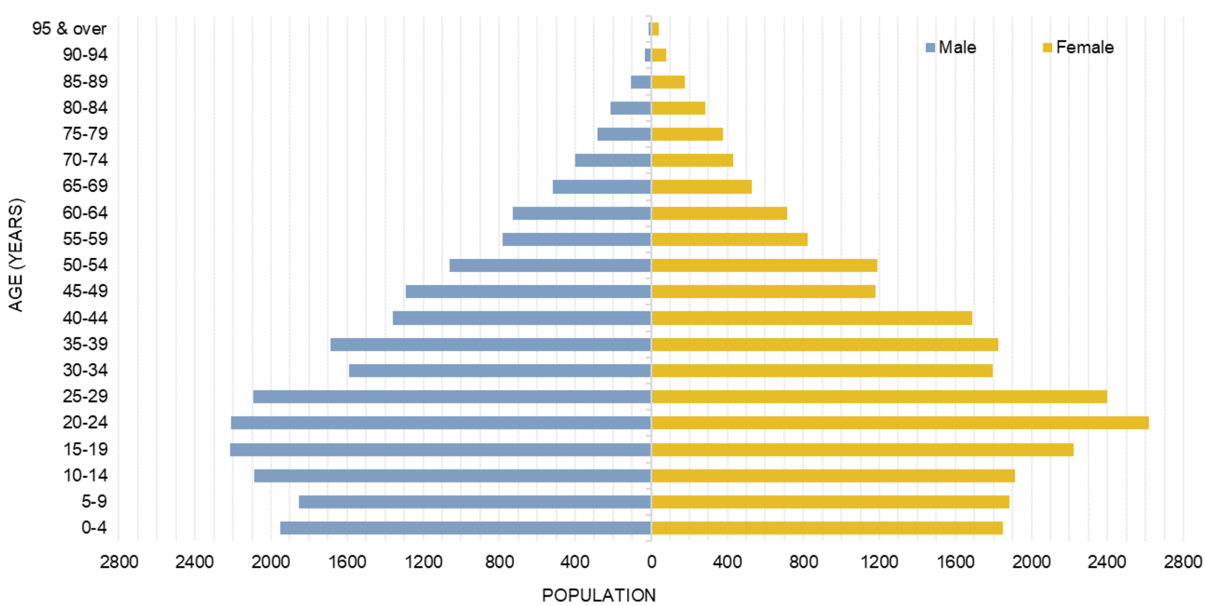
The segment of a population that is considered more vulnerable are the young (children less than five years) and the elderly (65 years and over); in the SIA population, 8.2% comprised the vulnerable young category and 7.5% comprised the elderly. Percentage age distribution in the SIA for the 0-14 years' age cohort (24.8%) is lower than that for St James and Jamaica (27.0% and 26.1% respectively). As mentioned previously, elderly persons aged 65 years and greater make up 7.5% of the SIA population; this is comparable to that for St. James and Jamaica (Table 4-68). Within the SIA, the 15-64 years' age category accounted for 67.7% and can therefore be considered a working age population.

Table 4-68 Age categories as percentage of the population for the year 2011

Age Categories	Jamaica	St. James	SIA
0-14	26.1%	27.0%	24.8%
15 - 64	65.9%	66.0%	67.7%
65 & Over	8.1%	7.0%	7.5%

Source: STATIN Population Census 2011

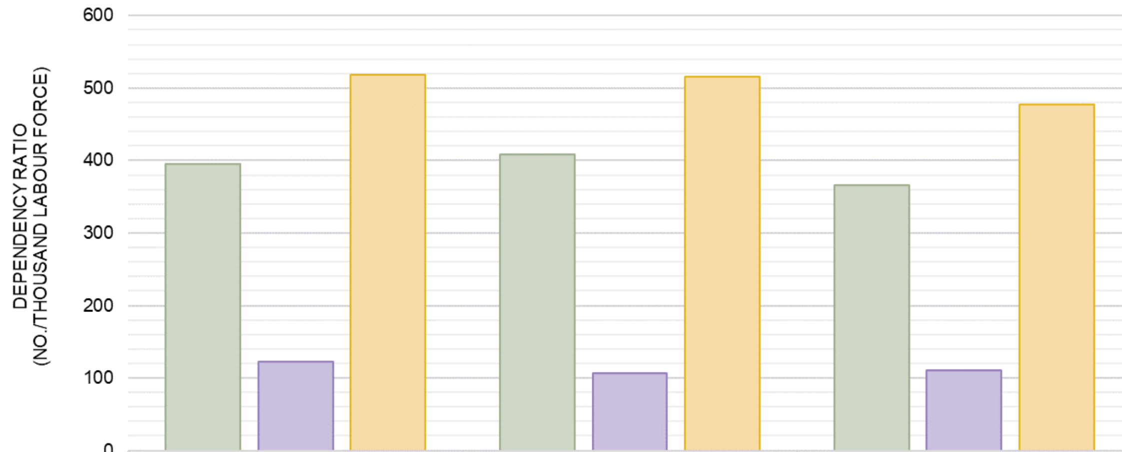
Overall sex ratio within the SIA for all age cohorts was calculated to be 93.5 males per one hundred females; however, this ratio varies across the SIA by ED and reaches a maximum of 190 males per one hundred females in Montego Bay (Figure 4-118). Within the community of Reading, females outnumbered their male counterparts, accounting for 53% of the overall total population (Social Development Commission, 2010). For all age categories considered, there is a greater proportion of females within the SIA population than males, with the exception of persons aged 0 - 4, 10-14, 45- 49 and 60 - 64 years, within which ranges there is a greater percentage of males (Figure 4-116).



Source data: STATIN Population Census 2011

Figure 4-116 Population pyramid in 2011 for the SIA

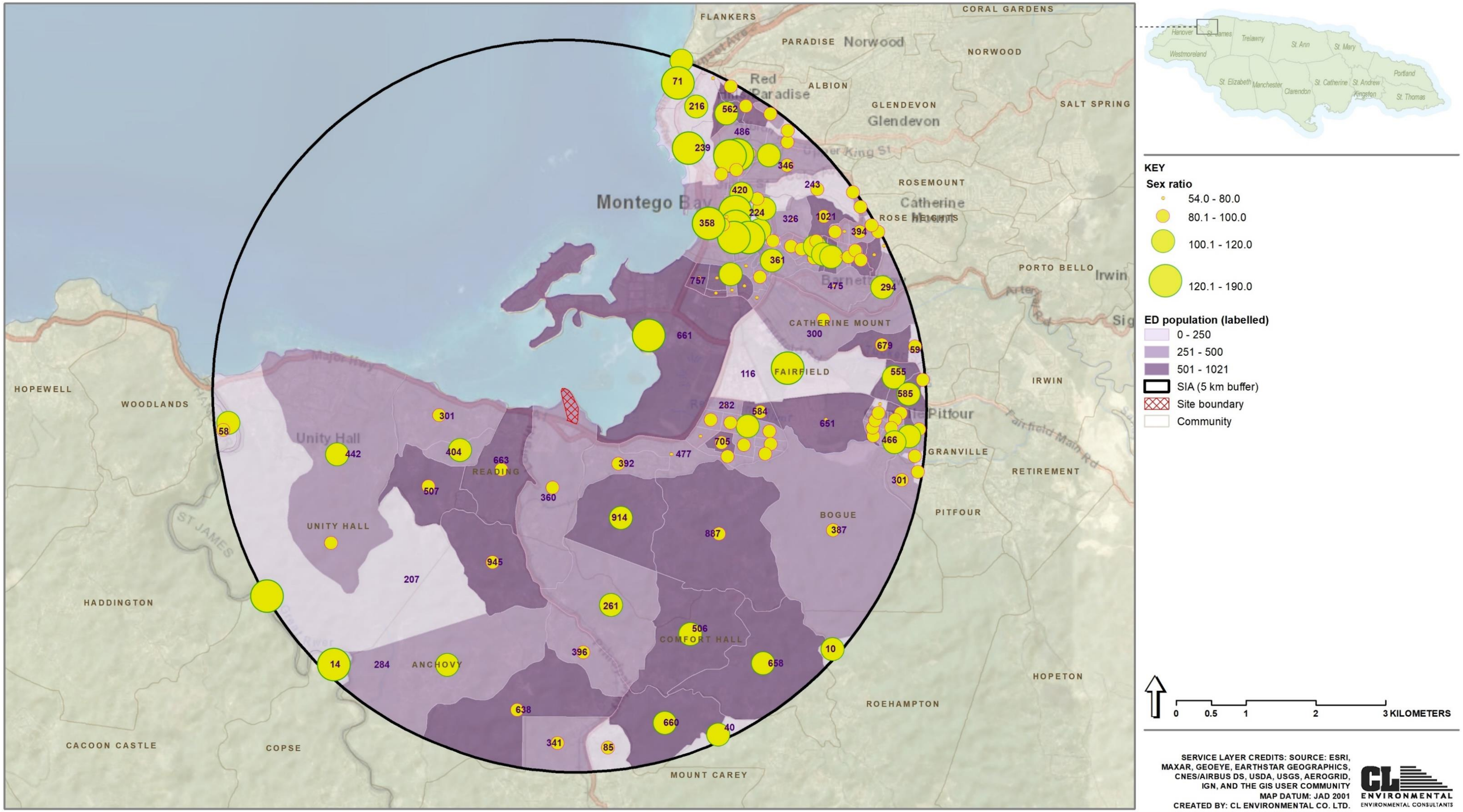
The child dependency ratio for the SIA in 2011 was 366.6 per 1000 persons of labour force age; old age dependency ratio stood at 111.2 per 1000 persons of labour force age; and societal dependency ratio of 477.8 per 1000 persons of labour force. This indicates that the youth (child dependency) are far more dependent on the labour force for support when compared with the elderly in the SIA (Figure 4-117).



	Jamaica	St. James	SA
Child Dependency	395.4	408.9	366.6
Old Age Dependency	122.4	106.7	111.2
Societal Dependency	517.8	515.6	477.8

Source: STATIN Population Census 2011

Figure 4-117 Comparison of dependency ratios for the year 2011



Source data: STATIN Population Census 2011

Figure 4-118 Sex ratio by ED within the SIA

4.4.2.3 Education

Twenty-nine schools are located within the demarcated SIA (Figure 4-119, Table 4-69).

Table 4-69 Schools found within 5 km of the project site

Name	Type	Capacity	Teachers	Enrolment
96Blossom Gd				
Albion Primary & Jnr. High	Primary & Jnr. High	765	55	1598
Anchovy Primary	Primary	672	27	984
Barracks Road Primary	Primary	925	45	1553
Bogue Hill All Age	All Age	170	11	288
Catherine Hall Primary & Infant	Primary & Infant	1000	41	1356
Challenge				
Chetwood Memorial Primary	Primary	585	29	1068
Corinaldi Primary	Primary	990	47	1771
Cornwall College High	High	1410	93	1229
DRB Grant				
Faith Basi				
Granville All Age	All Age	710	41	1294
Herbert Morrison High	High	1500	95	1485
Howard Cooke Primary	Primary	780	34	1291
LUAJ				
MoBay Infant	Infant	800	40	1174
Montego Bay Community College				
Montego Bay High	High	1035	40	764
Mount Alvernia High	High	1350	77	2540
Mount Salem Primary & Jnr. High	Primary & Jnr. High	615	54	1768
Open Bible				
Pilgrim Ho				
Ramble Hill				
Redemption				
R'way Lane				
Salvation Army				
St James High	High	1035	135	2457
Wee Care				

There is a propensity towards the attainment of primary and secondary education as the highest level of education, with 46.9% of the SIA population having attained secondary school education as the highest level, followed by 28.7% attaining primary education. Tertiary education attainment (combined university and other) as the highest level of education is 14.3% in the SIA, higher than the parish level of 9.9% (Table 4-70).

Table 4-70 SIA population 3 years old and over by highest level of educational attainment as a percentage for the year 2011

	Jamaica	St. James	SA
No Schooling	0.7%	0.8%	0.7%
Pre Primary	4.8%	4.8%	4.6%
Primary	34.4%	33.2%	28.7%
Secondary	45.7%	47.0%	46.9%
University	4.7%	4.0%	6.4%
Other Tertiary	5.2%	5.9%	7.9%
Other	0.5%	0.5%	0.4%
Not Stated	4.0%	3.8%	4.4%

Source: STATIN Population Census 2011

In the community of Reading, 55.4% of household heads have no academic qualifications (Social Development Commission, 2010). Approximately five percent (5.5%) of household heads attained passes in three or more subjects at CXC General, GCE ‘O, AEB Level and 5.4% have a college certificate. Approximately nine percent (9.5%) of household heads reported having a degree/postgraduate degree or professional qualification and 6.8% an associate degree/diploma. Data on academic qualifications of other members of the households reveal that 46.6% of persons in the community of Reading have no academic qualifications. Males dominate in this category (males – 15.9%; females –30.7%). Approximately twelve percent (12.5%) of residents have passes in three or more subjects at the CXC General, GCE ‘O, AEB level. Less than six percent (5.7%) of residents reported having an associate degree and 11.4% have a degree/postgraduate degree or professional qualification.

A relatively high percentage (80.3%) of household heads reported receiving training for a specific activity, occupation or trade. However, only 38.4% of household heads have received formal training in a specific activity, occupation or trade; of this amount 23.3% achieved professional or technical certification and 9.6% achieved vocational certification. The community skill set reveals that 21.4% of residents have professional and technical skills. Approximately eighteen percent (18.4%) of residents have machine and appliance skills and 17.5% have secretarial and office clerk skills (Social Development Commission, 2010).

4.4.2.4 Employment

In the community of Reading, approximately 52% of persons in the labour force are employed with an average of 1.4 persons employed within each household (Social Development Commission, 2010). Sixty percent (60%) of the employed labour force are males compared to 40% females. The 25-29 and 60 and over age cohorts account for the highest levels of employment – 18% and 16% respectively. Youth employment accounts for 12% of the employed labour force; this is less than the national percentage (14.6%) reported by the JSLC, 2007. Of this number, 8% are males and 4% females (Social Development Commission, 2010).

Approximately thirty-four percent (34.4%) of workers in Reading are employed as service, shop and market sales workers. Just over twenty-six percent (26.3%) of household members are employed as craft and related trade workers while 16.2% are employed in elementary occupations (Social Development Commission, 2010).

Of the unemployed labour force (48%); just over twenty-nine percent (29.1%) are males compared to almost seventy-one percent (70.9%) for females. The highest incidence of unemployment occurs among the elderly (60 and over) and youths (15-24) accounting for 54.5% and 18.2% respectively (Social Development Commission, 2010).

4.4.2.5 Poverty

The poverty GIS dataset developed by the Planning Institute of Jamaica (PIOJ) (with contributions from STATIN, Social Development Commission (SDC) and the University of Technology), primarily identifies areas of poverty by community. As described by PIOJ, for the 2002 poverty map:

> The indicators utilized were those that best predicted per capita consumption levels in households based on data from the Jamaica Survey of Living Conditions (JSLC) 2002. Relevant variables that were common to this survey and the Population Census 2001 were selected and tested for similarity. The satisfactory variables were then applied to the census data to obtain estimates of the consumption levels of the households that had consumption levels island wide. Members of households that had consumption levels below the poverty line for the region in which their household was located were deemed to be in poverty. The proportion of persons in poverty in each community was used to rank the 829 communities.

The SIA population has poverty levels between 0.1 and 33.4% of persons living in poverty, with most communities having poverty levels less than 20% (Figure 4-120).

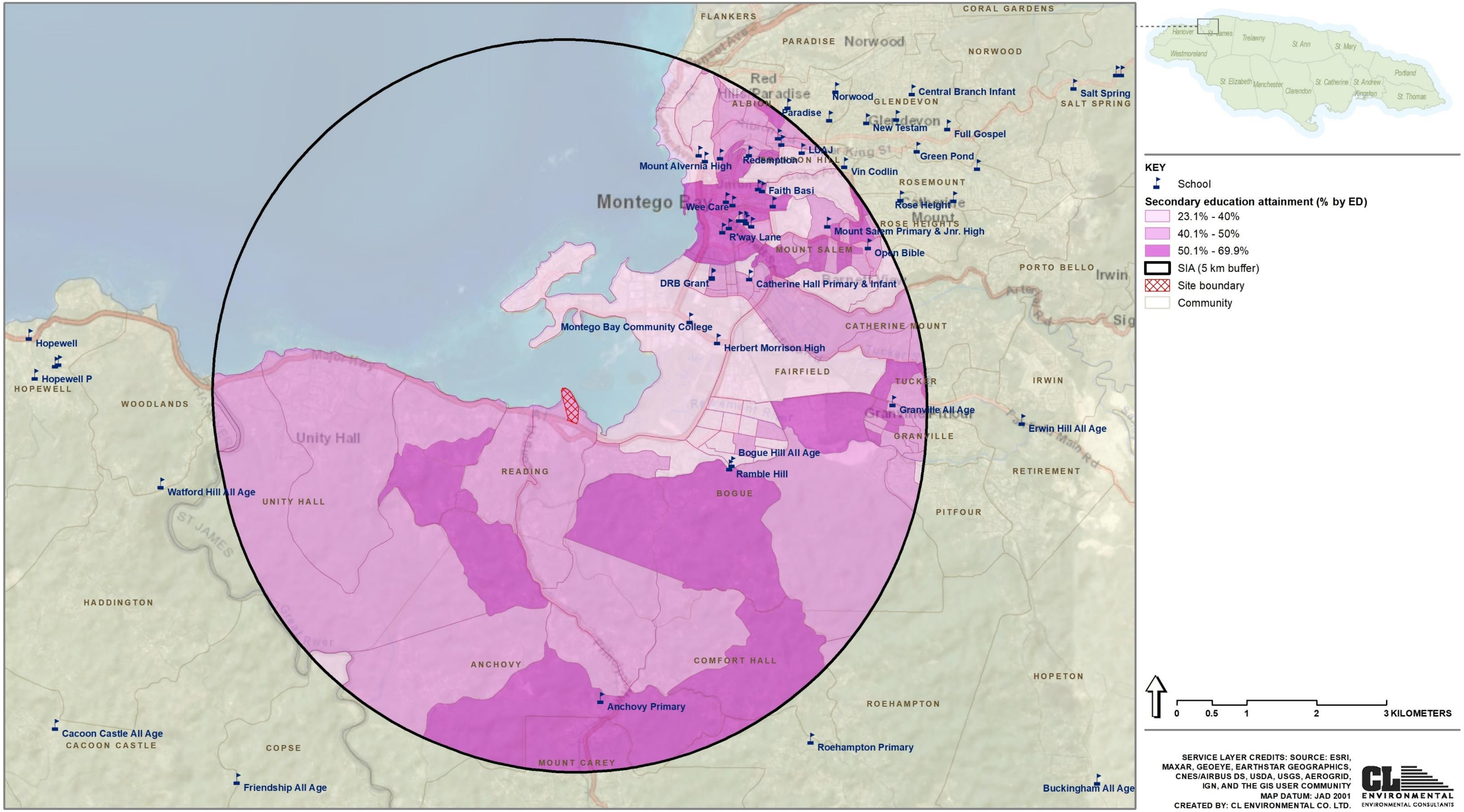


Figure 4-119 Secondary education attainment by ED and schools within the SIA

Data source: PIOJ (with contributions from STATIN, SDC and the University of Technology

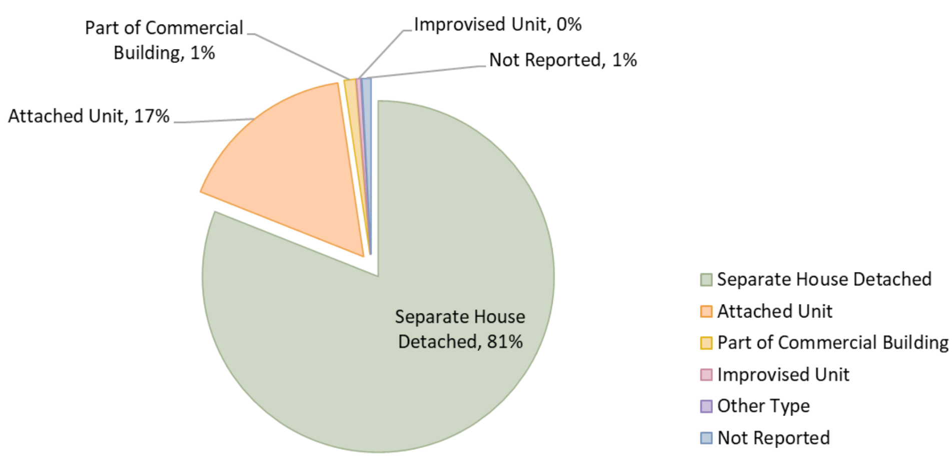
Figure 4-120 Proportion of persons in poverty in each community within the SIA

4.4.2.6 Housing

For the purposes of this study, the definitions of housing unit, dwelling and household are those used in the population census conducted by the Statistical Institute of Jamaica (STATIN). The definition states that:

- A **housing unit** is a building or buildings used for living purposes at the time of the census.
- A **dwelling** is any building or separate and independent part of a building in which a person or group of persons lived at the time of the census". The essential features of a dwelling unit are both "separateness and independence". Occupiers of a dwelling unit must have free access to the street by their own separate and independent entrance(s) without having to pass through the living quarters of another household. Private dwellings are those in which private households reside. Examples are single houses, flats, apartments and part of commercial buildings and boarding houses catering for less than six boarders.

There were 11,436 housing units (of which 81 % were separate detached houses, Figure 4-121), 14,394 dwellings and 14,737 households within the SIA in 2011. The average number of dwellings in each housing unit was 1.3 and the average household to each dwelling was also 1.0 (Figure 4-121). The average household size in the SIA was 3.2 persons/ household. Comparisons of the SIA with national and regional ratios indicate that the SIA had comparable household/dwelling, average household size and dwelling/ housing unit ratios (Table 4-71).



Source: STATIN Population Census 2011

Figure 4-121 Percentage of housing units by type within the SIA

Table 4-71 Comparison of national, regional and SIA housing ratios for 2011

	Jamaica	St. James	SA
Dwelling/Housing Unit	1.2	1.2	1.3
Household/Dwelling	1.0	1.0	1.0
Average Household Size	3.1	3.0	3.2

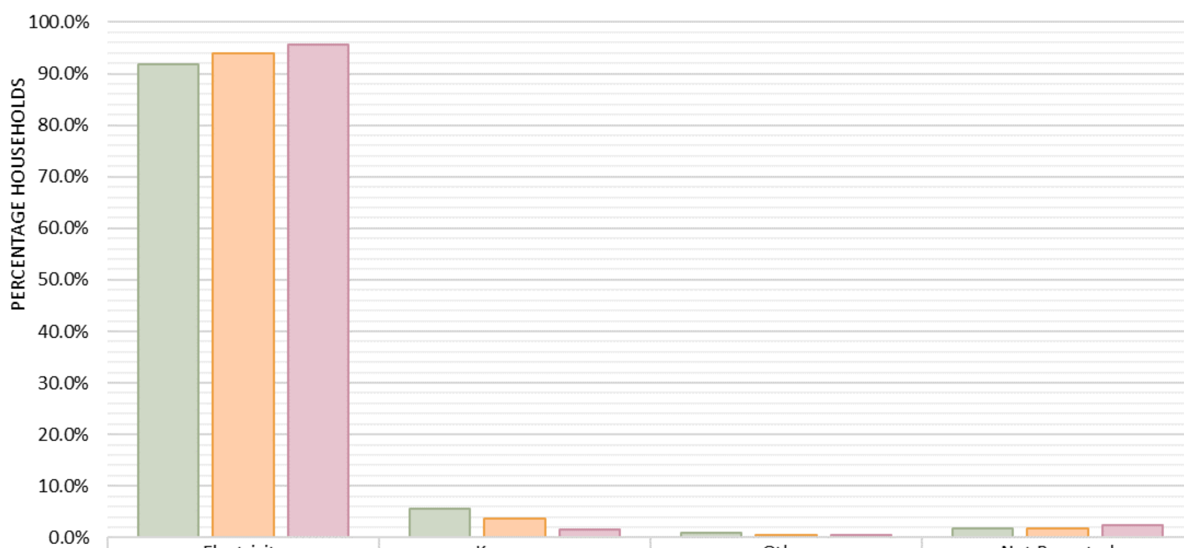
Source: STATIN Population Census 2001

In the community of Reading, most household heads (61.3%) own the house they reside in (Social Development Commission, 2010). Although home ownership in Reading is high, approximately 60% of the households do not own the land on which they reside. Thirty-two percent (32%) of households live on family-owned land and rented land accounts for 20% of households (Social Development Commission, 2010).

4.4.3 Utilities

4.4.3.1 Lighting

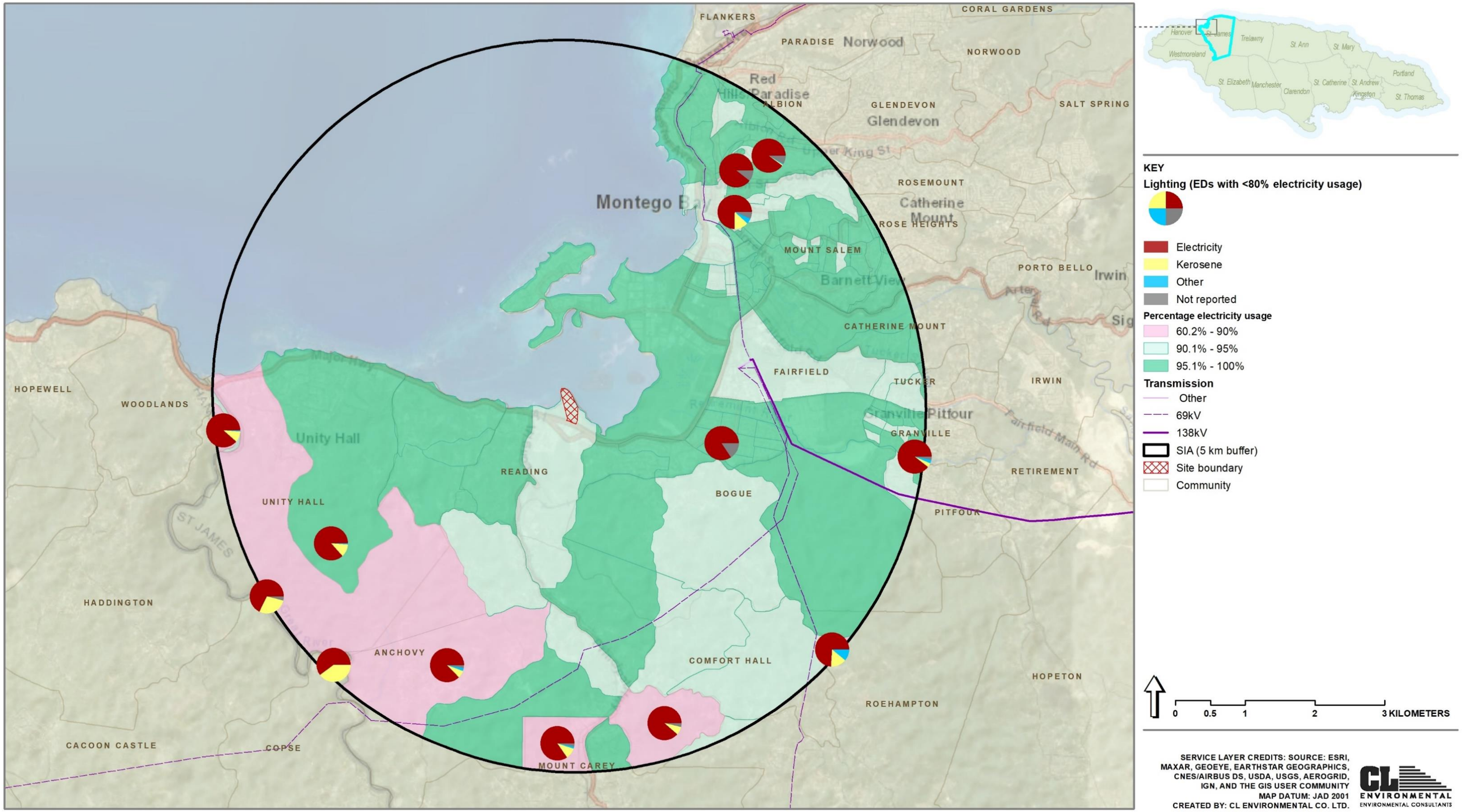
Figure 4-122 details the percentage of households using a category of lighting. Data for all extents (SIA, parish and national) revealed that majority of the population utilises electricity as their main source of lighting. Overall, approximately ninety-six percent (95.6%) of households within the SIA use electricity; the lowest percentage of households utilizing electricity with the SIA was 60.2% and in these EDs with lower electricity usage, kerosene was the second most used source of lighting (Figure 4-123). Lighting at all households (100%) in Reading is mainly provided by electricity (Social Development Commission, 2010).



	Electricity	Kerosene	Other	Not Reported
Jamaica	91.9%	5.5%	0.8%	1.8%
St. James	93.9%	3.6%	0.6%	1.8%
SA	95.6%	1.5%	0.5%	2.4%

Source: STATIN Population Census 2011

Figure 4-122 Percentage households by source of lighting



Source: STATIN Population Census 2011

Figure 4-123 Percentage electricity usage for the year 2011 and location of transmission lines within the SIA

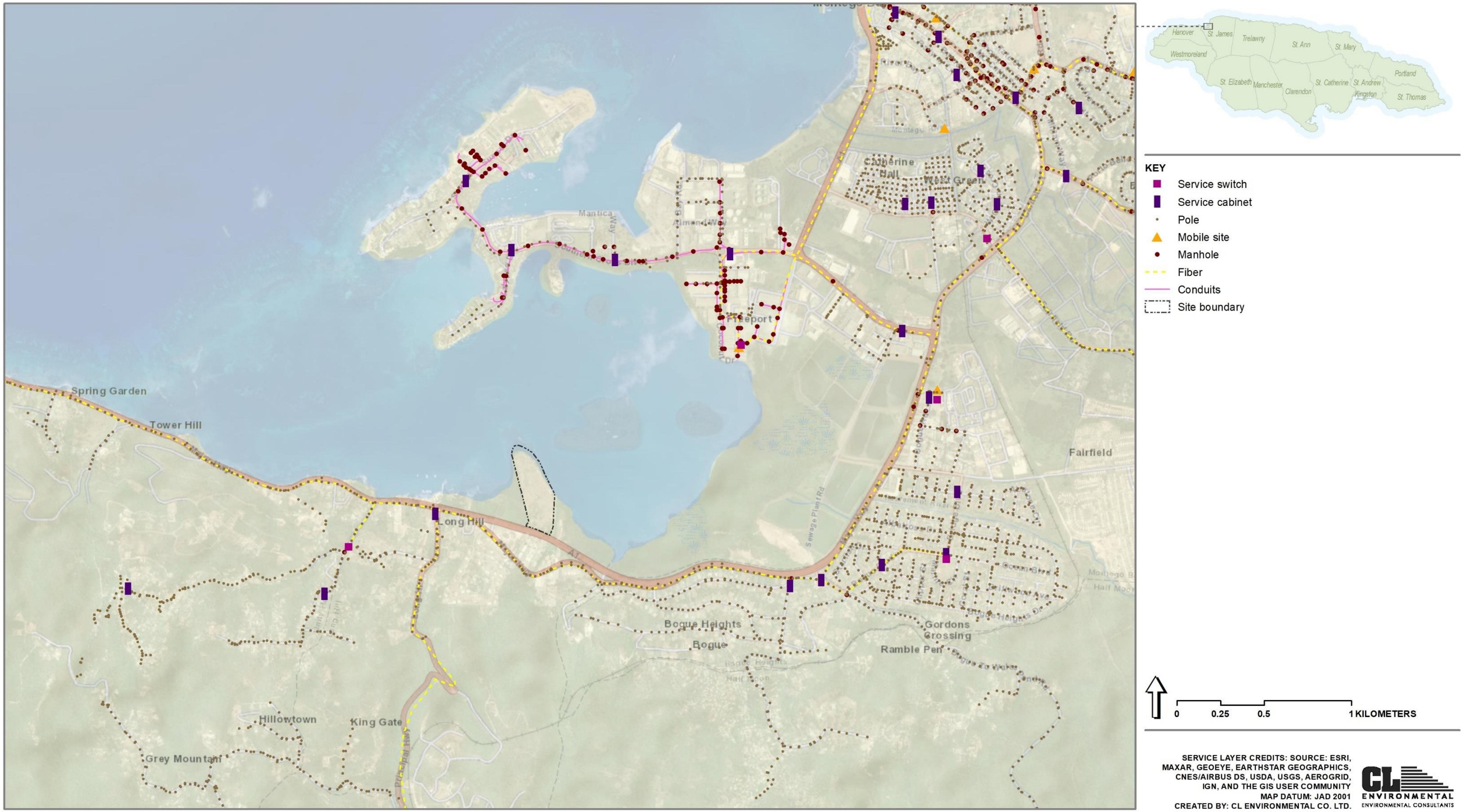


Figure 4-124 Electrical infrastructure and connections in the study area

4.4.3.2 Domestic Water Supply

The National Water Commission (NWC) is the public agency responsible for providing Jamaica's domestic water supply. Like the parish and national levels, the majority households within the SIA (92.6%) received their domestic water supply from NWC, whilst 4.0% from a private source, 0.3% from springs and rivers and 1.0% from water trucks (Table 4-72). Water supply source also varies spatially by ED (Figure 4-125).

Table 4-72 Percentage of households by water supply for the year 2011

	Category	Jamaica	St. James	SA
Public Source	Piped in Dwelling	49.7%	60.9%	76.4%
	Piped in Yard	16.5%	12.9%	12.8%
	Standpipe	7.1%	5.4%	2.7%
	Catchment	2.2%	0.7%	0.6%
Private Source	Into Dwelling	6.4%	5.0%	2.0%
	Catchment	9.8%	4.3%	2.0%
	Spring/ River	3.0%	6.0%	0.3%
	Trucked Water/Water Truck	2.1%	1.8%	1.0%
	Other	1.8%	1.7%	0.8%
	Not Reported	1.3%	1.2%	1.4%

Source: STATIN Population Census 2011

Three springs (Great River, Reading and Bogue Spring) and 26 wells (Table 4-73) are found within 5 km of the proposed alignment (Figure 4-125). The various potable water supply facilities and infrastructure located in proximity to the proposed site may be seen in Figure 4-126; also seen in this figure, is that the site is located within the Great River Water Management Unit.

Table 4-73 Wells found within 5km of the project site

Name	Owner	Watershed	Status	Use
Barnett (Pies River)	Barnett Estates	Montego River	Destroyed	
Tucker	National Water Commission	Montego River	Abandoned	Public/Domestic Supply
Casa Montego Hotel	Casa Montego Hotel	Montego River		
Bogue CH	Barnett Estates	Montego River	Destroyed	
Fairfield	National Water Commission	Montego River	Pumping	Public/Domestic Supply
Pitfour Pen		Montego River	Pumping	Public/Domestic Supply
Pitfour Pen	National Water Commission	Montego River	Pumping	Public/Domestic Supply
Reading - Bogue #2	Desnoes and Geddes Ltd.	Montego River	Non-Pumping	Industrial
Montego Bay (Catherine Mount #2)	National Water Commission	Montego River	Pumping	Public/Domestic Supply
Montego Bay (Catherine Mount #1)	National Water Commission	Montego River	Pumping	Public/Domestic Supply
Belfield- St. James	Barnett Estates	Montego River	Destroyed	
Bogue J.P.S.	Jamaica Public Service Company Ltd.	Montego River	Pumping	Industrial

Name	Owner	Watershed	Status	Use
Bogue	Barnett Estates	Montego River		
Bogue (Reading) D and G #1	Desnoes and Geddes Ltd.	Montego River		
Bogue- St. James	National Water Commission	Montego River	Pumping	Public/Domestic Supply
Spring Garden - Reading	Montego Spa Dev. Co.Li	Great River		
Pimento Hill	Great River Limited	Great River	Pumping	Public/Domestic Supply
Unity Hall - Great River	Great River Maintenance	Great River	Abandoned	Public/Domestic Supply
Anchovy	Beckford	Great River	Non Pumping	
Bogue Plant (CH)	Jamaica Public Service Company Ltd.	Montego River		
Catherine Mount Obs. #2	National Water Commission	Montego River		
Catherine Mount Obs. #1	National Water Commission	Montego River		
Abstraction Well # 3	Seawind Key Investments Limited	Montego River		Industrial
Abstraction Well # 5	Seawind Key Investments Limited	Montego River		Industrial
Abstraction Well # 6	Seawind Key Investments Limited	Montego River		Industrial
Abstraction Well # 7	Seawind Key Investments Limited	Montego River		Industrial

Water demand for the SIA in 2022 is estimated to be 11,842,019 litres/day (~3,128,331 gals/day) and is expected to increase to 15,337,040 litres/day (~4,051,618 gals/day) over the next twenty-five years based on population growth rates calculated previously.

4.4.3.3 Wastewater Generation and Disposal

In the community of Reading, water closet not linked to a main sewer system is utilized by 89.3% of households while pit latrine is utilized by 6.7% of households and 4% utilize soak away systems. Seven percent (7%) of households reported sharing toilet facilities (Social Development Commission, 2010).

Wastewater treatment infrastructure in proximity to the proposed site may be seen in Figure 4-126.

It is estimated that approximately 9,473,616 litres/day (~2,502,665 gals/day) of wastewater is generated within the study area (for 2022) and is expected to increase to 12,269,632 litres/day (~3,241,294 gals/day) over the next twenty-five years based on calculated growth rates.

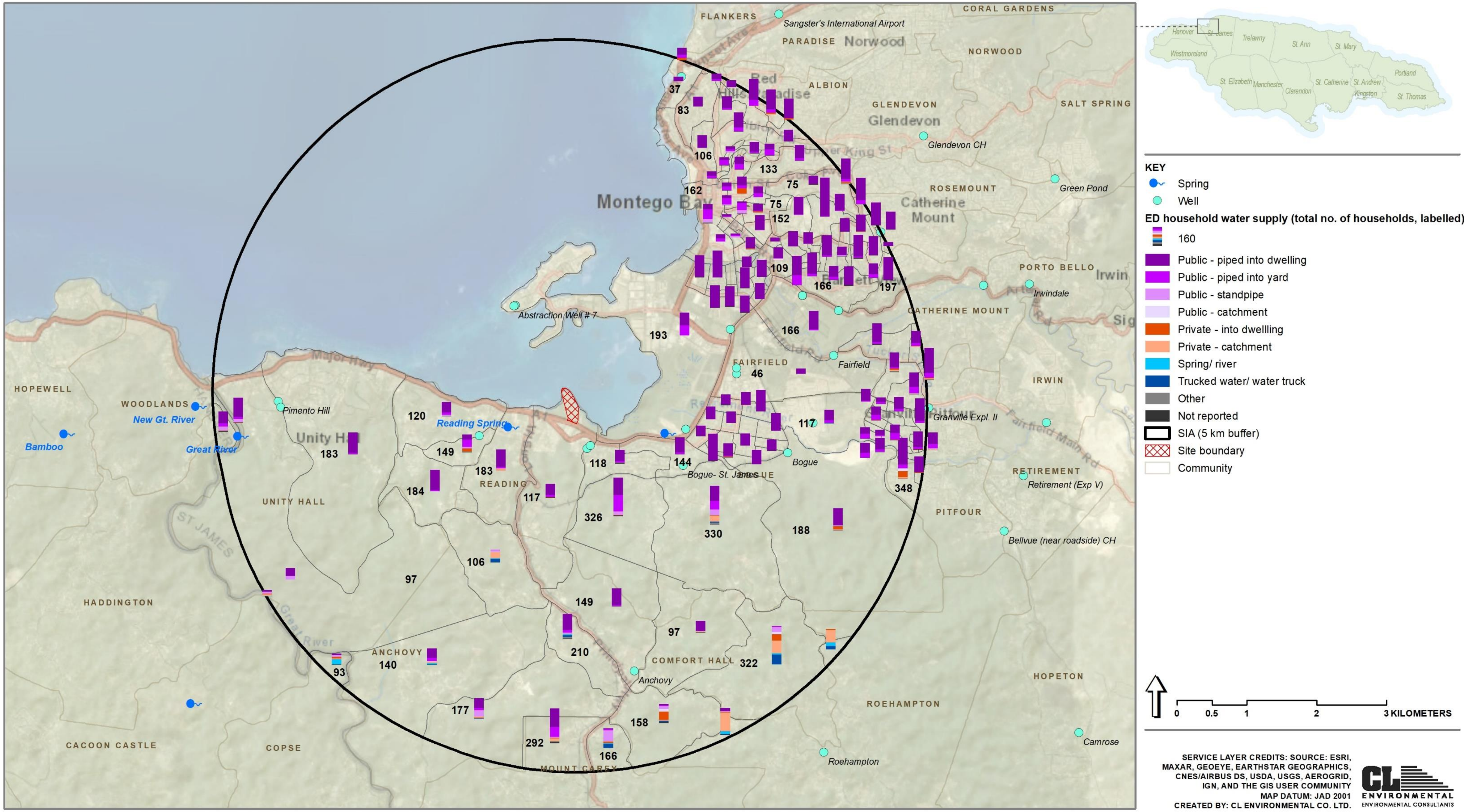


Figure 4-125 Source of water supply by ED, as well as wells and springs within the SIA

Figure 4-126 Potable water infrastructure, water management and wastewater treatment facilities in the study area

4.4.3.4 Solid Waste Generation and Disposal

The National Solid Waste Management Authority (NSWMA) is responsible for domestic solid waste collection within the study area. In residential areas, garbage is collected once per week. This service is provided free (partial covered by property taxes) for the households within the area. In Reading, garbage is picked up by the truck from 52.6% of households while 47.4% of households burn their garbage. Approximately ten percent (10.5%) of households utilize community receptacles and 3.9% of households bury their garbage (Social Development Commission, 2010).

It is estimated that at the time of this study (2022), approximately 67,871 kg/day (~67.9 tonnes/day) of solid waste was being generated. This is expected to increase to 87,902 kg (~87.9 tonnes) over the next twenty-five years based on calculated growth rates.

4.4.3.5 Communication

The study area is served with landlines provided by Flow Jamaica Limited (formerly LIME Jamaica Limited). Wireless (mobile) communication is provided by Digicel Jamaica Limited and Flow and a network to support internet connectivity is also provided by Flow.

In St. James, the majority of household heads (78%) used mobile cellar services only, in comparison to other types of telephone devices (Table 4-74). In the community of Reading, all households (100%) have access to telephone service; of this amount, 56.6% utilize cellular telephone service only; 40.8% utilize both landline and cellular phones and 2.6% utilize landline only (Social Development Commission, 2010). Approximately twenty-seven percent (27.1%) of households in Reading reported having access to the internet. This is higher than the national percentage of 7.6% reported for Jamaica in 2007 (JSLC, 2007) (Social Development Commission, 2010).

Residents of Reading are served by the Reading Post Office and Montego Bay # 2 Post Office (Social Development Commission, 2010), seen in Figure 4-127.

Table 4-74 Access to telephone facilities in households by age of head in St. James

Source: STATIN Population Census 2011

Parish and Device	Total Heads	Age of Head			
		Under 25	25-44	45-64	65+
St James	**59,513**	**3,989**	**26,834**	**20,180**	**8,510**
Fixed Cellular or Landline only	2,192	41	647	778	726
Mobile Cellular only	46,479	3,681	22,533	15,117	5,148
Both Fixed and Mobile	8,365	161	2,933	3,449	1,822
None	1,590	41	354	522	673
Not Stated	887	65	367	314	141

4.4.4 Transportation

4.4.4.1 Road Network and Modes of Transport

The existing road network within the SIA is depicted in Figure 4-127. The project site is located to the north of the Bogue Main Road, which is a class A arterial roadway. This roadway links the commercial district of Fairview to residential areas such as Bogue and Reading in Montego Bay and terminates at the Bogue/Long Hill Intersection which provides road users with the option of heading westward to Hanover or towards the southern coast of the Island. This segment of the road network is a highly traversed area.

Public transport within as well as to and from the community is very reliable; Reading is served by its own route taxis which ply the Montego Bay/Reading route (Social Development Commission, 2010). The community also benefits from taxis plying other routes such as the Montego Bay to Anchovy, Moy Hall/Tower Hill. The North Coast Highway - Negril to Montego Bay Leg and the Long Hill Main Road serves as the main thoroughfares through the community of Reading.

As shown in Table 4-75, the primary modes of road transport in St. James in 2011 were taxis (64% route and robot taxis combined), private vehicles (19%) and walking (7%). In reading, the main means of transportation is licensed taxis (used by 64.5% of the households); other forms of transportation used include private motor cars (40.8%), buses (21.1%), robot taxis (5.3%) and motorcycle (1.3%) (Social Development Commission, 2010).

Table 4-75 Total population 3 years old and over by usual mode of transportation in St. James

Source: STATIN Population Census 2011

Mode of Transportation and Parish	Total Population	Age Group			
		Under 15	15-29	30-64	65+
St James	**173,153**	**39,879**	**52,717**	**67,839**	**12,718**
JUTC/Govt	887	327	180	306	74
Minibus	9,537	2,727	3,180	2,978	652
Hackney Carriage Taxi	96	21	35	32	8
Motorcycle	210	10	48	140	12
Walk	12,140	7,461	1,695	2,400	584
Chartered Vehicle	1,069	621	69	129	250
Robot Taxi	3,107	715	1,071	1,105	216
Coaster/Hino Bus	837	210	311	273	43
Route Taxi	108,559	21,446	38,992	40,840	7,281
Company Vehicle	808	25	192	566	25
Bicycle	372	12	64	258	38
Private Vehicle	32,557	5,621	6,387	17,942	2,607
Other	101	43	9	35	14
Never Went Out	1,575	260	151	349	815
Not Stated	1,298	380	333	486	99

Figure 4-127 Road network and services located in the SIA

Source: Social Development Commission (Asset Data for St. James Parish, 2019)

Figure 4-128 SDC community assets in proximity to the project site

4.4.4.2 Traffic Impact Assessment

Objectives and Approach

A Traffic Impact Assessment (TIA) was undertaken to understand the effect of the project on the surrounding traffic conditions (CEAC Solutions Co. Ltd., 2022). The key objectives of this exercise were to:

1. Define the general environment in which the development will be constructed by conducting or acquiring traffic counts in the vicinity of the Bogue Road (A1 Highway) and the adjacent intersection at Bogue Road/Long Hill.
2. The determination of Average Daily Traffic (ADT) and Peak Hourly Traffic (PHT) along the Bogue Road (A1 Highway) and the adjacent intersection at Bogue Road/Long Hill.
3. Determine the expected ADT and PHT at the proposed entrance of the Peninsula during construction and post-construction phases
4. Determine the impact on roadway level of service (LOS) that the development will have.
5. Provide mitigative measures based on the impacts discovered.

The approach involved dialogue with the National Works Agency (NWA) and other relevant stakeholders to guide the assessment scope and methods. The methodology included project inception meetings; desktop data collection (NWA road network); field data collection, including traffic count information and various field parameters (signage and road markings, lane and shoulder widths, sight distance and grade/slope of road); and impact analysis. The impact analysis utilised the capacity analysis methodology published in the Highway Capacity Manual (HCM) 2000 edition and the Sidra Intersection 8.0 traffic analysis software was used to analyse the performance of the intersections.

The efficiency of traffic operations was measured using the Level of Service (LOS) grading system (Table 4-76 and Table 4-77). Evaluation of the roadway and associated intersections involved the assignment of grades from “A” to “F” with “A” representing the highest level of operating conditions and “F” representing extremely congested and restricted operations.

The scenarios investigated were:

i. Pre-construction scenario (Existing Conditions)
ii. During Construction
iii. Operational (Post-construction) scenario at year 1
iv. Operational (Post construction) scenario at year 10 with 3% growth per annum
v. Operational (Post construction) scenario at year 10 with 3% growth per annum with Actuated Signalized Intersection.

Table 4-76 Level of Service at signalized intersections

Source: Chap 10 Traffic and Highway Engineering, Garber, L. Hoel.

Level of Service (LOS) Category	Category Characteristics
A	Describes that level of operation at which the average delay per vehicle is 10.0 seconds or less. At LOS A, vehicles arrive mainly during the green phase, resulting in only a few vehicles stopping at the intersection. Short cycle lengths may help in obtaining low delays.
B	Describes that level of operation at which delay per vehicle is greater than 10 seconds but not greater than 20 seconds. At LOS B, the number of vehicles stopped at the intersection is greater than that for LOS A, but progression is still good, and cycle length also may be short.
C	Describes that level of operation at which delay per vehicle is greater than 20 seconds but not greater than 35 seconds. At LOS C, many vehicles go through the intersection without stopping, but a significant number of vehicles are stopped. In addition, some vehicles at an approach will not clear the intersection during the first cycle (cycle failure). The higher delay may be due to the significant number of vehicles arriving during the red phase (fair progression) and/or relatively long cycle lengths.
D	Describes that level of operation at which the delay per vehicle is greater than 35 seconds but not greater than 55 seconds. At LOS D, more vehicles are stopped at the intersection, resulting in a longer delay. The number of individual cycles failing is now noticeable. The longer delay at this level of service is due to a combination of two or more of several factors that include long cycle lengths, high (v/c) ratios, and unfavourable progression.
E	Describes that level of operation at which the delay per vehicle is greater than 55 seconds but not greater than 80 seconds. At LOS E, individual cycles frequently fail. This long delay, which is usually taken as the limit of acceptable delay by many agencies, generally includes high (v/c) ratios, long cycle lengths, and poor progression
F	Describes that level of operation at which the delay per vehicle is greater than 80 seconds. This long delay is usually unacceptable to most motorists. At LOS F, oversaturation usually occurs—that is, arrival flow rates are greater than the capacity at the intersection. Long delay can also occur as a result of poor progression and long cycle lengths. Note that this level of service can occur when approaches have high (v/c) ratios which are less than 1.00 but also have many individual cycles failing.

Table 4-77 Level of Service for freeway segments

Source: Chap 10 Traffic and Highway Engineering, Garber, L. Hoel.

Level of Service (LOS) Category	Category Characteristics
A	Free-flow operations in which vehicles are completely unimpeded in their ability to manoeuvre. Under these conditions, motorists experience a high level of physical and psychological comfort, and the effects of incidents or point breakdowns are easily absorbed.
B	Traffic is moving under reasonably free-flow conditions, and free-flow speeds are sustained. The ability to manoeuvre within the traffic stream is only slightly restricted. A high level of physical and psychological comfort is provided and the effects of minor incidents and point breakdowns are easily absorbed.
C	Speeds are at or near the free-flow speed, but freedom to manoeuvre is noticeably restricted. Lane changes require more care and vigilance by the driver. When minor incidents occur, local deterioration in service will be substantial. Queues may be expected to form behind any significant blockage

Level of Service (LOS) Category	Category Characteristics
D	Speeds can begin to decline slightly and density increases more quickly with increasing flows. Freedom to manoeuvre is more noticeably limited, and drivers experience reduced physical and psychological comfort. Vehicle spacings average 165 ft (8 car lengths) and maximum density is 35 pc/mi/ln. Because there is so little space to absorb disruptions, minor incidents can be expected to create queuing.
E	Operations are volatile because there are virtually no useable gaps. Manoeuvres such as lane changes or merging of traffic from entrance ramps will result in a disturbance of the traffic stream. Minor incidents result in immediate and extensive queuing. Capacity is reached at its highest density value of 45 pc/mi/ln.
F	Operation is under breakdown conditions in vehicular flow. These conditions prevail in queues behind freeway sections experiencing temporary or long-term reductions in capacity. The flow conditions are such that the number of vehicles that can pass a point is less than the number of vehicles arriving upstream of the point or at merging or weaving areas where the number of vehicles arriving is greater than the number discharged. Breakdown occurs when the ratio of forecasted demand to capacity exceeds 1.00.

Analysis

ROADS AND INTERSECTIONS

The proposed development is to be located on a currently vacant site. As a result, there is no current impact on traffic volumes influenced by site conditions. The site's entrance is located within a section of the Bogue main road that is bounded by two signalized intersections: the Long Hill Road intersection and the Scarlett Road intersection (Figure 4-129). The Long Hill Intersection (Figure 4-130) is a crucial component of the network as it provides a unique link to the southern and western coasts of the island with no other notable alternatives. The Scarlett Road intersection provides access to a local industrial area and the nearby Bogue heights community.

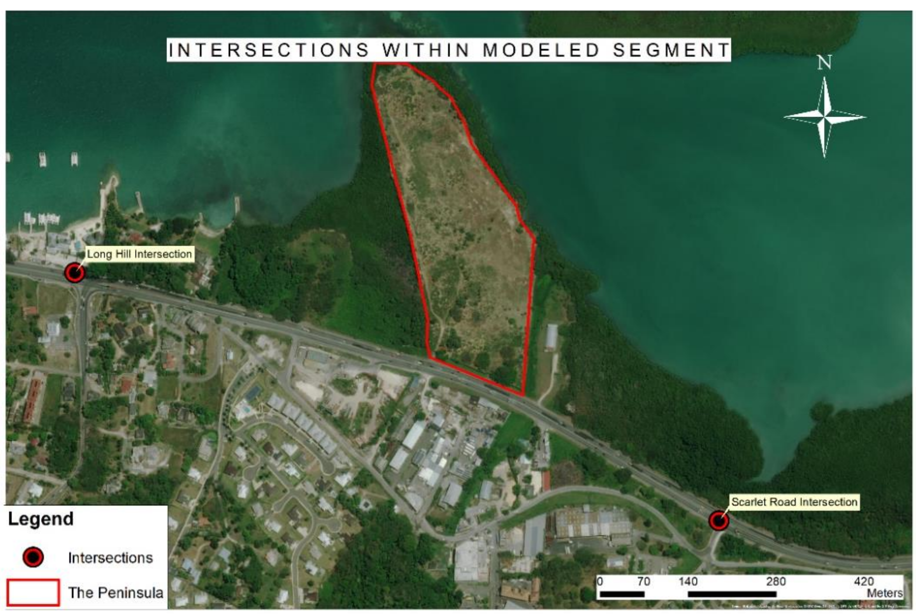


Figure 4-129 Existing signalized intersections in proximity to The Peninsula

Source: Drones Eye View

Figure 4-130 Long Hill Intersection from South

The segment is a two-way arterial roadway with 4 lanes. It is a Class A roadway and a part of the A1 designation road network that links Kingston to Lucea, Hanover. The observed speed limit on the modelled segment of the Bogue main road was noted to be 80km/h. Based on the posted speeds, the minimum required stopping site distance was determined to be 130m. By traversing the area, the site distance was deemed to be satisfactory within most of the roadway areas adjacent and accessible by the site.

Figure 4-131 Road Classification type of the Bogue Main Rd

TRAFFIC VOLUMES

Traffic count data was retrieved from the NWA for the Bogue/Long Hill Intersection for the dates, March 12th, 2016 (7 am -7 pm) and August 22nd, 2019 (9 am -7 pm). The counts were collected at 5 minutes intervals. This data, along with a suggested annual increase in traffic volumes was used to predict the hourly traffic flow volumes for the intersections during 2021.

The traffic counts revealed that the AM peak was between the hours of 7:30 AM - 8:30 AM period. While the PM peak volume was recorded between 5:00 PM and 6:00 PM.

The 2016 traffic data was used to supplement traffic volumes that were missing between 7:00 am and 8:45 am in the 2019 dataset. A 3% annual traffic volume increase was applied to that period. The modified 2019 traffic volumes were then used to determine the 2021 traffic volumes also by using the 3% annual volume increase.

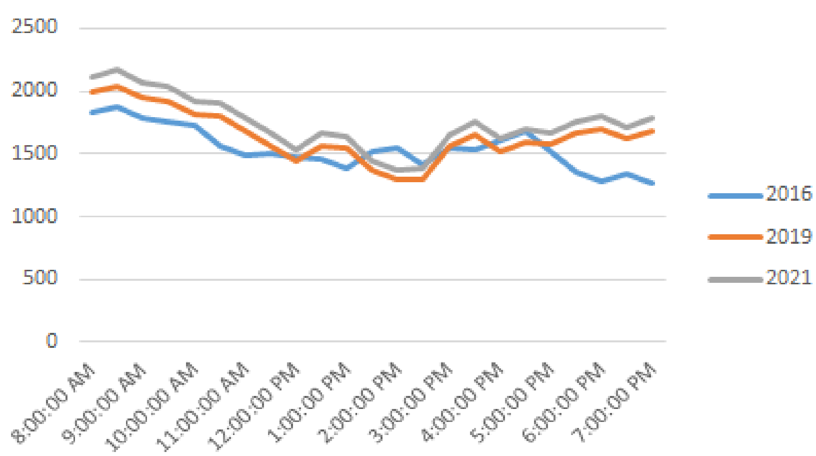


Figure 4-132 Comparative hourly traffic flow volume trends at the Bogue/Long Hill Intersection

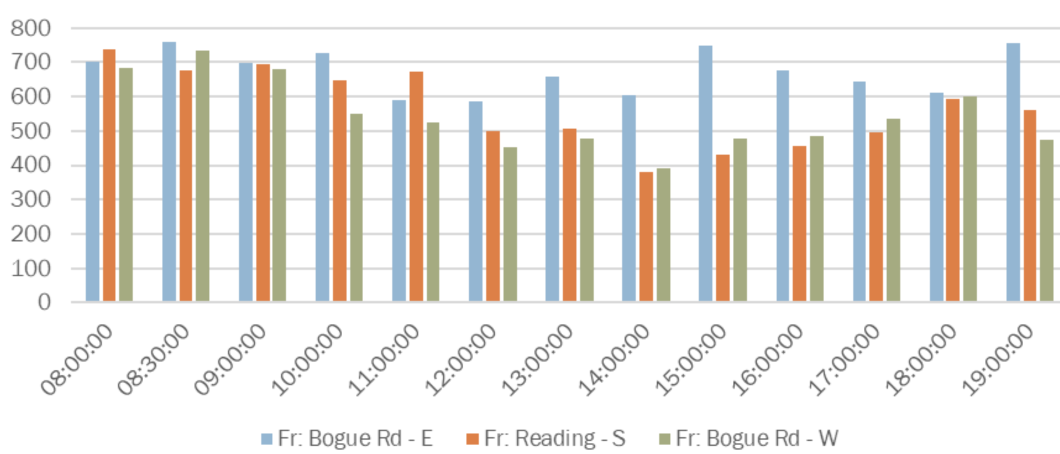


Figure 4-133 Breakdown of traffic volumes at Bogue/Long Hill intersection by direction, predicted August 2021.

The peak hour flows from the Bogue/Reading Intersection and trips expected to be generated from areas in proximity to the Scarlett/Bogue Road intersection were used to generate a peak hour flow at the latter intersection (
Figure 4-134).

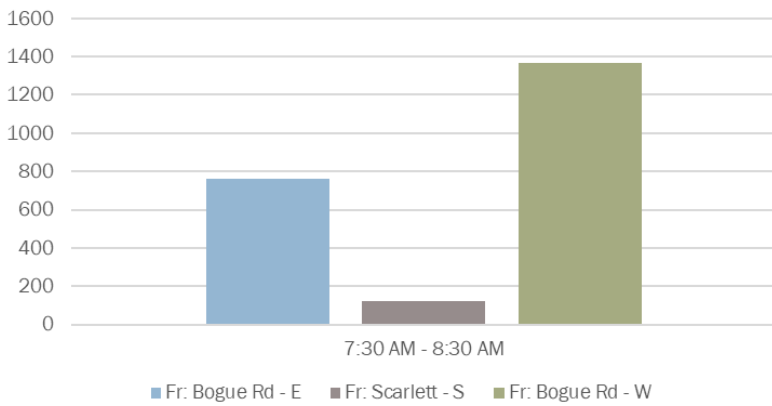


Figure 4-134 Traffic volumes arriving at the Bogue and Scarlett Road intersections, estimated for August 2021 using ITE trip manual rates and existing flows

MODEL OUTPUTS

Analysis of the existing scenario gives a comparative baseline for the expected impacts of the proposed developments. The current performance shows a good to satisfactory level of performance by providing low delays to traffic flowing in high volume flow directions. Lanes handling a high volume of traffic only experienced average delays of up to 29 seconds. Longer delays were noticed for vehicles attempting to turn south towards Long Hill or Scarlett roads, this is of course attributable to the actuated traffic signal giving priority to higher flow directions.

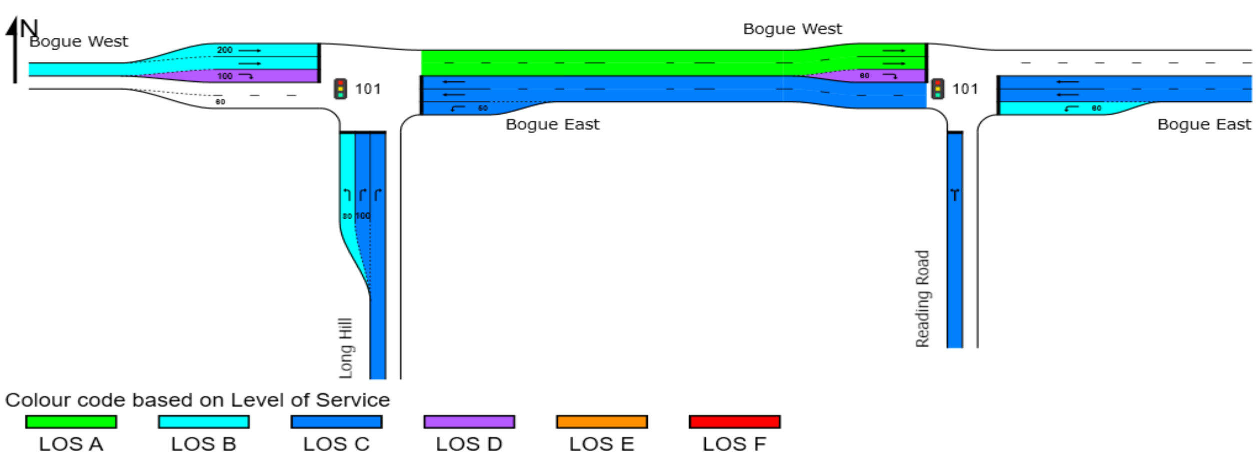


Figure 4-135 Level of Service of roadway network between Scarlett Road and Long Hill

Table 4-78 Movement performance at the Bogue/Long Hill Intersection for the AM Peak Hour Pre-Construction

Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	Sec		veh	m				km/h
South: Long Hill												
1	L2	13	0	0.015	15.9	LOS B	0.1	1	0.55	0.63	0.55	40.7
3	R2	723	3.9	0.7	30.3	LOS C	6.9	50.3	0.93	0.83	0.93	27.6
Approach		736	3.8	0.7	30.1	LOS C	6.9	50.3	0.92	0.83	0.92	27.9
East: Bogue East												
4	L2	408	5.3	0.613	28.4	LOS C	7.5	54.7	0.90	0.84	0.90	41.4
5	T1	420	7.8	0.445	21.8	LOS C	5.2	38.6	0.81	0.75	0.81	45.2
Approach		827	6.6	0.613	25.0	LOS C	7.5	54.7	0.85	0.80	0.85	43.2
West: Bogue West												
11	T1	762	5.6	0.373	10.3	LOS B	4.6	33.5	0.60	0.52	0.60	39.2
12	R2	36	3	0.23	39.9	LOS D	0.8	5.4	0.94	0.71	0.94	32.3
Approach		798	5.4	0.373	11.6	LOS B	4.6	33.5	0.61	0.53	0.61	38.5
All Vehicles		2361	5.3	0.7	22.1	LOS C	7.5	54.7	0.79	0.72	0.79	37.3

Table 4-79 Movement performance at the Bogue/Scarlett Road Intersection for the AM Peak Hour Pre-Construction

Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Scarlett Road												
1	L2	50	19.6	0.340	29.9	LOS C	2.4	19.6	0.85	0.76	0.85	27.8
3	R2	85	19.2	0.340	29.9	LOS C	2.4	19.6	0.85	0.76	0.85	37.2
Approach		135	19.4	0.340	29.9	LOS C	2.4	19.6	0.85	0.76	0.85	34.5
East: Bogue East												
4	L2	75	23.2	0.063	10.0	LOS B	0.4	3.5	0.28	0.68	0.28	52.2
5	T1	752	5.7	0.499	20.2	LOS C	6.1	44.6	0.77	0.76	0.77	42.6
Approach		827	7.3	0.499	19.3	LOS B	6.1	44.6	0.73	0.75	0.73	43.9
West: Bogue West												
11	T1	1440	4.2	0.648	7.1	LOS A	7.1	51.1	0.45	0.45	0.49	53.5
12	R2	45	24.2	0.329	40.9	LOS D	1.0	8.3	0.98	0.74	0.98	31.6
Approach		1485	4.8	0.648	8.1	LOS A	7.1	51.1	0.51	0.46	0.51	52.4
All Vehicles		2447	6.2	0.648	13.2	LOS B	7.1	51.1	0.60	0.57	0.60	48.9

4.4.4.3 Airfields, Aerodromes and Airports

Air transport facilities do not exist within the SIA (Figure 319); the closest facility is the Sangster International Airport, 5.5 km north northeast of the project site. This airport is the leading tourism gateway to the island of Jamaica and is the larger of two international airports in Jamaica. Approximately 95% of total passengers at this airport are passengers travelling internationally and of the approximately 1.7 million annual visitors to Jamaica, 72% use this airport as their primary airport. Peak arriving and departing capacity is 4,200 passengers per hour (MBJ Airports Limited, 2016).

4.4.4.4 Ports, Docks and Marinas

The Port of Montego Bay is the second largest international port in the island and is located in Freeport. It has been owned by the Port Authority of Jamaica since 1986 and Port Handlers Limited manages its operations, which include both cargo and cruise ship activities. A 2694 m^2 cruise ship terminal, approximately 427 metres of berth, 1.2 hectares of yard space for container storage and 1858 m^2 warehouse are provided at the Port.

The Montego Bay Yacht Club is located in Montego Bay Freeport on the peninsula. A pier provides berthing facilities in the protected basin where water depths are generally less than 6 metres. Additionally, Pier One Marina is located on Howard Cooke Boulevard; various boat operators charter from this dock (for deep Sea Fishing, sailing, sunset Cruises or just sightseeing), where the management body for the MBMP, the Montego Bay Marine Park Trust is located. It has docking for marine vessels up to 45.7 m (150 ft) in length and 4.6 m (50 ft) draft (Pier 1 on the Waterfront, 2014).

4.4.5 Health, Safety and Emergency Services

4.4.5.1 Healthcare

Five health centres are located within the SIA: Catherine Hall, Creek Street Mobay V, Granville, Mount Salem and Tower Hill; Tower Hill is closest to the project site (Figure 4-127). Those accessed by residents of reading are listed in Figure 4-135.

Cornwall Regional Hospital is also located within the SIA, 4.2km northeast of the project site in Mount Salem. It is a Type 'A' hospital with a 400-bed capacity. Type A hospitals typically provide comprehensive secondary and tertiary health care services and are referral centres for hospitals both in the public and private health systems. In addition to various medical, speciality, diagnostic and therapeutic services, air, and ground ambulance services are offered.

The health facilities in the SIA are part of the Western Regional Health Authority, which provides healthcare to the population of Jamaica's western Parishes via a network of four Hospitals and eighty-four Health Centres.

Eighty percent of households in the community of Reading utilize public health care facilities (Social Development Commission, 2010); this is higher than the national average is 40.5% (JSLC, 2007). Forty-three percent of household heads indicated that they experience obstacles when accessing health care for their families. The main reasons include long waiting time (24.4%), financial constraints (9.3%), health facility located too far from home (5.8%) and poor transportation (3.5%). Resident of Reading suffer from several chronic diseases (hypertension, arthritis, diabetes and respiratory related diseases); hypertension (26.8%), diabetes (19.7%), arthritis (16.9%) and sinusitis (14.1%) are the main health problems affecting residents of Reading (Social Development Commission, 2010).

Table 4-80 Accessibility to social services by number and condition

Source: (Social Development Commission, 2010)

Types	Name of nearest facility	Number	Proximity to nearest facility	Condition of facility
Hospitals	Cornwall Regional Hospital	2	6km	Good
Health Centre	Catherine Hall Health Centre Payne Street Health Centre		2km 5km	Fair Good
School	Ebber Kindergarten & Prep. School Early Learners Day Care & Pre School Reading Kindergarten & Prep. School St. James College	4	Within	Good Good Good Good
Churches	Church on the Rock Reading Sacred Heart Catholic Church	2	Within	Good Good
Post Office	Reading Post Office Montego Bay # 2 P.O	2	Within 5 km	Good Fair
Police Station	Freeport Police Station	1	3km	Good
Fire Station	Freeport Fire Station	1	4km	Fair
Community Center	None			
Sports Complex	None			
Cemeteries	Pye River Cemetery Dove Cot Cemetery	2	2km 12km	Poor Good
Markets	Charles Gordon Market	1	4km	Fair
Playfields	None			
Court Houses	Montego Bay Resident Magistrate Court	2	5km	Fair
Libraries	St. James Parish Library	1	8km	Good

4.4.5.2 Fire Stations

The closest fire station is found within the SIA in Freeport, 1.7 kilometres northeast of the proposed site (Figure 4-127). Barnett Street fire station is also located in Montego Bay. The community of Reading is served by the Montego Bay Fire Department located at Freeport; which has 5 functional units manned by 180 firefighters (Social Development Commission, 2010).

4.4.5.3 Police Stations and Community Safety

Six police stations are located within the SIA: Albion, Montego Bay, Granville, Anchovy, Mount Salem and Freeport (Figure 4-127).

The majority (98%) of Reading residents either felt very safe (44%) or safe (54%) in their community; 97.3% of respondents viewed the level of crime in their community as low (92%) or moderate (5.3%). Approximately thirty-eight percent (37.8%) of respondents felt that it is unlikely that they could be a victim of crime over the next year and 25.7% of respondents felt that it was very likely that they would be a victim of crime over the next year (Social Development Commission, 2010).

Public safety issues affecting the community of Reading include inadequate street lighting, improper disposal of solid waste and failed infrastructure (Social Development Commission, 2010).

4.4.6 Industrial and Economic Activity

4.4.6.1 Tourism

Hotels and Attractions

Tourism is a major activity in the general Montego Bay area. There are numerous hotels, other guest accommodations and attractions within the SIA; those closest to the project site are Serenity Plans Hotel, Palm Bay Guest House and Restaurant, Pineapple Beach and Rocklands Bird Sanctuary. Indeed, the density of visitor accommodations and attractions to the north of the project site in Montego Bay is far greater.

International and Regional Trends

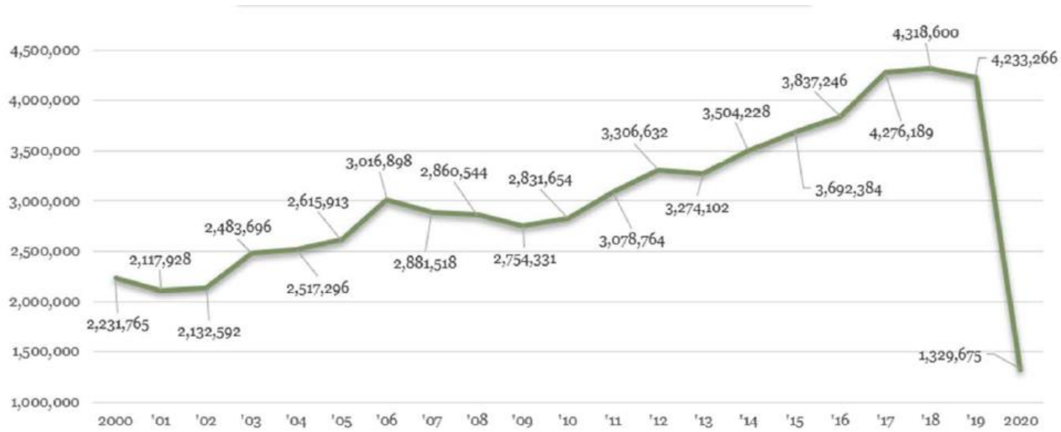
The year 2020 suffered the greatest crisis on record in international travel worldwide. The outbreak of the COVID-19 pandemic created an unprecedented health, social and economic emergency. The World Tourism Organization (UNWTO) reported that international tourist arrivals plunged by 74.0% in 2020 compared to the same period in 2020, reaching a low of 381 million (Jamaica Tourist Board, 2020). All world regions recorded declines in international tourist arrivals for 2020; the Americas, to which Jamaica is a part, recorded a decline of 150.1 million international tourists lowering the total to 69.0 million.

The Caribbean Tourism Organization (CTO) reported that in 2020 there was an estimated 11.1 million visitors who came to 'enjoy the un-equalled and diverse experiences' the Caribbean had to offer. This was a contraction of approximately 21.0 million less tourist arrivals, a 65.5% decrease over the 32.0 million in 2019. No Caribbean destination recorded growth for 2020, all had travel restrictions, border, and port closures, so as to contain the spread of COVID-19 (Jamaica Tourist Board, 2020).

Arrivals to Jamaica

Total visitor arrivals for the year 2020 reached a total of 1,329,675, which was 68.6% below the 4,234,150 arrivals recorded in 2019. This figure represents 2,903,595 less arrivals than in 2019 (Figure 4-136). Stopover arrivals of 80,404 decreased by 67.2%; foreign national of 798,290 decreased by 67.9%; non-resident Jamaicans of 82,114 decreased by 58.5%; and cruise passenger arrivals of 449,271 decreased by 71.1%. The global health crisis associated with the COVID-19 pandemic significantly impacted visitor arrivals to Jamaica (Jamaica Tourist Board, 2020).

The most popular resort region to which visitors stayed in 2020 was Montego Bay with 303,0298 or 34.4% of visitors (Table 4-81). The accommodation of choice which visitors stayed during 2020 was Hotels with 560,314 or 63.6% (Jamaica Tourist Board, 2020).



Source: (Jamaica Tourist Board, 2020)

Figure 4-136 Visitor arrivals to Jamaica, 2006-2020

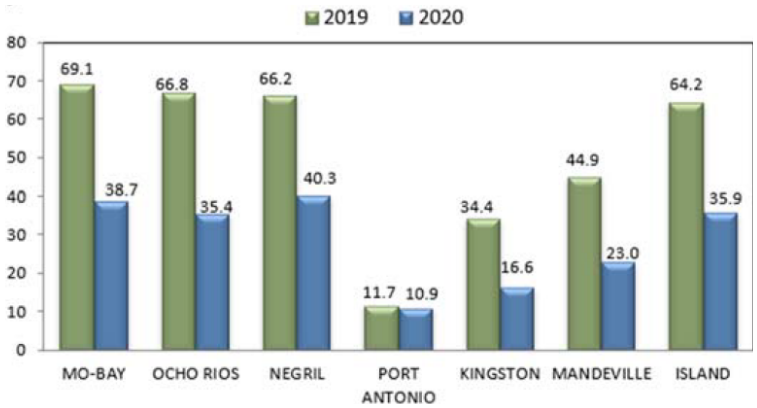
Table 4-81 Visitors to Jamaica by type of accommodation and region, 2020

Source: (Jamaica Tourist Board, 2020)

ACCOMMODATION	Kingston	Mandeville	Montego Bay	Ocho Rios	Port Antonio	Negril	Other Areas	Total	% Share	Average Length of Stay
Hotels	18,034	11,465	248,474	131,147	528	150,513	153	560,314	63.6%	6.3
Resort Villas	4	1,956	14,057	7,070	1,138	4,477	36	28,738	3.3%	8.8
Guesthouses	2,784	1,251	3,792	1,685	468	5,289	335	15,604	1.8%	12.8
Apartments	203	-	1,656	2,588	-	518	-	4,965	0.6%	12.1
Private Homes	59,922	36,988	32,681	33,208	7,887	15,115	71,223	257,024	29.2%	20.0
Other/Not Stated	2,298	1,054	2,369	1,375	333	944	5,386	13,759	1.6%	14.9
Total	**83,245**	**52,714**	**303,029**	**177,073**	**10,354**	**176,856**	**77,133**	**880,404**	**100.0%**	**10.7**
% Share	9.5%	6.0%	34.4%	20.1%	1.2%	20.1%	8.8%	100.0%		
Average Length of Stay	15.8	17.8	7.5	9.5	20.0	8.6	18.7	10.7		

HOTEL ROOM OCCUPANCY

The average available room capacity fell by 35.7% in 2020, moving from 24,432 rooms in 2019 to 15,709 rooms in 2020. In the resort region of Montego Bay, the annual hotel room occupancy rate was 38.7%, compared to 69.1% recorded in 2019. The total number of room nights sold fell by 66.1% moving from 2,416,049 in 2019 to 819,673 in 2020. The average room capacity declined by 39.6% in 2020, moving from 9,578 rooms in 2019 to 5,782 rooms in 2020. The number of stopovers that intended to stay in Montego Bay at hotel accommodations declined from 833,689 in 2019 to 248,474, a decrease of 70.2% in 2019 (Jamaica Tourist Board, 2020).

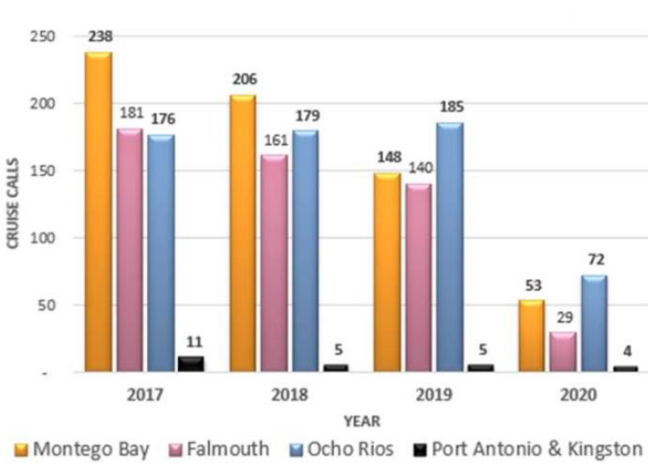


Source: (Jamaica Tourist Board, 2020)

Figure 4-137 Hotel room occupancy by resort area

CRUISE PASSENGERS

The port of Montego Bay accounted for 100,248 passengers or 22.3%.



Source: (Jamaica Tourist Board, 2020)

Figure 4-138 Cruise calls by port of arrivals, 2017-2020

VISITOR EXPENDITURE

Gross visitor expenditure in 2020 was estimated at approximately US$1.256 billion; this represents a decrease of 65.5% against the estimated US$3,639 billion earned in 2019 (Jamaica Tourist Board, 2020).

EMPLOYMENT

The number of persons employed directly in the accommodation sub-sector was adversely affected by the closure of properties due to the Covid-19 pandemic. Between April and May approximately 90% of the accommodation staff were laid off and by the end of 2020, 30% of tourism workers had been brought back on a fulltime basis and another 10- 20 % part-time, moving from 51,226 in 2019 to 30,655, a significant decrease of 40.2%. The main resorts of Montego Bay, Ocho Rios and Negril accounted for 25,089 persons or 81.8% of the total number of persons employed directly in the accommodation sub-sector. Montego Bay with 10,796 direct jobs represented 35.2% of those employed (Jamaica Tourist Board, 2020).

4.4.6.2 Montego Bay Free Zone (MBFZ)

In 1985 the Montego Bay Free Zone (MBFZ) was established in the Montego Freeport area by the Port Authority of Jamaica (PAJ). Investment from various sectors and in particular information and communications technology (ICT) sector, apparel and other light manufacturing was encouraged. As of 2000, the ICT sector strengthened and its development in the MBFZ was amplified by the relative competitiveness of Jamaica's near shore position, its skilled workforce and secured Free Zone environment (Montego Bay Freezone Ltd., 2012). Today, a number of industrial, commercial and manufacturing facilities are located at the MBFZ.

4.4.6.3 Agriculture and Fisheries

Approximately thirty-four percent (34.2%) of households in Reading engage in farming/agricultural activities. The cultivation of green bananas (32.8%), fruits (31%) and ground provisions (20.7%) are the major farming activities engaged in by residents. (Social Development Commission, 2010). Seventy-two percent (72%) of these farms are located in the same community as the household. The majority of the land use for farming is family owned (95.7%) while 4.3% of farmers rent their farmlands. Approximately eighty-one percent (80.8%) of households engage in subsistence agriculture for home use only while 19.2% of households farm for home use and sell their surplus at the local market (Social Development Commission, 2010).

Fishing beaches in proximity to the project site are Spring Garden (2.8 km west) and Railway Beach (1.5 km northwest) (Natural Resources Conservation Authority, 2000).

4.4.7 Land Use and Zoning

4.4.7.1 Land Cover and Use

Present Land Use

Land cover within the SIA consists of buildings and other infrastructure, disturbed broadleaved forest, secondary forest and fields, mangrove forests, open dry forest, and plantation (Figure 4-140). Montego Bay, which is partially located in the SIA, is the second largest city in Jamaica, the capital of the parish of St. James and is also considered the island’s tourism capital. For this reason, existing land cover in Montego Bay is primarily buildings and infrastructure, with a multitude of uses, including, commercial, industrial, residential, educational, and recreational. The Montego Bay Free Zone (MBFZ) is home to several industrial, commercial, and manufacturing facilities. Companies such as Gas Pro Ltd. (formally Shell Gas) and Caribbean Producers Jamaica Limited are located in Montego Bay Freeport and this is mixed with the city’s tourist appeal, with hotels, restaurants/ bars, the Montego Bay Cruise Ship Terminal and the Yacht Club located on the peninsula (CL Environmental Co. Ltd, 2016).

In addition to the tourist accommodations, numerous residential areas also exist in Montego Bay. In order to serve the resident and visiting populations, social and emergency services outlined previously, as well as other features typical of a city also exist in Montego Bay (though not necessarily within the SIA) such as retail stores, supermarkets, wholesales, restaurants, financial institutions, a market, churches, cemeteries, Wastewater Treatment Plant and Power Station. Hotel, public and fishing beaches are also located in Montego Bay.

At the project site, scrubland dominates the interior regions and mangrove forest forms a tidal buffer zone around the site. The mangrove forest varies in thickness around the site periphery and along the property's western edge, a relatively steep slope exists (likely the result of fill material deposited there). There are varying degrees of historic human modification within the eastern and western areas of the site, and areas with little to no human interference in the north.

Future Developments

FREEPORT DREAMS AND SPA HOTEL

Freeport Dreams and Spa Hotel is a proposed 281-room hotel development bordered to the north by the Caribbean Sea; to the east by Sunscape Splash Hotel; to the south by Sunset Drive and residential apartments; and to the west by Secrets Wild Orchid Hotel.

MONTEGO BAY PERIMETER ROAD

The Montego Bay Perimeter Road includes the following four components: Montego Bay Perimeter Road, Long Hill Bypass, Barnett Street Upgrade and West Green Avenue Upgrade.

The length of the Montego Bay Perimeter Road corridor is an approximately 15.4 km, 4-lane highway starting at Alice Eldemire Drive and Howard Cooke Highway with the end point at the Intersection with the A1 North Coast Highway at Ironshore.

The Long Hill Bypass Alignment component encompasses the construction of approximately 10.5 kilometres of 2-lane, rural arterial highway leading from Montpelier intersection of B8 Road and B6 Road to Temple Gallery Road. The implementation of this road section will essentially connect the Montego Bay Perimeter Road with the western end of the Phase 2B corridor of the East West Highway.

The Barnett Street Road improvement is located in Mount Salem, West Green and Catherine Mount. It involves is the dualization of 1.06 km of the existing two-lane road section from the intersection of West Green and Fairfield Road in a northerly direction and ending at Cottage Road.

The West Green Avenue improvement is located in Bogue and is the dualization of the 0.82 km existing link road between Howard Cooke Boulevard and the Bogue Road at the Fairfield Road intersection.

SANGSTER INTERNATIONAL AIRPORT EXPANSION

Runway Extension and associated works at Sangster International Airport Expansion will include: Extension of Runway 7-25 pavement by 408 meters to the east; Construction of a new runway turn pad for Runway 25; Grading and drainage improvements to the extended Runway End Safety Areas (RESA) and strip; Relocation of existing Kent Avenue and Route A1 within the future airport perimeter fence; Demolition of the former Texaco service station and existing Sandals boat yard and Realignment and widening of approximately 200 meters of Taxiway Echo and installation of a Jet Blast Screen.

MIXED-USE DEVELOPMENT AT IRONSHORE

This mixed-used development proposes an anchor offshore university/medical school providing technical and professional education in a resort setting. Some of the main components include: residential villas and apartments, global and domestic logistics and distribution centres, retail commercial spaces, retail office spaces, business process outsourcing, members wholesale shopping.

4.4.7.2 Protected Areas

Protected areas examined here include all areas of land or water protected by various laws in Jamaica, as well as international agreements, that fall within or in proximity to the project area; these include fish sanctuaries or Special Fishery Conservation Areas (SFCAs), protected areas (declared and proposed), national parks, forest reserves, marine parks, game reserves and national heritage and monuments. Specific to this project, the following areas protected under various legislation are important (Figure 4-140).

- Bogue Lagoon Creek Game Reserve
- Bogue Islands Lagoon SFCA
- Montego Bay Marine Park

Bogue Lagoon Creek Game Reserve

The proposed site is located within the Bogue Lagoon Creek Game Reserve; a Game Reserve is a parcel of private land, body of water or area comprising both private land and water within which hunting is prohibited.

Bogue Islands Lagoon Special Fisheries Conservation Area (SFCA)

Special Fishery Conservation Areas are no-fishing zones reserved for the reproduction of fish populations. Their nature reserve statuses are declared under the Fishing Industry Act of 1975 and it is illegal to engage in any unauthorized fishing activities in the demarcated zones. The Bogue Island Lagoon, Montego Bay was established on 25 July 1979 and along with Bowen Inner Harbour, St Thomas, were the first two fish sanctuaries (now referred to as SFCAs) to be declared. The Bogue Lagoon continues to serve as a critical nursery for juvenile fish and crustaceans in the Montego Bay area. The SFCA is about 450 hectares in area and is managed by the Montego Bay Marine Park Trust (MBMPT).

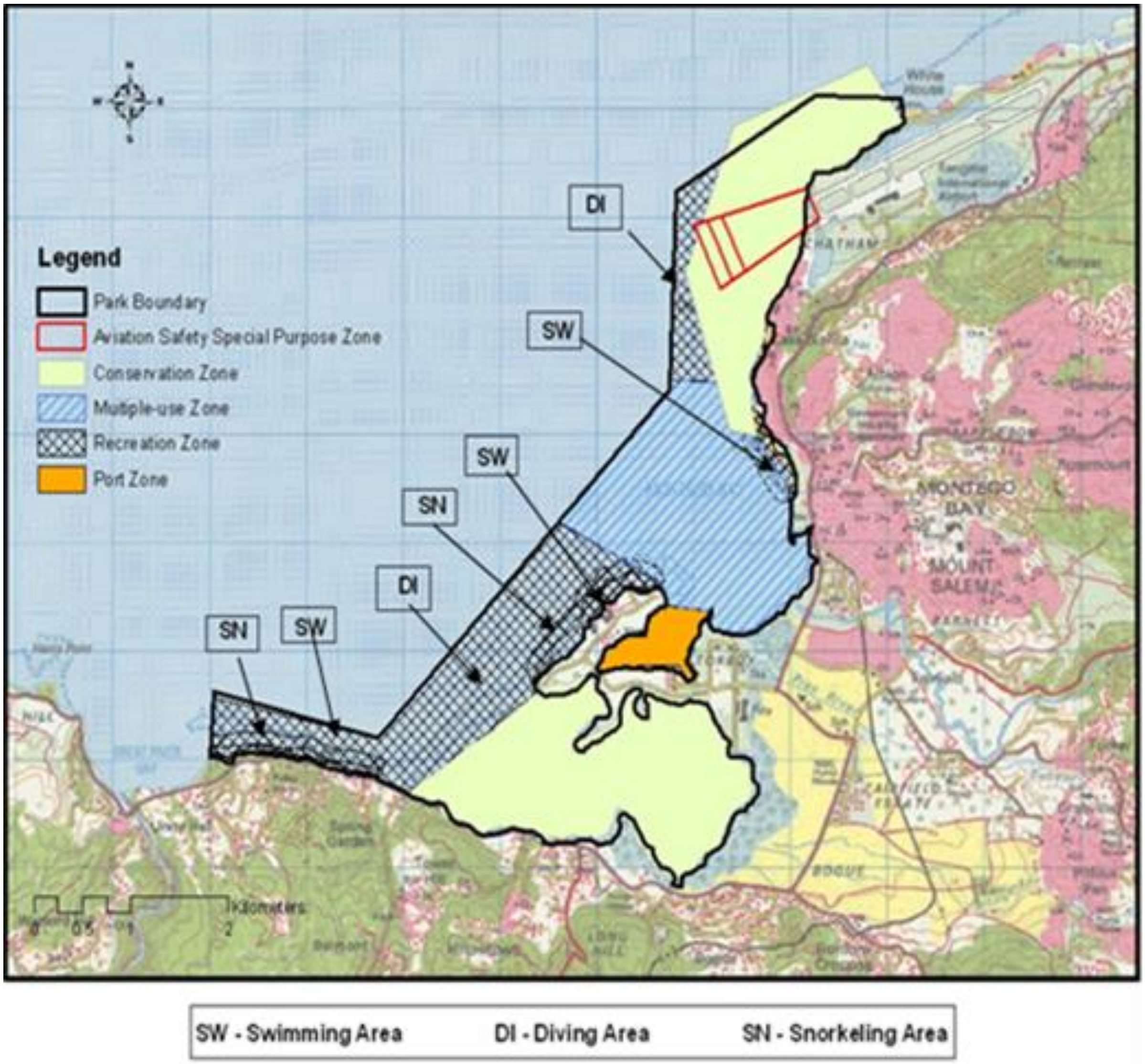
The SFCAs declared in Jamaica are anticipated to gradually increase fish populations affected by overfishing, habitat degradation and land-based nonpoint-source pollution, among other stressors. SFCA establishment has been scientifically proven to improve fish stocks by 3 to 21 times its original biomass. Furthermore, due to the ‘spill over’ effect, adjacent marine areas benefit as excess fish from the reserves will migrate into these areas where fishing is allowed. The SFCA's will also maintain genetic diversity of marine species within Jamaica’s water – reducing the probability of extinction. The habitats provide the marine species the opportunity to reach full sexual maturity therefore increasing their egg producing/spawning potential and survival of the species overall.

Montego Bay Marine Park

The shoreline along the project site borders the Bogue Islands Lagoon SFCA and the Montego Bay Marine Park. The MBMP encompasses the marine areas adjacent to Montego Bay, with a 9 km coastal boundary stretching from its northernmost point at White House, St. James (Sangster International Airport), stretching south past the Project Site, to the eastern extent of Great River Bay. It is 15.3 km2 (1,530 ha) with distances from shore between 350 m and 2.3 km. A mixture of uses is present within the park, recreational and commercial activities such as fishing, tourism, shipping, diving, boating, swimming and beach walking are the main uses.

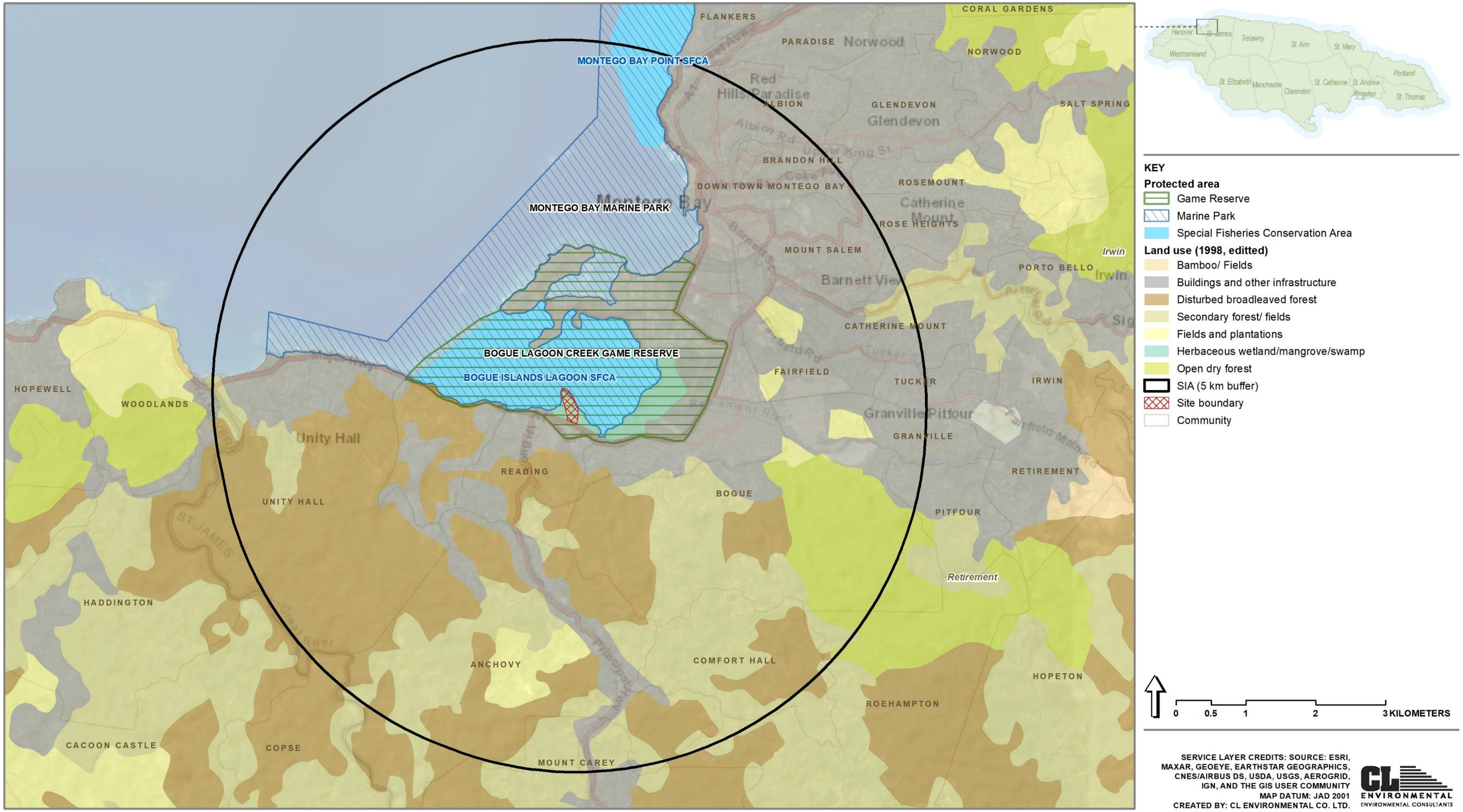
Although management regulations are in place, a zoning plan to further assist in the effective management of the area is yet to be approved (The Protected Areas Branch, National Environment and Planning Agency, 2013). For this reason, "The Montego Bay Marine Park Zoning Plan, 2013-2018" was created in 2013 by the Protected Areas Branch, NEPA with input from other branches at NEPA and the Montego Bay Marine Park Trust (MBMPT), the management body for the MBMP. The proposed plan provides the framework for the management of uses over a five-year period (2013-2018), within four major zones (Figure 322):

1) **Conservation Zone**: This zone encompasses the Bogue Islands Lagoon SFCA, and the Montego Bay SFCA. Both are 'No Fishing' areas reserved for the reproduction of fish populations. The project site borders this zone.
2) **Recreation Zone**: This zone includes all areas used for recreational activities, specifically all recreational beaches and their respective swim areas, dive, and snorkel sites. It is divided into two (2) Special Purpose Areas, namely i) Swimming Area and ii) Diving/Snorkelling Area
3) **Multiple-use Zone**: This zone includes all the areas outside the boundaries of the conservation and recreation zones. It has no further functional subdivisions but will allow for a range of specialized uses such as ship channels, fishing as well as recreational boating. This area was so designated based on traditional uses for commercial and recreational activities that are sustainable and consistent with the overall objectives of the Marine Park. It complements other marine park zones and by nature provides an integrated approach to the management of the Marine Park.
4) **Port Zone**: This zone is designated for the port/harbour activities and occupies the Site of the Montego Bay Yacht Club as well as the Terminals for cruise ships and commercial shipping. It allows for operation and maintenance of a port area and shipping channels and dredging for navigational purposes.



Source: NEPA (The Montego Bay Marine Park Zoning Plan, 2013-2018)

Figure 4-139 The proposed Zonation of the MBMP



Data sources: Land use (Edited based on Forestry Department, 1998), forest estates (Forestry Department) and protected areas (NEPA and MGI)

Figure 4-140 Land use, protected areas and forest estates within the SIA

4.4.7.3 Zoning

As seen in Figure 4-141, the SA falls within spatial limits of the **Town and Country Planning (St. James Parish) Provisional Development Order, 2018** and specifically within the Montego Bay Local Planning Area. The project site falls in a zone proposed for conservation, and adjacent to this land, proposed zoning is for Commercial/ Industrial-Light and Residential. Similarly, within the **Town and Country Planning (St. James Parish) Provisional Development Order (Confirmation) Notification, 1982**, Reading Pen is zoned as "Conservation" (Figure 4-142).

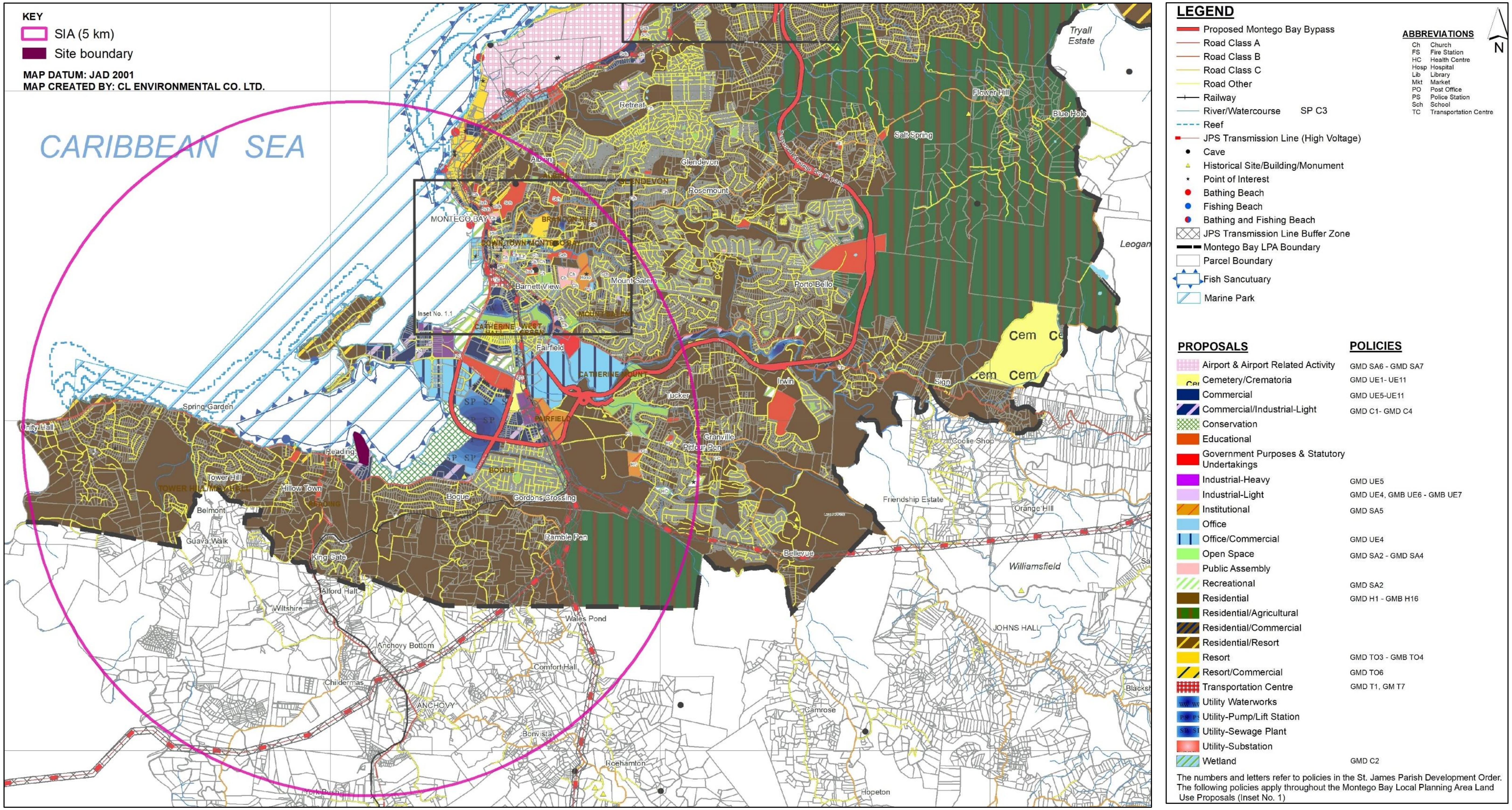


Figure 4-141 The Montego Bay Local Planning Area, Town and Country Planning (St. James Parish) Provisional Development Order, 2018 in relation to the SA

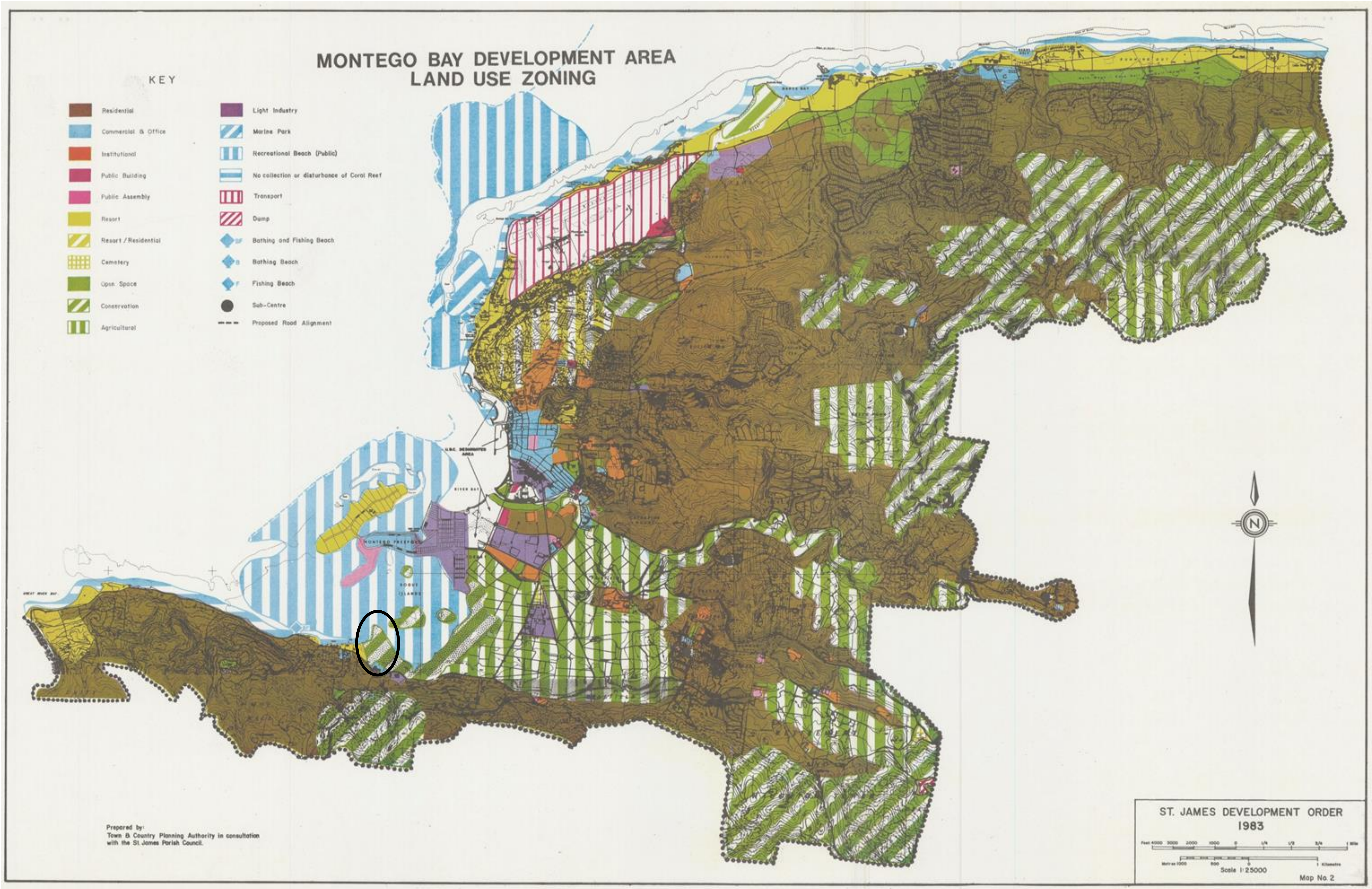


Figure 4-142 Town and Country Planning (St. James Parish) Provisional Development Order (Confirmation) Notification, 1982, with Reading Pen circled in black

4.4.8 Cultural/Heritage

According to the Jamaica National Heritage Trust website *(http://www.jnht.com/st_james.php),* there are six (6) national heritage sites found within approximately 5 km of the proposed project site. These are described below.

Saint James Parish Church (located approx. 3.5 km northeast of the proposed project area) – The St. James Parish Church, which is dedicated to St. James the Great (patron Saint of Spain), was built between 1775 and 1782. The Church is constructed of white limestone and is of the Greek cross plan with a bell tower at the west end. The building also has large, round-headed sash windows and an elaborate Palladian window is behind the altar at the west end. The Church was severely damaged in the earthquake of 1951, but repair work resulted in only minor departures from the original design. (Plate 4-23).

Plate 4-23 St. James Parish Church

Saint James Parish Courthouse (located approx. 3.7 km northeast of the proposed project area) – Built in or around 1774 this building has proven to be quite an important monument in St. James' history. Now owned by the St. James Parish Council, the Old Court House in Montego Bay is probably best known for the trial of National Hero Samuel Sharpe which was held in 1832. Sharpe led the Great Slave Rebellion of Christmas 1831. Many estates, including the surrounding areas of the Parish were burnt. Sharpe and many others who had been involved in the rebellion were tried and hanged. It is argued by many historians that although the rebellion did not result in freedom for the slaves, it accelerated the abolition of slavery 1834.

The site was also restored and is now known as the Montego Bay Civic Centre. The Museum of Montego Bay is housed at this site. (Plate 4-24).

Plate 4-24 St. James Parish Church (http://www.jnht.com/st_james.php)

Fort Montego (located approx. 3.8 km north northeast of the proposed project area) – Fort Montego, located in Montego Bay in the parish of St. James, appeared to be a large fort. It housed four 12 pounder guns and five smaller guns. It was built to guard the approaches to the town of Montego Bay, however, it was an inefficient fort. In 1760, one of the fort's rusty guns exploded and killed a gunner while firing a salute to celebrate the surrender of Havana. Edward Long, noted Jamaican historian, a few years later found the fort in decay and doubted whether it was worth repairing, since its location, according to him, was not very strategic. The only occasion the fort fired at a ship was in 1795 when the officers at the fort mistook an English ship for a French privateer. Luckily there were no casualties. (Plate 4-25).

Plate 4-25 Fort Montego (http://www.jnht.com/st_james.php)

1 King Street (located approx. 3.6 km northeast of the proposed project area) – The property at number One King Street and the corner of Market Street, Montego Bay, St. James was formerly the Manse of the Burchell Baptist Church. The Church was named after the renowned Baptist Missionary and pioneer Thomas Burchell. He did most of his pioneering actions in the western parishes of the island. Thomas Burchell lived in the Manse, while he worked in the parish of St. James. Built along the Jamaica Georgian lines of architecture, the Old Baptist Manse depicts the transition of European design being adapted to the tropical environment. This two-storey structure has a double mansard gable roof; with a wide trough galvanize zinc sheet finish. Punctuating each gabled end, are fixed louvre arched windows for ventilation and to some extent illumination.

The first floor level boasts a series of six panel sash windows all fitted in a wooden frame. The walls at the first floor of the building are constructed of wooden cladding, which terminates at the belt beam level of the roof. The walls at the ground floor are constructed of brick, and a series of sash windows are replicated in a symmetrical pattern at both levels. The entrance elevation boasts an arcade with wooden Doric columns. The first level has an elaborate piazza, with balustrades highlighting an intricate lattice design (Plate 4-26).

Plate 4-26 One King Street (http://www.jnht.com/st_james.php)

Sam Sharpe Square (located approx. 3.5 km northeast of the proposed project area) – In 1976 Charles Square in Montego Bay was renamed Sam Sharpe Square in honour of national hero Sam Sharpe who was from Montego Bay. Sharpe was executed in the Montego Bay Market Place on May 23, 1832 for his role in the 1831-32 Emancipation War. The square includes several heritage structures: the Sam Sharpe Monument, the Cage, the Civic Centre and the Freedom Monument and a fountain.

The Sam Sharpe Monument, designed by Kay Sullivan, portrays Sharpe holding his Bible and speaking to his people. The five statues were cast in bronze in Jamaica. They were unveiled by the then Prime Minister the Most Honourable Edward Seaga on October 16, 1983 at a ceremony in the Square. Built in 1806, the Cage was used as a goal for enslaved Africans, disorderly seamen and vagrants. About 1822 the Vestry replaced the wooden structure of the Cage with one of stone and brick. The Cage has since seen several uses.

The Court House, now the Civic Centre, was built in 1803. It was at this Court House that the trial of many of the enslaved Africans, including Sam Sharpe, who participated in the Emancipation War, was held. Sharpe was tried here on April 19, 1832.By 1959 the court offices and local government offices had become too large for the building to accommodate them, and the court offices were moved to new premises on St. James Street. The courthouse was destroyed by fire in 1968. In 2001 the building was restored by the Urban Development Corporation, with funding from the Venezuelan Government through the San Jose Accord. The building was reopened as the Montego Bay Civic Centre. It is a multi-faceted facility with provision for a museum, art gallery, performing arts and conferencing facilities.

The Freedom Monument was erected in 2007 to memorialize the enslaved persons who participated in 1831-32 war of emancipation (Plate 4-27).

Plate 4-27 Freedom Monument at Sam Sharpe Square (http://www.jnht.com/st_james.php)

Barnett Street Police Station (located approx. 3.4 km northeast of the proposed project area) – The Barnett Street Police Station dates back to the late nineteenth century and is of architectural significance, being constructed of cut stone. The design features of the building are symmetrical and therefore indicative of the Georgian style of architecture. The stone wall surrounding the compound is in pristine condition and is one of the few remaining walls of its type in Montego Bay.

The Barnett Street Police Station featured prominently in the Montego Bay Riots of 1902. Riots played a great part in the history of the police force of the nation, as it was the first time in Jamaica that policemen marched in ranks with fixed bayonets. (Plate 4-28).

Plate 4-28 Barnett Street Police Station (http://www.jnht.com/st_james.php)

5.0 PUBLIC PARTICIPATION

5.1 INTRODUCTION

During the period May 7 - 10 and May 17 - 25, 2022 One Hundred and Sixty-Six (166) community questionnaires were administered within a two-kilometre radius of the proposed project site (Appendix 10 and Appendix 11).

For respondents participating in the community perception survey, approximately sixty-four percent (63.9%) of respondents were male while 36.1% were female.

Of the One Hundred and Sixty-Six (166) respondents age cohort distribution was as follows; 13.9% were 18-25 years of age, 17.0% were 26-33 years, 12.7% were age 34-41 years, 23.6% were age 42-50 years, 15.8% were age 51-60 years and 17.0% were older than sixty years of age.

Respondents were from seven main communities. These communities were Bogue Hill (23.5%), Bogue Village (33.1%), Moy Hall (25.3%), Tower Hill (8.4%), Spring Garden (4.3%), Reading (3.6%) and Freeport (1.8%).

During the survey exercise some challenges were experienced. These included:

- Changes in the use of dwellings from being primary residences to short term rental properties for tourists (e.g. Airbnb rentals). This was experienced most in the Reading area.
- Properties being unoccupied during the survey period. This was most experienced in the Reading Area. It was learnt during the survey exercise that many properties have been converted to short term rental properties for tourists (e.g. Airbnb rentals).
- Lack of participation by residents. This was experienced in the Bogue Heights community. No surveys were administered in this community as residents did not respond when attempts were made to solicit participation. It was observed during the survey exercise, that homes in this community were recessed from the roadway and therefore made it difficult to get the attention of residents.
- Difficulty accessing gated residential communities. This was experienced in the Freeport and Reading communities. Despite telephone and email contact to the respective property management offices seeking access permission and submitting the survey instrument electronically and by hardcopy, there was no participation or very poor participation from these gated communities.

While limited responses were received from some communities (such as Freeport and Reading) and may not be representative of the community, they have been incorporated in the overall analysis. Percentages presented are for the total number of persons offering responses; in instances where respondents did not offer an answer to a question, they were not considered part of the analysis for the specific question(s).

5.2 RESULTS AND FINDINGS

5.2.1 General

Of those persons interviewed who offered a response (97.6%), 43.8% indicated that they were self-employed, while 32.7% stated that they had an employer and 13.6% stated they were unemployed. Approximately ten percent (9.9%) of individuals were retired. Additionally, 66.1% of interviewees when asked confirmed that they were the head of their household while 33.9% indicated that they were not the household head.

Regarding the number of persons residing in households, just under nineteen percent (18.9%) of households had one occupant while 23.3% had two occupants, 16.4% had three occupants and 20.1% had four persons living in the household. Approximately nine percent (9.4%) had five persons living in the household and 11.9% of households had more than five persons residing.

In general, interviewees resided in their communities over the long term. Just over forty-seven percent (47.2%) of individuals resided in their communities for all their life, and 16.3% resided in their community more than fifteen years. Approximately eleven percent (11.3%) stated that they lived in their community for between ten and fifteen years; 6.9% resided for between five and ten years. Just under thirteen percent (12.6%) resided in their community for between three and five years and 5.7% for under two years.

On the issue of where healthcare was mostly obtained, 10.8% stated the public clinic, 55.4% stated the public hospital and 36.7% stated that healthcare needs were mostly sourced through the private doctor. Just under five percent (4.8%) of interviewees stated the private hospital. As it pertained to the specific healthcare provider, the public hospital most referenced was the Cornwall Regional Hospital, while the health centre most referenced was the Catherine Hall Health Centre. It should be noted that percentages exceeded 100.0% as some respondents offered multiple responses.

As it related to whether respondents suffered from specific medical conditions, 7.8% of interviewees indicated that they were asthmatic, 12.0% indicated that they suffered from sinusitis, 3.0% confirmed coughing as an ailment, while 1.8% indicated that they suffered from congestion/bronchial problems. No one interviewed (0.0%) indicated that they suffered from chest pains or frequent bouts of diarrhoea. Approximately seventy-four (73.5%) percent of those interviewed indicated that they did not suffer from any of the specific conditions named. It should be noted that 1.8% of interviewees offered no response.

Respondents in general, expressed some reluctance to disclose information pertaining to income. Of those interviewed, fifty-five percent (55.0%) of respondents refused to offer a response relating to their personal weekly income. Approximately fifteen percent (14.6%) of persons indicated that they did not have a weekly income, while 2.5% indicated that their weekly income was under the national minimum wage of $9,000.00 per week. Just over five percent (5.1%) of interviewees indicated that their weekly income was $9,000.00 per week; 6.3% stated that their weekly income was between $9,001.00 and $12,000.00, while 5.1% stated a weekly income ranging between $12,001.00 and $20,000.00.

Approximately eleven percent (11.4%) indicated that their weekly income was in excess of twenty thousand dollars ($20,000.00) per week.

Regarding the highest level of education completed, 94.0% of those interviewed offered a response. Of this number 1.9% of persons stated that they did not attend any type of learning institution. Approximately twelve percent (11.5%) stated they completed primary/all age school, 6.4% stated that they started but did not complete high school, 41.0% completed high school, 14.2% college, 17.3% university and 7.7% HEART/Vocational Training Institution.

As it pertained to education, 48.7% of those interviewed stated that no one in the household was currently attending school while, 51.3% of interviewees indicated someone in the household was attending school. As it related to the school being attended 16.0% stated that the school being attended was infant/basic, 48.1% stated primary/all age, 44.4% stated high school, 9.9% stated college, 6.2% stated university while 1.2% stated that HEART/a vocational training institute was the school being attended. It should be noted that percentages exceeded one hundred as multiple persons from households attend school.

When respondents were asked about the presence of recreational spaces in their community 47.1% of those offering a response indicated that a recreational space was present while 52.9% stated that no recreational space was present in the community. Recreational spaces named were:

- Community Centre/Playing Field (82.4%)
- Green Space within community (informally used) (10.8%)
- Clubhouse (within gated communities) (4.1%)

On the issue of respondents' awareness of a company named LCH Development Limited, 98.2% of interviewees offered a response. Of these persons 5.5% indicated that they heard of LCH Development Limited while 94.5% stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", 97.6% of survey participants offered a response. Approximately six percent (5.6%) of interviewees stated that they had heard of the project name while 94.4% stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 97.6% of interviewees offered a response. Approximately ten percent (9.9%) of respondents stated that they knew what the term meant while 90.1% indicated that they did not know what "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 97.6% of participants responded. Just under nine percent (8.6%) of those interviewed stated that they were aware of the project while 91.4% stated that they were not aware of the project.

Of the 8.6% of interviewees confirming awareness of the proposed project:

- 28.6% stated that they were aware that the development would include residential villas, while 71.4% indicated that they were not aware

- 50.0% stated that they were aware that the development would include four residential towers, while 50.0% indicated that they were not aware

- 28.6% stated that they were aware that the development would include buildings being up to twenty-eight (28) storeys tall, while 71.4% indicated that they were not aware

- 21.4% stated that they were aware that the development would include commercial spaces, while 64.3% indicated that they were not aware and 14.3% offered no response.

- 7.1% stated that awareness of the project was via the television medium, 14.3% indicated social medial and 78.6% stated "word of mouth' as the medium by which they were made aware of the project.

When asked if there have been any problems/issues on the proposed development site 97.6% of interviewees offered a response. Approximately twenty-five percent (24.7%) of interviewees stated that they were unaware of the site having problems/issues in the past, while 73.4% of persons stated that there were no problems/issues with the proposed site. Approximately two percent (1.9%) of respondents indicated that there have been problems/issues at the proposed site in the past. Of this 1.9%, just over thirty-three percent (33.3%) stated that flooding was the issue, while 33.3% stated that the area was swampy reclaimed land. No responses were offered by 33.4% of survey participants.

As it related to respondents having any concerns pertaining to the proposed development project, 6.8% of those interviewed expressed uncertainty while, 63.0% of interviewees indicated that they did not have any concern while 30.2% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- The availability of work opportunities for local community members (16.3%)

- The structural integrity of the completed building(s) based on the site (soil type) (8.2%)

- Dust nuisance during the project construction phase (6.1%)

- Loss of the mangrove habitat (24.5%)

- Proper disposal of sewage (20.4%)

- Impact of the development project on the environment (10.2%)

- Reduced water supply for existing communities/residential areas (8.2%)

- The strain on the (existing) limited infrastructure in the area (e.g. water, public transportation) (2.0%)

- Traffic congestion (during construction and after construction) (22.4%)
- Affordability of the housing units to be constructed (4.1%)
- Overpopulation of the area/Increased population density (2.0%)
- The development as proposed has a projected population too dense for the area (2.0%)
- The technical competence of the developer to undertake the project (2.0%)
- Possible relocation/displacement of home/landowners (2.0%)
- Community development projects/input by the project developers (2.0%)
- Flooding of other/adjacent areas post construction (4.1%)
- Access to the commercial spaces (e.g. Supermarket and mini food court) by the wider public (6.1%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked about possible suggestions to address highlighted concerns, the following suggestions were put forward:

LCH Development Limited should:

- Give locals (community residents and Jamaican Nationals) first preference for employment opportunities (10.2%)
- Consult with the government building regulatory agency (2.0%)
- Consult with the government environmental regulatory agency (NEPA) (4.1%)
- Wet the roads regularly during construction to mitigate dust nuisance (6.1%)
- Replant mangrove seedlings (2.0%)
- Create a fish sanctuary (2.0%)
- Not destroy the entire mangrove habitat (6.1%)
- Find an alternate project location with better infrastructure to accommodate the proposed development (2.0%)
- Build a sewage plant exclusively for the development (6.1%)

- Ensure houses are affordable for the working class (4.1%)
- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (6.1%)
- Have a community meeting to discuss the highlighted concerns (2.0%)
- Not build at that location (10.2%)
- Produce proof of competence to build on this soil type (swampy land) (2.0%)
- Relocate home/ landowners who may be displaced (2.0%)
- Assist in building a community centre (community development) (2.0%)
- Ensure that proper drainage systems are installed (2.0%)
- Construct a seawall/wave break (2.0%)
- Limit public access (2.0%)
- Allow public access to commercial enterprises (e.g. supermarket) (2.0%)
- Ensure that ingress and egress to and from the development merge with the main thoroughfare at already existing traffic signal intersections (D & G traffic signal intersection) (2.0%)
- Ensure proper land reclamation and compaction (2.0%)
- Enhance public transportation by developing an electric rail system (2.0%)
- No suggestion offered (17.0%)

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 97.6% of interviewees offered a response. Of these individuals, 5.0% expressed uncertainty, 68.5% stated that they had no concerns, while 26.5% indicated that they were concerned about the height of the residential towers being 28-storeys.

Concerns highlighted were:

- Existing fire trucks cannot reach/access floor levels above five (5) storeys (4.7%)
- The building height (of 28 storeys) will obstruct the aircraft flight path of the (Sir Donald Sangster International) Airport (20.9%)
- The ability and stability of the soil to accommodate the weight of the building (30.2%)

- 28-stoerys in height was too tall (25.6%)
- The residential towers will block/obstruct view (14.0%)
- Public safety (2.3%)
- Risk of falling from heights (especially children) (2.3%)
- Accessing upper floor levels with heavy items (e.g. furniture) (2.3%)
- The capability of the emergency services to reach up to 28 floor levels (4.7%)
- The density of the development (2.3%)

Suggestions put forward to address highlighted concerns were:

LCH Development Limited should:

- Not construct above five (5) storeys (2.3%)
- Consult with the Airport Authority of Jamaica (AAJ) (2.3%)
- Consult with the government building regulatory agency (4.7%)
- Reduce the building height (37.2%)
- Not build on the site (4.7%)
- Fill and compact the site adequately (2.3%)
- Ensure that the building is structurally sound (4.7%)
- Reconfigure the residential towers to be less than 28-storeys while maintaining the same number of habitable housing units (4.7%)
- Have a roof-top helipad (on each tower) for emergency evacuation (2.3%)
- Reduce the size of the development (2.3%)
- No suggestion offered (32.5%)

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity or recreation, 97.0% offered a response. Of these respondents, 10.6% of individuals confirmed that they depended on the proposed site while 89.4% stated that they did not depend on the site.

The 10.6% of respondents indicated that the proposed site was used for:

- Recreation (to include swimming, kayaking, paddle boarding) (41.2%)
- Fishing (29.4%)
- Crab hunting (29.4%)
- Playing football (soccer) (5.9%)

Percentages exceeded 100.0% as some respondents offered multiple responses.

On the issue of using the proposed marina area for any type of activity, 95.2% of interviewees offered a response. Of these individuals, 5.7% confirmed that they depended on the proposed marina area while 94.3% stated that they did not depend on this area.

The 5.7% of respondents indicated that the proposed marina area was used for:

- Recreation (to include swimming, kayaking) (11.1%)
- Fishing (44.4%)
- A source for purchasing fish (11.1%)
- No response offered (33.4%)

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity or recreation 96.4% of survey participants responded. Approximately thirteen percent (12.5%) stated that they knew of persons who used the area, while 87.5% of respondents stated that they did not know of anyone who used the proposed location.

The purposes that these persons depended on/used the area for were stated as follows:

- Recreation (to include swimming, kayaking, paddle boarding) (25.0%)
- Fishing (30.0%)
- Crab hunting (55.0%)
- Docking boats (5.0%)
- Cattle rearing (5.0%)
- Commercial boat tours (5.0%)

Percentages exceeded 100.0% as some respondents stated that the area was used for used for multiple purposes.

On the issue of whether respondents thought the project would affect their life 97.0% of interviewees offered a response. Forty-six percent (46.0%) of respondents indicated that the project would not affect their life in any way, while 26.1% were not sure if the project would affect their life. Of the 27.9% of persons anticipating some effect on their lives, 4.3% anticipated a negative impact, 21.7% anticipated a positive impact and 1.9% anticipated both a positive and negative impact from the project.

For those anticipating some positive effect, they anticipated:

- Increased opportunity to generate income (10.5%)
- Employment opportunity (65.8%)
- Home ownership opportunity (13.2%)
- Property appreciation (5.3%)
- Community/National development (10.5%)
- Commercial amenities/resources in close proximity (2.6%)

Percentages exceeded 100 as some respondents anticipated multiple positive impacts.

For those anticipating a negative effect, they anticipated:

- Loss of livelihood (10.0%)
- Increased traffic congestion (60.0%)
- Devaluation of nearby properties (10.0%)
- Environmental hazards (10.0%)
- Loss of view (caused by residential towers) (10.0%)
- Dust nuisance (10.0%)
- Strain on existing infrastructure (10.0%)

Percentages exceeded 100.0% as some respondents anticipated multiple negative impacts.

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (10.0%)
- Do not build on the proposed site (10.0%)
- Employ proper Town Planning initiatives/best practices (10.0%)
- Regulate traffic flow of the development with existing traffic signals (10.0%)
- Upgrade public transportation network/system (10.0%)
- No suggestion offered (50.0%)

Regarding whether respondents thought the project would affect their community 97.0% of interviewees offered a response. Just over twenty-four percent (24.2%) stated that they were unsure if there would be an impact while 31.7% of individuals interviewed indicated that the project would not have any impact on the community. Approximately forty-four (44.1%) percent of respondents anticipated that the project would impact their community. Just over thirty-one percent (31.1%) of interviewees anticipated a positive effect and 13.0% anticipated a negative effect.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (72.0%)
- There will be community/national development (28.0%)
- Property appreciation (6.0%)
- Home ownership opportunity (4.0%)
- Easier access to commercial enterprises (2.0%)
- Increased community population (2.0%)

Percentages exceeded 100.0% as multiple responses were offered.

For those anticipating a negative effect on the community, the following were stated:

- Increased traffic congestion (33.2%)
- Reduced water supply (19.0%)
- Strain on existing (limited) infrastructure (4.8%)
- Noise nuisance (4.8%)

- Strain on existing sewage disposal system/network (4.8%)
- Community tradesmen will not be given employment opportunities (4.8%)
- Locals (nearby community residents) will not have access to the proposed commercial amenities as the development will be gated (4.8%)
- Loss/Obstruction of view (14.2%)
- Dust Nuisance (4.8%)
- Human impact associated with population increase/density (4.8%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Employ local (community) tradesmen (4.8%)
- Reduce the population density of the proposed development project (4.8%)
- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (9.5%)
- Reconfigure the residential towers to be less than 28-storeys while maintaining the same number of habitable housing units (9.5%)
- No suggestions (74.4%)

As it pertained to whether respondents thought the project would affect the environment, 95.8% of persons interviewed offered a response. Thirty-nine percent (39.0%) of respondents stated that the mixed-use residential development project would not have an impact on the environment, while 32.0% stated that they were unsure if there would be any impact. Twenty-nine percent (29.0%) of interviewees anticipated an impact to the environment. Just over twenty-five percent (25.2%) anticipated a negative effect while 3.8% anticipated a positive effect.

For those anticipating a positive effect on the environment, the following were stated:

- Mosquito breeding sites will be reduced (16.7%)
- Community Development (66.7%)

The remaining 16.6%, while anticipating a positive impact did not offer specific information.

For those anticipating a negative effect on the environment, the following were stated:

- Loss of wildlife and wildlife sanctuary/habitat (30.0%)
- Dust nuisance (during construction phase of project) (5.0%)
- Destruction of mangroves (45.0%)
- Increased potential for flooding and storm surge (12.5%)
- Improper sewage disposal (7.5%)
- Increased environmental pollution (12.5%)
- Improper garbage disposal (2.5%)
- Loss/obstruction of view (2.5%)
- Marine contamination from the operations of the marina (2.5%)

Percentages exceeded 100.0% as multiple responses were offered.

When asked about possible suggestions to mitigate/address the anticipated negative impact on the environment, the following suggestions were put forward:

- Do not disturb mangrove habitat (to include no land reclamation or building within the area) (20.0%)
- Replant mangroves (7.5%)
- Do not develop the property (2.5%)
- Wet roads during construction (5.0%)
- Relocate wildlife (5.0%)
- Use environmentally friendly chemicals and materials (2.5%)
- Consult with the government environmental regulatory agency (NEPA) (2.5%)
- Consult with the government building regulatory agency (5.0%)
- Repurpose the mangrove area into an ecotourism attraction (2.5%)
- Ensure proper management of the marina post construction (2.5%)

Some respondents (40.0%) offered no suggestion regarding how the anticipated negative impact could be addressed.

As it related to housing 96.4% of interviewees offered responses. Approximately Fifty-six percent (55.6%) of respondents stated that they owned the house they lived in, 4.4 % stated that their residence was leased, 17.5% lived in rented homes, while 22.5% stated that they lived in family-owned homes. No one interviewed lived in government owned housing or squatted in homes.

As it pertained to the land on which dwelling homes were located 96.4% of interviewees offered responses. Just over forty-one percent (41.3%) of respondents stated that they owned the land on which the house is located, 11.2% stated that the land was leased, 3.7% indicated that they squatted on the land, while 27.5% stated that their homes were built on family land, while 16.3% stated “other” and indicated that the home they lived in was rented but there was no arrangement made with respect to the land. No one interviewed (0.0%) had their homes on government owned lands,

Regarding the type of wall that dwellings were made of 86.3% of interviewees indicated that the walls of their homes was made of concrete and blocks, 10.6% stated wood/board while 3,1% stated that walls were made of both concrete and blocks as well as wood/board. It should be noted that for respondents who indicated that the walls of their homes were made of both materials, this was mainly due to structural additions to increase habitable living space.

Regarding the type of roof that dwellings had, 51.2% of respondents indicated that the roof of their homes was metal sheeting, while 42.5% stated concrete and 2.5% stated wood as the roof material. Just under three percent (2.8%) of interviewees stated that their roofs were made of multiple materials, and specified metal sheeting and concrete as the materials. This was due to structural additions to increase habitable living space.

As it pertained to the type of toilet facility present 97.0% of respondents offered a response. Approximately ninety-six percent (95.7%) of respondents indicated that their homes had water closets, while 3.7% stated that pit latrine was the toilet facility and 0.6% stated “other” but offered no further details. No one (0.0%) indicated that their homes did not have a toilet facility.

As it related to what the household used for lighting 97.0% of respondents offered a response. Just under ninety-nine percent (98.8%) of interviewees stated that electricity was used while 0.6% stated kerosene oil was used for household lighting and a similar 0.6% stated solar as the household lighting source.

Regarding the type of fuel used mostly for cooking 97.0% of respondents offered a response. Approximately ninety-seven percent (97.5%) of persons interviewed indicated that gas was used mostly, 0.6% stated electricity, while 1.9% stated that they mostly used wood for cooking.

On the issue of the main source of household domestic water supply 97.0% of respondents offered a response. Ninety-seven percent (97.0%) of respondents confirmed that their household domestic water supply was the public piped water supply. Less than one percent (0.6%) of respondents stated that the main source of domestic water was private tank, 1.2% indicated that the public standpipe, while 0.6% stated that household water was supplied from a spring or river. Rainfall harvesting was stated as the main source for domestic household water supply by 0.6% of survey participants.

As it pertained to respondents' having any problems with the domestic water supply 97.0% of respondents offered a response, and 19.3% of those who responded indicated that there were problems with the water supply while 80.7% indicated that there were no problems with the domestic water supply. For those persons who confirmed that there were problems with the domestic water supply 3.2% stated that no pipes were run in the area, 77.4% indicated that the water supply was irregular while 12.9% stated that water pressure was low. Approximately seven percent (6.5%) of individuals surveyed did not indicate the specific problem experience with domestic water supply.

In response to how persons coped with problems related to domestic/household water supply, of those confirming that there were problems with supply,19.4% stated that rainwater was harvested, 32.3% stated that they bought water, 22.6% collected water from a spring/river, while 3.2% stated that they used the community standpipe. The remaining 22.5% of persons did not offer any specific information.

On the issue of access to a residential (fixed-line/land-line) telephone 96.4% of respondents offered a response. Sixty-five percent (65.0%) of interviewees indicated that they did not have access to a residential telephone while 35.0% confirmed that they had access. Of the 65% of persons indicating that they did not have a fixed line at their residence 97.1% of these individuals indicated that they owned a mobile phone, while 1.9% stated that they did not own a mobile phone. One percent (1.0%) of these respondents offered no response.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 95.8% of respondents offered a response. Approximately eleven percent (10.7%) of respondents stated that they were not aware of fixed line service being in the community, while 28.9% stated that the community did not have fixed line service. Just over sixty percent (60.4%) of interviewees stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 94.6% of respondents offered a response. Just over ninety-six percent (96.2%) of those interviewed indicated that the public garbage truck was the main garbage disposal method, 2.5% indicated private collection while 1.3% indicated that burning was the main method used to dispose of garbage.

Regarding the frequency of collections of the 96.2% of respondents who indicated that the garbage truck was the main method of garbage disposal, 87.4% indicated that garbage collections were done once per week, 4.0% stated twice per week while 8.6% stated every two weeks

When asked about flooding, 97.0% of respondents offered a response. Of these respondents 95.0% of respondents indicated that their community was not affected by flooding, while 5.0% stated that their community experienced frequent flood events. Of the 5.0% of survey participants confirming community flooding 12.5% stated that flooding occurred each time there was a rainfall event while 87.5% stated that flooding occurred only in times of heavy rains.

Regarding the frequency of rain events resulting in community flooding, 12.5% of respondents stated a frequency of once per month, 62.5% stated once in three months while 12.5% stated less than once per year.

The affected areas named were the:

- Bogue Village Community
- Roadways entering and within the Bogue Village community

As it pertained to the depth of flood water, 57.1% stated that water levels were less that 0.3 metres (1.0 foot) in depth, while 42.9% stated that water levels ranged between depths of 0.3-1.5m (1.0-5.0ft).

Regarding whether there were problems with frequent flooding at or near the proposed site 97.0% of respondents offered a response. Approximately seventy-five percent (74.5%) of interviewees, stated that the area was not affected by flooding, while 24.8% stated that they did not know if the area was affected, while 0.7% stated that the area was affected by flooding. Of the 0.7% of those stating that there were flooding problems, all (100.0%) persons stated that flooding occurred each time there was a rainfall event and further indicated that rain events causing flooding occurred once per month. These respondents also indicated that water levels ranged between 0.3 metre and 1.5 metres (1.0ft – 5.0ft)

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 96.4% of interviewees offered a response. Thirty-five percent (35.0%) of respondents stated that they did not know if the area was affected while 61.2% stated that the area was not affected by tidal changes and 3.8% indicated that the area was affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 96.4% of interviewees offered a response. Just over twenty-three percent (23.1%) of interviewees stated they did not know of any such area or site, 67.5% stated that no such area was located near to the proposed area while 9.4% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main places named were:

- The Montego Bay Marine Park
- The Bogue Lagoons & Fish Sanctuary
- The Mangroves

5.2.2 Community Analysis

Percentages presented for each community cohort are for the total number of persons within the specific community offering responses. Where community respondents did not offer an answer to a question, they were not considered part of the analysis for the specific question(s).

5.2.2.1 Bogue Hill

Approximately twenty-four percent (23.5%) of respondents were from the Bogue Hill community. Just over eighty-two percent (82.1%) of respondents were male and 17.9% were female.

Age cohort distribution was as follows; 20.4% were 18-25 years of age, 15.4% were 26-33 years, 15.4% were age 34-41 years, 30.8% were age 42-50 years, 2.6% were age 51-60 years and 15.4% were older than sixty years of age.

Of those persons interviewed who offered a response (97.4%), 55.3% indicated that they were self-employed, while 18.4% stated that they had an employer and 18.4% stated they were unemployed. Approximately eight percent (7.9%) of individuals were retired. Additionally, 66.7% of interviewees when asked confirmed that they were the head of their household while 33.3% indicated that they were not the household head.

Regarding the number of persons residing in households, just over twenty-six percent (26.3%) of households had one occupant while 23.7% had two occupants, 13.2% had three occupants and 15.8% had four persons living in the household. Approximately thirteen percent (13.2%) had five persons living in the household and 7.8% of households had more than five persons residing.

In general, interviewees resided in their communities over the long term. Just under seventy-nine percent (78.9%) of individuals resided in their communities for all their life, and 5.3% resided in their community more than fifteen years. Approximately eight percent (7.9%) stated that they lived in their community for between ten and fifteen years; no one (0.0%) was encountered who resided in the community for between five and ten years. Just under three percent (3.0%) resided in their community for between three and five years and 5.3% for under two years.

On the issue of where healthcare was mostly obtained, 10.3% stated the public clinic, 74.4% stated the public hospital and 24.6% stated that healthcare needs were mostly sourced through the private doctor. As it pertained to the specific healthcare provider, the public hospital most referenced was the Cornwall Regional Hospital, while the health centre most referenced was the Catherine Hall Health Centre. It should be noted that percentages exceeded 100.0% as some respondents offered multiple responses.

As it related to whether respondents suffered from specific medical conditions, 7.7% of interviewees indicated that they were asthmatic, 5.1% indicated that they suffered from sinusitis, 2.6% confirmed coughing as an ailment, while 2.6% indicated that they suffered from congestion/bronchial problems. Approximately eighty (79.5%) percent of those interviewed indicated that they did not suffer from any of the specific conditions named. It should be noted that 2.5% of interviewees offered no response.

Respondents in general, expressed some reluctance to disclose information pertaining to income. Of those interviewed, 57.9% of respondents refused to offer a response relating to their personal weekly income. Approximately twenty-one percent (21.1%) of persons indicated that they did not have a weekly income, while 2.6% indicated that their weekly income was under the national minimum wage of $9,000.00 per week. No one interviewed (0.0%) indicated that their weekly income was $9,000.00 per week; 2.6% stated that their weekly income was between $9,001.00 and $12,000.00, similarly 2.6% also stated a weekly income ranging between $12,001.00 and $20,000.00. Approximately thirteen percent (13.2%) indicated that their weekly income was in excess of twenty thousand dollars ($20,000.00) per week.

Regarding the highest level of education completed, 92.3% of those interviewed offered a response. Of this number, approximately nineteen percent (19.4%) stated they completed primary/all age school, 5.6% stated that they started but did not complete high school, 52.8% completed high school, 11.0% college, 5.6% university and 5.6% HEART/Vocational Training Institution.

As it pertained to education, 51.4% of those interviewed stated that no one in the household was currently attending school while, 48.6% of interviewees indicated someone in the household was attending school. As it related to the school being attended 22.2% stated that the school being attended was infant/basic, 50.0% stated primary/all age, 33.3% stated high school, 5.6% stated college, 5.6% also stated university while no one (0.0%) stated that HEART/a vocational training institute was the school being attended. It should be noted that percentages exceeded one hundred as multiple persons from households attend school.

When respondents were asked about the presence of recreational spaces in their community 70.3% of those offering a response indicated that a recreational space was present while 29.7% stated that no recreational space was present in the community. The recreational space named was:

- Community Centre/Playing Field (100.0%)

It should be noted that this recreational space is located on the compound of the community basic school.

On the issue of respondents' awareness of a company named LCH Development Limited, 97.4% of interviewees offered a response. Of these persons 10.5% indicated that they heard of LCH Development Limited while 89.5% stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", 94.9% of survey participants offered a response. Approximately five percent (5.4%) of interviewees stated that they had heard of the project name while 94.6% stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 94.9% of interviewees offered a response. Approximately eight percent (8.1%) of respondents stated that they knew what the term meant while 91.9% indicated that they did not know what "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 94.9% of participants responded. Just over eight percent (8.1%) of those interviewed stated that they were aware of the project while 91.9% stated that they were not aware of the project.

Of the 8.1% of interviewees confirming awareness of the proposed project:

- All respondents (100.0%) stated that they were not aware that the development would include residential villas
- 33.3% stated that they were aware that the development would include four residential towers, while 66.7% indicated that they were not aware
- 33.3% stated that they were aware that the development would include buildings being up to twenty-eight (28) storeys tall, while 66.7% indicated that they were not aware
- 50.0% stated that they were aware that the development would include commercial spaces, while 50.0% also indicated that they were not aware.
- 33.3% indicated social medial and 66.7% stated "word of mouth' as the medium by which they were made aware of the project.

When asked if there have been any problems/issues on the proposed development site 94.9% of interviewees offered a response. Approximately eight percent (8.1%) of interviewees stated that they were unaware of the site having problems/issues in the past, while 86.5% of persons stated that there were no problems/issues with the proposed site. Approximately five percent (5.4%) of respondents indicated that there have been problems/issues at the proposed site in the past. Of this 5.4%, fifty percent (50.0%) stated that flooding was the issue. No responses were offered by 50.0% of survey participants.

As it related to respondents having any concerns pertaining to the proposed development project, 2.7% of those interviewed expressed uncertainty while, 78.4% of interviewees indicated that they did not have any concern while 18.9% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- The availability of work opportunities for local community members (57.1%)
- The structural integrity of the completed building(s) based on the site (soil type) (14.3%)
- Dust nuisance during the project construction phase (14.3%)
- Loss of the mangrove habitat (14.3%)

When asked about possible suggestions to address highlighted concerns, the following suggestions were put forward:

LCH Development Limited should:

- Give locals (community residents and Jamaican Nationals) first preference for employment opportunities (28.6%)
- Consult with the government building regulatory agency (14.3%)
- Wet the roads regularly during construction to mitigate dust nuisance (14.3%)
- Replant mangrove seedlings (14.3%)
- Create a fish sanctuary (14.3%)
- No suggestion offered (14.2%)

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 94.9% of interviewees offered a response. Of these individuals, 8.1% expressed uncertainty, 73.0% stated that they had no concerns, while 18.9% indicated that they were concerned about the height of the residential towers being 28-storeys.

Concerns highlighted were:

- Existing fire trucks cannot reach/access floor levels above five (5) storeys (14.3%)
- The building height (of 28 storeys) will obstruct the aircraft flight path of the (Sir Donald Sangster International) Airport (57.1%)
- The ability and stability of the soil to accommodate the weight of the building (14.3%)
- 28-stoerys in height was too tall (14.3%)

Suggestions put forward to address highlighted concerns were:

LCH Development Limited should:

- Not construct above five (5) storeys (14.3%)
- Consult with the Airport Authority of Jamaica (AAJ) (14.3%)
- Consult with the government building regulatory agency (14.3%)
- Reduce the building height (57.1%)

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity or recreation, 94.9% offered a response. Of these respondents, 16.2% of individuals confirmed that they depended on the proposed site while 83.8% stated that they did not depend on the site.

The 16.2% of respondents indicated that the proposed site was used for:

- Recreation (to include swimming, kayaking, paddle boarding) (16.7%)
- Fishing (66.7%)
- Crab hunting (33.3%)

Percentages exceeded 100.0% as some respondents offered multiple responses.

On the issue of using the proposed marina area for any type of activity, 89.7% of interviewees offered a response. Of these individuals, 2.9% confirmed that they depended on the proposed marina area while 97.1% stated that they did not depend on this area.

The 2.9% of respondents indicated that the proposed marina area was used for:

- Fishing (100.0%)

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity, or recreation 94.9% of survey participants responded. Approximately twenty-two percent (21.6%) stated that they knew of persons who used the area, while 78.4% of respondents stated that they did not know of anyone who used the proposed location.

The purposes that these persons depended on/used the area for were stated as follows:

- Recreation (to include swimming, kayaking, paddle boarding) (12.5%)
- Fishing (37.5%)
- Crab hunting (87.5%)

Percentages exceeded 100.0% as some respondents stated that the area was used for used for multiple purposes.

On the issue of whether respondents thought the project would affect their life 94.9% of interviewees offered a response. Just under thirty-eight percent (37.9%) of respondents indicated that the project would not affect their life in any way, while 24.3% were not sure if the project would affect their life. Of the 37.8% of persons anticipating some effect on their lives, 5.4% anticipated a negative impact, while 32.4% anticipated a positive impact from the project.

For those anticipating some positive effect, they anticipated:

- Increased opportunity to generate income (250%)
- Employment opportunity (58.3%)
- Home ownership opportunity (16.7%)

For those anticipating a negative effect, they anticipated:

- Loss of livelihood (50.0%)
- Increased traffic congestion (50.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (50.0%)
- No suggestion offered (50.0%)

Regarding whether respondents thought the project would affect their community 94.9% of interviewees offered a response. Nineteen percent (19.0%) stated that they were unsure if there would be an impact while 32.4% of individuals interviewed indicated that the project would not have any impact on the community. Approximately forty-nine (48.6%) percent of respondents anticipated that the project would impact their community. Just under forty-six percent (45.9%) of interviewees anticipated a positive effect and 2.7% anticipated a negative effect.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (82.4%)
- There will be community/national development (17.6%)

For those anticipating a negative effect on the community, the following was stated:

- Increased traffic congestion (100.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestion was put forward:

- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (100.0%)

As it pertained to whether respondents thought the project would affect the environment, 94.9% of persons interviewed offered a response. Approximately forty-three percent (43.3%) of respondents stated that the mixed-use residential development project would not have an impact on the environment, while 40.5% stated that they were unsure if there would be any impact. Just over sixteen percent (16.2%) of interviewees anticipated an impact to the environment. Approximately fourteen percent (13.5%) anticipated a negative effect while 2.7% anticipated a positive effect.

For those anticipating a positive effect on the environment, the following were stated:

- Mosquito breeding sites will be reduced (100.0%)

For those anticipating a negative effect on the environment, the following were stated:

- Destruction of mangroves (100.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact on the environment, the following suggestions were put forward:

- Do not disturb mangrove habitat (to include no land reclamation or building within the area) (60.0%)
- Replant mangroves (20.0%)

Some respondents (20.0%) offered no suggestion regarding how the anticipated negative impact could be addressed.

As it related to housing 94.9% of interviewees offered responses. Forty-six percent (46.0%) of respondents stated that they owned the house they lived in, 10.8% stated that their residence was leased, 8.1% lived in rented homes, while 35.1% stated that they lived in family-owned homes.

As it pertained to the land on which dwelling homes were located 94.9% of interviewees offered responses. Just over sixteen percent (16.3%) of respondents stated that they owned the land on which the house is located, 27.0% stated that the land was leased, 10.8% indicated that they squatted on the land, while 37.8% stated that their homes were built on family land, while 8.1% stated “other” and indicated that the home they lived in was rented but there was no arrangement made with respect to the land.

Regarding the type of wall that dwellings were made of 73.0% of interviewees indicated that the walls of their homes was made of concrete and blocks, 18.9% stated wood/board while 5.4% stated that walls were made of both concrete and blocks as well as wood/board. It should be noted that for respondents who indicated that the walls of their homes were made of both materials, this was mainly due to structural additions to increase habitable living space. Some respondents (2.7%) offered no information regarding the type of wall that dwellings were made of.

Regarding the type of roof that dwellings had, 32.4% of respondents indicated that the roof of their homes was metal sheeting, while 59.5% stated concrete. Just over five percent (5.4%) of interviewees stated that their roofs were made of multiple materials, and specified metal sheeting and concrete as the materials. This was due to structural additions to increase habitable living space. Some respondents (2.7%) offered no information regarding the type of roof that dwellings had.

As it pertained to the type of toilet facility present 94.9% of respondents offered a response. Approximately ninety-two percent (91.9%) of respondents indicated that their homes had water closets, while 8.1% stated that pit latrine was the toilet facility.

As it related to what the household used for lighting 94.9% of respondents offered a response. All (100.0%) interviewees stated that electricity was used for household lighting.

Regarding the type of fuel used mostly for cooking 94.9% of respondents offered a response. Approximately ninety-seven percent (97.3%) of persons interviewed indicated that gas was used mostly, while 2.7% stated that they mostly used wood for cooking.

On the issue of the main source of household domestic water supply 94.9% of respondents offered a response. Approximately ninety-two percent (91.9%) of respondents confirmed that their household domestic water supply was the public piped water supply, while 5.4% indicated the public standpipe. Rainfall harvesting was stated as the main source for domestic household water supply by 2.7% of survey participants.

As it pertained to respondents' having any problems with the domestic water supply 94.9% of respondents offered a response, and 27.0% of those who responded indicated that there were problems with the water supply while 73.0% indicated that there were no problems with the domestic water supply. For those persons who confirmed that there were problems with the domestic water supply, 70.0% indicated that the water supply was irregular while 20.0% stated that water pressure was low. Ten percent (10.0%) of individuals surveyed did not indicate the specific problem experience with domestic water supply.

In response to how persons coped with problems related to domestic/household water supply, of those confirming that there were problems with supply,40.0% stated that rainwater was harvested, 10.0% stated that they bought water, 20.0% collected water from a spring/river, while 10.0% stated that they used the community standpipe. The remaining 20.0% of persons did not offer any specific information.

On the issue of access to a residential (fixed line/landline) telephone 94.9% of respondents offered a response. Just under seventy-six percent (75.7%) of interviewees indicated that they did not have access to a residential telephone while 24.3% confirmed that they had access. Of the 75.7% of persons indicating that they did not have a fixed line at their residence 96.4% of these individuals indicated that they owned a mobile phone, while 3.6% stated that they did not own a mobile phone.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 92.3% of respondents offered a response. Approximately seventeen percent (16.6%) of respondents stated that they were not aware of fixed line service being in the community, while 27.8% stated that the community did not have fixed line service. Just under fifty-six percent (55.6%) of interviewees stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 89.7% of respondents offered a response. All survey participants (100.0%) indicated that the public garbage truck was the main garbage disposal method.

Regarding the frequency of collections, 80.0% indicated that garbage collections were done once per week, 2.9% stated twice per week while 17.1% stated every two weeks.

When asked about flooding, 94.9% of respondents offered a response. Of these respondents all individuals (100.0%) indicated that their community was not affected by flooding.

Regarding whether there were problems with frequent flooding at or near the proposed site 94.9% of respondents offered a response. Approximately eighty-four percent (83.8%) of interviewees, stated that the area was not affected by flooding, while 16.2% stated that they did not know if the area was affected.

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 94.9% of interviewees offered a response. Approximately twenty-two percent (21.6%) of respondents stated that they did not know if the area was affected while 78.4% stated that the area was not affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 94.9% of interviewees offered a response. Just under twenty-two percent (21.6%) of interviewees stated they did not know of any such area or site, 73.0% stated that no such area was located near to the proposed area while 5.4% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main place named was:

- The Bogue Lagoons & Fish Sanctuary

5.2.2.2 Bogue Village

Approximately thirty-three percent (33.1%) of respondents were from the Bogue Village community. Just under forty-four percent (43.6%) of respondents were male and 56.4% were female.

Age cohort distribution was as follows; 18.5% were 18-25 years of age, 14.8% were 26-33 years, 13.0% were age 34-41 years, 20.4% were age 42-50 years, 25.9% were age 51-60 years and 7.4% were older than sixty years of age.

Of those persons interviewed who offered a response (96.4%), 30.3% indicated that they were self-employed, while 50.9% stated that they had an employer and 9.4% stated they were unemployed. Approximately nine percent (9.4%) of individuals were retired. Additionally, 64.8% of interviewees when asked confirmed that they were the head of their household while 35.2% indicated that they were not the household head.

Regarding the number of persons residing in households, sixteen percent (16.0%) of households had one occupant while 32.0% had two occupants, 20.0% had three occupants and 18.0% had four persons living in the household. Ten percent (10.0%) had five persons living in the household and 4.0% of households had more than five persons residing.

Just under four percent (3.8%) of individuals resided in their communities for all their life, and 24.5% resided in their community more than fifteen years. Approximately nineteen percent (18.9%) stated that they lived in their community for between ten and fifteen years; 15.1% resided for between five and ten years. Just over twenty-eight percent (28.3%) resided in their community for between three and five years and 9.4% for under two years.

On the issue of where healthcare was mostly obtained, 1.8% stated the public clinic, 36.4% stated the public hospital and 60.0% stated that healthcare needs were mostly sourced through the private doctor. Approximately percent (5.5%) of interviewees stated the private hospital. It should be noted that percentages exceeded 100.0% as some respondents offered multiple responses.

As it related to whether respondents suffered from specific medical conditions, 10.9% of interviewees indicated that they were asthmatic, 14.5% indicated that they suffered from sinusitis, 5.5% confirmed coughing as an ailment, while 1.8% indicated that they suffered from congestion/bronchial problems. No one interviewed (0.0%) indicated that they suffered from chest pains or frequent bouts of diarrhoea. Approximately sixty-six (65.5%) percent of those interviewed indicated that they did not suffer from any of the specific conditions named. It should be noted that 1.8% of interviewees offered no response.

Respondents in general, expressed some reluctance to disclose information pertaining to income. Of those interviewed, sixty-seven percent (66.6%) of respondents refused to offer a response relating to their personal weekly income. Approximately ten percent (9.8%) of persons indicated that they did not have a weekly income, while 2.0% indicated that their weekly income was under the national minimum wage of $9,000.00 per week. Two percent (2.0%) of interviewees also indicated that their weekly income was $9,000.00 per week; 2.0% stated that their weekly income was between $9,001.00 and $12,000.00, while 7.8% stated a weekly income ranging between $12,001.00 and $20,000.00. Approximately ten percent (9.8%) indicated that their weekly income was in excess of twenty thousand dollars ($20,000.00) per week.

Regarding the highest level of education completed, 94.5% of those interviewed offered a response. Of this number 3.8% of persons stated that they did not attend any type of learning institution. Two percent (2.0%) stated they completed primary/all age school, 1.9% stated that they started but did not complete high school, 32.7% completed high school, 23.1% college, 34.6% university and 1.9% HEART/Vocational Training Institution.

As it pertained to education, 39.2% of those interviewed stated that no one in the household was currently attending school while, 60.8% of interviewees indicated someone in the household was attending school. As it related to the school being attended 12.9% stated that the school being attended was infant/basic, 32.3% stated primary/all age, 41.9% stated high school, 9.7% stated college, 9.7% stated university while 3.2% stated that HEART/a vocational training institute was the school being attended. It should be noted that percentages exceeded one hundred as multiple persons from households attend school.

When respondents were asked about the presence of recreational spaces in their community 74.0% of those offering a response indicated that a recreational space was present while 26.0% stated that no recreational space was present in the community. Recreational spaces named were:

- Community Centre/Playing Field (91.9%)
- Green Space within community (informally used) (2.7%)
- No response offered (5.4%)

It should be noted that the Bogue Village Community has a community centre.

On the issue of respondents' awareness of a company named LCH Development Limited, 98.2% of interviewees offered a response. Of these persons 3.7% indicated that they heard of LCH Development Limited while 96.3% stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", 98.2% of survey participants offered a response. Approximately seven percent (7.4%) of interviewees stated that they had heard of the project name while 92.6% stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 98.2% of interviewees offered a response. Thirteen percent (13.0%) of respondents stated that they knew what the term meant while 87.0% indicated that they did not know what "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 98.2% of participants responded. Just under four percent (3.7%) of those interviewed stated that they were aware of the project while 96.3% stated that they were not aware of the project.

Of the 3.7% of interviewees confirming awareness of the proposed project:

- 100.0% stated that they were not aware that the development would include residential villas.
- 50.0% stated that they were aware that the development would include four residential towers, while 50.0% indicated that they were not aware.
- 100.0% stated that they were not aware that the development would include buildings being up to twenty-eight (28) storeys tall.
- 100.0% stated that they were not aware that the development would include commercial spaces.
- 50.0% stated that awareness of the project was via the television medium, and 100.0% stated "word of mouth' as the medium by which they were made aware of the project. Some respondents were made aware by multiple media, therefore percentages exceeded one hundred.

When asked if there have been any problems/issues on the proposed development site 98.2% of interviewees offered a response. Approximately thirty-nine percent (38.9%) of interviewees stated that they were unaware of the site having problems/issues in the past, while the remaining 61.1% of persons stated that there were no problems/issues with the proposed site.

As it related to respondents having any concerns pertaining to the proposed development project, 11.1% of those interviewed expressed uncertainty while, 51.9% of interviewees indicated that they did not have any concern while 37.0% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- The availability of work opportunities for local community members (5.0%)
- Loss of the mangrove habitat (25.0%)
- Proper disposal of sewage (45.0%)
- Impact of the development project on the environment (15.0%)
- Reduced water supply for existing communities/residential areas (10.0%)
- Traffic congestion (during construction and after construction) (40.0%)
- Affordability of the housing units to be constructed (5.0%)
- Overpopulation of the area/Increased population density (5.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked about possible suggestions to address highlighted concerns, the following suggestions were put forward:

LCH Development Limited should:

- Give locals (community residents and Jamaican Nationals) first preference for employment opportunities (5.0%)
- Consult with the government environmental regulatory agency (NEPA) (5.0%)
- Not destroy the entire mangrove habitat (10.0%)
- Find an alternate project location with better infrastructure to accommodate the proposed development (5.0%)
- Build a sewage plant exclusively for the development (15.0%)
- Ensure houses are affordable for the working class (5.0%)
- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (25.0%)
- Have a community meeting to discuss the highlighted concerns (5.0%)
- Not build at that location (5.0%)
- No suggestion offered (20.0%)

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 98.2% of interviewees offered a response. Of these individuals, 3.7% expressed uncertainty, 666.7% stated that they had no concerns, while 29.6% indicated that they were concerned about the height of the residential towers being 28-storeys.

Concerns highlighted were:

- Existing fire trucks cannot reach/access floor levels above five (5) storeys (6.2%)
- The building height (of 28 storeys) will obstruct the aircraft flight path of the (Sir Donald Sangster International) Airport (12.5%)
- The ability and stability of the soil to accommodate the weight of the building (18.8%)
- 28-stoerys in height was too tall (43.8%)
- The residential towers will block/obstruct view (12.5%)

- Public safety (6.2%)

Suggestions put forward to address highlighted concerns were:

LCH Development Limited should:

- Consult with the government building regulatory agency (6.3%)
- Reduce the building height (43.8%)
- Not build on the site (6.3%)
- Fill and compact the site adequately (6.3%)
- Ensure that the building is structurally sound (6.3%)
- No suggestion offered (31.0%)

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity or recreation, 96.4% offered a response. Of these respondents, 7.5% of individuals confirmed that they depended on the proposed site while 92.5% stated that they did not depend on the site.

The 7.5% of respondents indicated that the proposed site was used for:

- Recreation (to include swimming, kayaking, paddle boarding) (75.0%)
- Crab hunting (25.0%)

On the issue of using the proposed marina area for any type of activity, 96.4% of interviewees offered a response. Of these individuals, 7.5% confirmed that they depended on the proposed marina area while 92.5% stated that they did not depend on this area.

The 7.5% of respondents indicated that the proposed marina area was used for:

- Fishing (25.0%)
- A source for purchasing fish (25.0%)
- No response offered (50.0%)

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity or recreation 94.5% of survey participants responded. Approximately six percent (5.8%) stated that they knew of persons who used the area, while 94.2% of respondents stated that they did not know of anyone who used the proposed location.

The purposes that these persons depended on/used the area for were stated as follows:

- Recreation (to include swimming, kayaking, paddle boarding) (66.7%)
- Fishing (33.3%)
- Crab hunting (33.3%)

Percentages exceeded 100.0% as some respondents stated that the area was used for used for multiple purposes.

On the issue of whether respondents thought the project would affect their life 96.4% of interviewees offered a response. Forty-nine percent (49.0%) of respondents indicated that the project would not affect their life in any way, while 24.5% were not sure if the project would affect their life. Of the 26.5% of persons anticipating some effect on their lives, 5.7% anticipated a negative impact, 18.9% anticipated a positive impact and 1.9% anticipated both a positive and negative impact from the project.

For those anticipating some positive effect, they anticipated:

- Employment opportunity (81.8%)
- Home ownership opportunity (18.2%)
- Property appreciation (9.1%)
- Community/National development (9.1%)

Percentages exceeded 100 as some respondents anticipated multiple positive impacts.

For those anticipating a negative effect, they anticipated:

- Increased traffic congestion (75.0%)
- Devaluation of nearby properties (25.0%)
- Environmental hazards (25.0%)

Percentages exceeded 100.0% as some respondents anticipated multiple negative impacts.

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Do not build on the proposed site (25.0%)
- Employ proper Town Planning initiatives/best practices (25.0%)
- No suggestion offered (50.0%)

Regarding whether respondents thought the project would affect their community 96.4% of interviewees offered a response. Just under thirty-six percent (35.8%) stated that they were unsure if there would be an impact while 26.4% of individuals interviewed indicated that the project would not have any impact on the community. Approximately thirty-eight (37.8%) percent of respondents anticipated that the project would impact their community. Seventeen percent (17.0%) of interviewees anticipated a positive effect and 20.8% anticipated a negative effect.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (55.6%)
- There will be community/national development (33.5%)
- Property appreciation (22.2%)
- Home ownership opportunity (11.1%)

Percentages exceeded 100.0% as multiple responses were offered.

For those anticipating a negative effect on the community, the following were stated:

- Increased traffic congestion (54.5%)
- Reduced water supply (18.2%)
- Strain on existing (limited) infrastructure (9.1%)
- Noise nuisance (9.1%)
- Strain on existing sewage disposal system/network (9.1%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (9.1%)
- No suggestions (90.9%)

As it pertained to whether respondents thought the project would affect the environment, 94.5% of persons interviewed offered a response. Just over twenty-three percent (23.1%) of respondents stated that the mixed-use residential development project would not have an impact on the environment, while 38.5% stated that they were unsure if there would be any impact. Twenty-nine percent (38.4%) of interviewees anticipated an impact to the environment. Just over twenty-five percent (36.5%) anticipated a negative effect while 1.9% anticipated a positive effect.

Those respondents anticipating a positive effect on the environment did not offer any specific information.

For those anticipating a negative effect on the environment, the following were stated:

- Loss of wildlife and wildlife sanctuary/habitat (26.3%)
- Dust nuisance (during construction phase of project) (5.3%)
- Destruction of mangroves (31.6%)
- Increased potential for flooding and storm surge (5.3%)
- Improper sewage disposal (10.5%)
- Increased environmental pollution (26.3%)
- Improper garbage disposal (5.3%)

Percentages exceeded 100.0% as multiple responses were offered.

When asked about possible suggestions to mitigate/address the anticipated negative impact on the environment, the following suggestions were put forward:

- Do not disturb mangrove habitat (to include no land reclamation or building within the area) (5.3%)
- Do not develop the property (5.3%)
- Wet roads during construction (5.3%)
- Relocate wildlife (10.5%)
- Use environmentally friendly chemicals and materials (5.3%)
- Consult with the government environmental regulatory agency (NEPA) (5.3%)

- Consult with the government building regulatory agency (5.3%)

Some respondents (57.7%) offered no suggestion regarding how the anticipated negative impact could be addressed.

As it related to housing 94.5% of interviewees offered responses. Approximately Fifty-two percent (51.9%) of respondents stated that they owned the house they lived in, 5.8% stated that their residence was leased, 36.5% lived in rented homes, while 5.8% stated that they lived in family-owned homes.

As it pertained to the land on which dwelling homes were located 94.5% of interviewees offered responses. Just over forty-eight percent (48.1%) of respondents stated that they owned the land on which the house is located, 11.5% stated that the land was leased, 5.8% stated that their homes were built on family land, while 34.6% stated “other” and indicated that the home they lived in was rented but there was no arrangement made with respect to the land.

Regarding the type of wall that dwellings were made of 100.0% of interviewees indicated that the walls of their homes was made of concrete and blocks.

Regarding the type of roof that dwellings had, 84.6% of respondents indicated that the roof of their homes was metal sheeting, while 9.6% stated concrete and 5.8% stated wood as the roof material.

As it pertained to the type of toilet facility present 96.4% of respondents offered a response. Approximately ninety-eight percent (98.1%) of respondents indicated that their homes had water closets, while 1.9% stated “other” but offered no further details.

As it related to what the household used for lighting 96.4% of respondents offered a response. Just over ninety-eight percent (98.1%) of interviewees stated that electricity was used while 1.9% stated solar as the household lighting source.

Regarding the type of fuel used mostly for cooking 96.4% of respondents offered a response. Approximately ninety-eight percent (98.1%) of persons interviewed indicated that gas was used mostly, while 1.9% stated electricity was mostly used for cooking.

On the issue of the main source of household domestic water supply 96.4% of respondents offered a response. Approximately ninety-eight percent (98.1%) of respondents confirmed that their household domestic water supply was the public piped water supply. Approximately two percent (1.9%) of respondents stated that the main source of domestic water was private tank.

As it pertained to respondents’ having any problems with the domestic water supply 96.4% of respondents offered a response, and 5.7% of those who responded indicated that there were problems with the water supply while 94.3% indicated that there were no problems with the domestic water supply. For those persons who confirmed that there were problems with the domestic water supply, 66.7% indicated that the water supply was irregular while 33.3% stated that water pressure was low.

In response to how persons coped with problems related to domestic/household water supply, of those confirming that there were problems with supply, 33.3% stated that rainwater was harvested, a similar 33.3% stated that they bought water. The remaining 33.4% of persons did not offer any specific information.

On the issue of access to a residential (fixed line/landline) telephone 94.5% of respondents offered a response. Just under twenty-seven percent (26.9%) of interviewees indicated that they did not have access to a residential telephone while 73.1% confirmed that they had access. Of the 26.9% of persons indicating that they did not have a fixed line at their residence all (100.0%) of these individuals indicated that they owned a mobile phone.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 94.5% of respondents offered a response. Approximately eight percent (7.7%) of respondents stated that they were not aware of fixed line service being in the community, while 3.8% stated that the community did not have fixed line service. Just under eighty-nine percent (88.5%) of interviewees stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 92.7% of respondents offered a response. Ninety-eight percent (98.0%) of those interviewed indicated that the public garbage truck was the main garbage disposal method, while 2.0% indicated that burning was the main method used to dispose of garbage.

Regarding the frequency of collections, of the 98.0% of respondents who indicated that the garbage truck was the main method of garbage disposal, 76.0% indicated that garbage collections were done once per week, 8.0% stated twice per week while 14.0% stated every two weeks. Two percent (2.0%) of interviewees did not indicate the garbage collection frequency for their community.

When asked about flooding, 96.4% of respondents offered a response. Of these respondents 86.8% of respondents indicated that their community was not affected by flooding, while 13.2% stated that their community experienced frequent flood events. Of the 13.2% of survey participants confirming community flooding 14.3% stated that flooding occurred each time there was a rainfall event while 85.7% stated that flooding occurred only in times of heavy rains.

Regarding the frequency of rain events resulting in community flooding, 14.3% of respondents stated a frequency of once per month, 57.1% stated once in three months while 14.3% stated less than once per year. Some respondents (14.3%) offered no specific info

The affected areas named were the:

- Bogue Village Community
- Roadways entering and within the Bogue Village community

As it pertained to the depth of flood water, 50.0% stated that water levels were less than 0.3 metres (1.0 foot) in depth, while 50.0% stated that water levels ranged between depths of 0.3-1.5m (1.0-5.0ft).

Regarding whether there were problems with frequent flooding at or near the proposed site 96.4% of respondents offered a response. Approximately fifty-nine percent (58.5%) of interviewees, stated that the area was not affected by flooding, while 39.6% stated that they did not know if the area was affected, while 1.9% stated that the area was affected by flooding. Of the 1.9% of those stating that there were flooding problems, all (100.0%) persons stated that flooding occurred each time there was a rainfall event and further indicated that rain events causing flooding occurred once per month. These respondents also indicated that water levels ranged between 0.3 metre and 1.5 metres (1.0ft – 5.0ft)

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 96.4% of interviewees offered a response. Just under fifty-seven percent (56.7%) of respondents stated that they did not know if the area was affected while 35.8% stated that the area was not affected by tidal changes and 7.5% indicated that the area was affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 96.4% of interviewees offered a response. Just under thirty-six percent (35.8%) of interviewees stated they did not know of any such area or site, 52.8% stated that no such area was located near to the proposed area while 11.4% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main places named were:

- The Bogue Lagoons & Fish Sanctuary
- The Mangroves

5.2.2.3 Moy Hall

Approximately twenty-five percent (25.3%) of respondents were from the Moy Hall community. Just under seventy-four percent (73.8%) of respondents were male and 26.2% were female.

Age cohort distribution was as follows; 2.4% were 18-25 years of age, 21.4% were 26-33 years, 16.7% were age 34-41 years, 21.4% were age 42-50 years, 14.3% were age 51-60 years and 23.8% were older than sixty years of age.

Of those persons interviewed who offered a response (100.0%), 50.0% indicated that they were self-employed, while 26.2% stated that they had an employer and 11.9% stated they were unemployed. Approximately twelve percent (11.9%) of individuals were retired. Additionally, 69.0% of interviewees when asked confirmed that they were the head of their household while 31.0% indicated that they were not the household head.

Regarding the number of persons residing in households, just over twelve percent (12.1%) of households had one occupant while 19.5% had two occupants, 22.0% had three occupants and 22.0% had four persons living in the household. Approximately ten percent (9.8%) had five persons living in the household and 14.6% of households had more than five persons residing.

In general, interviewees resided in their communities over the long term. Seventy-five percent (75.0%) of individuals resided in their communities for all their life, and 10.0% resided in their community more than fifteen years. Five percent (5.0%) stated that they lived in their community for between ten and fifteen years; and a similar 5.0% resided for between five and ten years. Five percent (5.0%) resided in their community for between three and five years and no one interviewed (0.0%) resided in the community for under two years.

On the issue of where healthcare was mostly obtained, 14.3% stated the public clinic, 64.3% stated the public hospital and 16.7% stated that healthcare needs were mostly sourced through the private doctor. Just over seven percent (7.1%) of interviewees stated the private hospital. As it pertained to the specific healthcare provider, the public hospital most referenced was the Cornwall Regional Hospital, while the health centre most referenced was the Catherine Hall Health Centre. It should be noted that percentages exceeded 100.0% as some respondents offered multiple responses.

As it related to whether respondents suffered from specific medical conditions, 7.1% of interviewees indicated that they were asthmatic, 14.3% indicated that they suffered from sinusitis, while 2.4% confirmed coughing as an ailment. No one interviewed (0.0%) indicated that they suffered from congestion/bronchial problems, chest pains or frequent bouts of diarrhoea. Approximately seventy-six (76.2%) percent of those interviewed indicated that they did not suffer from any of the specific conditions named.

Respondents in general, expressed some reluctance to disclose information pertaining to income. Of those interviewed, fifty-five percent (57.5%) of respondents refused to offer a response relating to their personal weekly income. Approximately thirteen percent (12.5%) of persons indicated that they did not have a weekly income, while no one (0.0%) indicated that their weekly income was under the national minimum wage of $9,000.00 per week. Ten percent (5.1%) of interviewees indicated that their weekly income was $9,000.00 per week; 10.0% also stated that their weekly income was between $9,001.00 and $12,000.00, while 5.0% stated a weekly income ranging between $12,001.00 and $20,000.00. Five percent (5.0%) indicated that their weekly income was in excess of twenty thousand dollars ($20,000.00) per week.

Regarding the highest level of education completed, 90.5% of those interviewed offered a response. Of this number 2.6% of persons stated that they did not attend any type of learning institution. Approximately twenty-four percent (23.7%) stated they completed primary/all age school, 5.2% stated that they started but did not complete high school, 47.4% completed high school, 5.3% college, 2.6% university and 13.2% HEART/Vocational Training Institution.

As it pertained to education, 52.5% of those interviewed stated that no one in the household was currently attending school while, 47.5% of interviewees indicated someone in the household was attending school. As it related to the school being attended 21.1% stated that the school being attended was infant/basic, 52.6% stated primary/all age, 52.6% stated high school, 21.1% stated college, 5.3% stated university while no one (0.0%) stated that HEART/a vocational training institute was the school being attended. It should be noted that percentages exceeded one hundred as multiple persons from households attend school.

When respondents were asked about the presence of recreational spaces in their community 5.0% of those offering a response indicated that a recreational space was present while 95.0% stated that no recreational space was present in the community. Recreational space named was:

- Green Space within community (informally used) (100.0%)

On the issue of respondents' awareness of a company named LCH Development Limited, 97.6% of interviewees offered a response. Of these persons 2.4% indicated that they heard of LCH Development Limited while 97.6% stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", 97.6% of survey participants offered a response. Approximately five percent (4.9%) of interviewees stated that they had heard of the project name while 95.1% stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 97.6% of interviewees offered a response. All respondents (100.0%) indicated that they did not know what the term "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 97.6% of participants responded. Just under ten percent (9.8%) of those interviewed stated that they were aware of the project while 90.2% stated that they were not aware of the project.

Of the 9.8% of interviewees confirming awareness of the proposed project:

- 25.0% stated that they were aware that the development would include residential villas, while 75.0% indicated that they were not aware
- 25.0% stated that they were aware that the development would include four residential towers, while 75.0% indicated that they were not aware
- all persons (100.0%) interviewed (0.0%) stated that they were not aware that the development would include buildings being up to twenty-eight (28) storeys tall
- 25.0% stated that they were aware that the development would include commercial spaces, while 75.0% indicated that they were not aware and 14.3% offered no response.
- 25.0% indicated social medial and 75.0% stated "word of mouth' as the medium by which they were made aware of the project.

When asked if there have been any problems/issues on the proposed development site 97.6% of interviewees offered a response. Twenty-two percent (22.0%) of interviewees stated that they were unaware of the site having problems/issues in the past, while 78.0% of persons stated that there were no problems/issues with the proposed site. None of the survey participants (0.0%) indicated that there have been problems/issues at the proposed site in the past.

As it related to respondents having any concerns pertaining to the proposed development project, 7.3% of those interviewed expressed uncertainty while, 65.9% of interviewees indicated that they did not have any concern while 26.8% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- The availability of work opportunities for local community members (9.1%)
- The structural integrity of the completed building(s) based on the site (soil type) (27.3%)
- Dust nuisance during the project construction phase (9.1%)
- Loss of the mangrove habitat (27.3%)
- Reduced water supply for existing communities/residential areas (18.2%)
- Traffic congestion (during construction and after construction) (9.1%)
- The technical competence of the developer to undertake the project (9.1%)
- Possible relocation/displacement of home/land owners (9.1%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked about possible suggestions to address highlighted concerns, the following suggestions were put forward:

LCH Development Limited should:

- Give locals (community residents and Jamaican Nationals) first preference for employment opportunities (9.1%)
- Wet the roads regularly during construction to mitigate dust nuisance (9.1%)
- Not destroy the entire mangrove habitat (9.1%)
- Not build at that location (18.2%)
- Produce proof of competence to build on this soil type (swampy land) (9.1%)
- Relocate home/ land owners who may be displaced (9.1%)

- No response offered (36.3%)

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 97.6% of interviewees offered a response. Of these individuals, 4.9% expressed uncertainty, 65.9% stated that they had no concerns, while 29.2% indicated that they were concerned about the height of the residential towers being 28-storeys.

Concerns highlighted were:

- The building height (of 28 storeys) will obstruct the aircraft flight path of the (Sir Donald Sangster International) Airport (25.0%)
- The ability and stability of the soil to accommodate the weight of the building (33.3%)
- 28-stoerys in height was too tall (16.7%)
- The residential towers will block/obstruct view (33.3%)

Percentages exceeded one hundred (100.0%) as multiple concerns were expressed by some participants.

Suggestions put forward to address highlighted concerns were:

LCH Development Limited should:

- Reduce the building height (33.3%)
- Reconfigure the residential towers to be less than 28-storeys while maintaining the same number of habitable housing units (8.3%)
- No suggestion offered (58.4%)

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity or recreation, 97.6% offered a response. Of these respondents, 9.8% of individuals confirmed that they depended on the proposed site while 90.2% stated that they did not depend on the site.

The 9.8% of respondents indicated that the proposed site was used for:

- Recreation (to include swimming, kayaking, paddle boarding) (25.0%)
- Fishing (25.0%)

- Crab hunting (50.0%)

On the issue of using the proposed marina area for any type of activity, 97.6% of interviewees offered a response. Of these individuals, 2.4% confirmed that they depended on the proposed marina area while 97.6% stated that they did not depend on this area.

The 2.4% of respondents indicated that the proposed marina area was used for:

- Fishing (100.0%)

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity or recreation 97.6% of survey participants responded. Approximately fifteen percent (14.6%) stated that they knew of persons who used the area, while 85.4% of respondents stated that they did not know of anyone who used the proposed location.

The purposes that these persons depended on/used the area for were stated as follows:

- Recreation (to include swimming, kayaking, paddle boarding) (16.7%)
- Fishing (16.7%)
- Crab hunting (50.0%)
- Docking boats (16.7%)
- Cattle rearing (16.7%)

Percentages exceeded 100.0% as some respondents stated that the area was used for used for multiple purposes.

On the issue of whether respondents thought the project would affect their life 97.6% of interviewees offered a response. Approximately Forty-nine percent (48.8%) of respondents indicated that the project would not affect their life in any way, while 31.8% were not sure if the project would affect their life. Of the 19.4% of persons anticipating some effect on their lives, 2.4% anticipated a negative impact, 14.6% anticipated a positive impact and 2.4% anticipated both a positive and negative impact from the project.

For those anticipating some positive effect, they anticipated:

- Increased opportunity to generate income (14.3%)
- Employment opportunity (71.4%)
- Community/National development (14.3%)

For those anticipating a negative effect, they anticipated:

- Increased traffic congestion (50.0%)
- Loss of view (caused by residential towers) (50.0%)
- Dust nuisance (50.0%)

Percentages exceeded 100.0% as some respondents anticipated multiple negative impacts.

When asked about possible suggestions to mitigate/address the anticipated negative impact, none (0.0%) of the persons interviewed offered a response.

Regarding whether respondents thought the project would affect their community 97.6% of interviewees offered a response. Just under twenty-seven percent (26.8%) stated that they were unsure if there would be an impact while 31.8% of individuals interviewed indicated that the project would not have any impact on the community. Approximately forty-one (41.4%) percent of respondents anticipated that the project would impact their community. Just over thirty-one percent (26.8%) of interviewees anticipated a positive effect and 14.6% anticipated a negative effect.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (72.7%)
- There will be community/national development (36.4%)

Percentages exceeded 100.0% as multiple responses were offered.

For those anticipating a negative effect on the community, the following were stated:

- Reduced water supply (16.7%)
- Community tradesmen will not be given employment opportunities (16.7%)
- Locals (nearby community residents) will not have access to the proposed commercial amenities as the development will be gated (16.6%)
- Loss/Obstruction of view (50.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Employ local (community) tradesmen (16.7%)
- Reconfigure the residential towers to be less than 28-storeys while maintaining the same number of habitable housing units (33.3%)
- No suggestions (50.0%)

As it pertained to whether respondents thought the project would affect the environment, 97.6% of persons interviewed offered a response. Approximately forty-four percent (43.9%) of respondents stated that the mixed-use residential development project would not have an impact on the environment, while 24.4% stated that they were unsure if there would be any impact. Just under thirty-two percent (31.7%) anticipated a negative effect while no one (0.0%) anticipated a positive effect.

For those anticipating a negative effect on the environment, the following were stated:

- Loss of wildlife and wildlife sanctuary/habitat (46.2%)
- Dust nuisance (during construction phase of project) (7.7%)
- Destruction of mangroves (46.2%)
- Increased potential for flooding and storm surge (30.8%)

Percentages exceeded 100.0% as multiple responses were offered.

When asked about possible suggestions to mitigate/address the anticipated negative impact on the environment, the following suggestions were put forward:

- Do not disturb mangrove habitat (to include no land reclamation or building within the area) (23.1%)
- Replant mangroves (15.4%)
- Wet roads during construction (7.7%)
- Consult with the government building regulatory agency (7.7%)
- Repurpose the mangrove area into an ecotourism attraction (7.7%)

Some respondents (38.4%) offered no suggestion regarding how the anticipated negative impact could be addressed.

As it related to housing 97.6% of interviewees offered responses. Approximately Sixty-six percent (65.9%) of respondents stated that they owned the house they lived in, 2.4% lived in rented homes, while 31.7% stated that they lived in family-owned homes. No one interviewed (0.0%) lived in leased, government owned housing or squatted in homes.

As it pertained to the land on which dwelling homes were located 97.6% of interviewees offered responses. Just under fifty-four percent (53.7%) of respondents stated that they owned the land on which the house is located, 2.4% stated that the land was leased, while 41.5% stated that their homes were built on family land, while 2.4% stated “other” and indicated that the home they lived in was rented but there was no arrangement made with respect to the land. No one interviewed (0.0%) squatted on or had their homes on government owned lands,

Regarding the type of wall that dwellings were made of 80.5% of interviewees indicated that the walls of their homes was made of concrete and blocks, while 19.5% stated wood/board.

Regarding the type of roof that dwellings had, 31.7% of respondents indicated that the roof of their homes was metal sheeting, while 61.0% stated concrete as the roof material. Just over seven percent (7.3%) of interviewees stated that their roofs were made of multiple materials, and specified metal sheeting and concrete as the materials. This was due to structural additions to increase habitable living space.

As it pertained to the type of toilet facility present 97.6% of respondents offered a response. Approximately ninety-three percent (92.7%) of respondents indicated that their homes had water closets, while 7.3% stated that pit latrine was the toilet facility.

As it related to what the household used for lighting 97.6% of respondents offered a response. Just under ninety-eight percent (97.6%) of interviewees stated that electricity was used while 2.4% stated kerosene oil was used for household lighting.

Regarding the type of fuel used mostly for cooking 97.6% of respondents offered a response. Approximately ninety-eight percent (97.6%) of persons interviewed indicated that gas was used mostly, while 2.4% stated that they mostly used wood for cooking.

On the issue of the main source of household domestic water supply 97.6% of respondents offered a response. Just under ninety-eight percent (97.6%) of respondents confirmed that their household domestic water supply was the public piped water supply, while 2.4% stated that household water was supplied from a spring or river.

As it pertained to respondents’ having any problems with the domestic water supply 97.6% of respondents offered a response, and 29.3% of those who responded indicated that there were problems with the water supply while 70.7% indicated that there were no problems with the domestic water supply. For those persons who confirmed that there were problems with the domestic water supply 8.3% stated that no pipes were run in the area, while 91.7% indicated that the water supply was irregular.

In response to how persons coped with problems related to domestic/household water supply, of those confirming that there were problems with supply, 8.3% stated that rainwater was harvested, 33.3% stated that they bought water, and 41.7% collected water from a spring/river. The remaining 16.7% of persons did not offer any specific information.

On the issue of access to a residential (fixed line/landline) telephone 97.6% of respondents offered a response. Approximately ninety-eight percent (97.6%) of interviewees indicated that they did not have access to a residential telephone while 2.4% confirmed that they had access. Of the 97.6% of persons indicating that they did not have a fixed line at their residence, all (100.0%) of these individuals indicated that they owned a mobile phone.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 97.6% of respondents offered a response. Approximately fifteen percent (14.6%) of respondents stated that they were not aware of fixed line service being in the community, while 56.1% stated that the community did not have fixed line service. Just over twenty-nine percent (29.3%) of interviewees stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 97.6% of respondents offered a response. Just under ninety-eight percent (97.6%) of those interviewed indicated that the public garbage truck was the main garbage disposal method, while 2.4% indicated that burning was the main method used to dispose of garbage.

Regarding the frequency of collections of the 97.6% of respondents who indicated that the garbage truck was the main method of garbage disposal, all persons (100.0%) indicated that garbage collections were done once per week.

When asked about flooding, 97.6% of respondents offered a response. Of these respondents all persons (100.0%) indicated that their community was not affected by flooding.

Regarding whether there were problems with frequent flooding at or near the proposed site 97.6% of respondents offered a response. Approximately eighty-one percent (80.5%) of interviewees, stated that the area was not affected by flooding, while 19.5% stated that they did not know if the area was affected. No one (0.0%) stated that the area was affected by flooding.

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 97.6% of interviewees offered a response. Twenty-two percent (22.0%) of respondents stated that they did not know if the area was affected while 75.6% stated that the area was not affected by tidal changes and 2.4% indicated that the area was affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 97.6% of interviewees offered a response. Just over seventeen percent (17.1%) of interviewees stated they did not know of any such area or site, 80.5% stated that no such area was located near to the proposed area while 2.4% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main place named was:

- The Montego Bay Marine Park

5.2.2.4 Tower Hill

Approximately eight percent (8.4%) of respondents were from the Tower Hill community. Just over seventy-one percent (71.4%) of respondents were male and 28.6% were female.

Age cohort distribution was as follows; 14.3% were 18-25 years of age, 21.4% were 26-33 years, no one (0.0%) was age 34-41 years, 28.6% were age 42-50 years, 14.3% were age 51-60 years and 21.4% were older than sixty years of age.

Of those persons interviewed who offered a response (100.0%), 50.0% indicated that they were self-employed, while 14.3% stated that they had an employer and 28.6% stated they were unemployed. Approximately seven percent (7.1%) of individuals were retired. Additionally, 57.1% of interviewees when asked confirmed that they were the head of their household while 42.9% indicated that they were not the household head.

Regarding the number of persons residing in households, just under thirty-six percent (35.7%) of households had one occupant. 28.6% had four persons living in the household while 35.7% of households had more than five persons residing. No household surveyed (0.0%) had two, three or five occupants.

In general, interviewees resided in their communities over the long term. Just over fifty-seven percent (57.1%) of individuals resided in their communities for all their life, and 214% resided in their community more than fifteen years. Approximately fourteen percent (14.4%) stated that they lived in their community for between ten and fifteen years. Just over seven percent (7.1%) resided in their community for between three and five years. No one interviewed (0.0%) resided in the community for between five and ten years. and for less than two years.

On the issue of where healthcare was mostly obtained, 28.6% stated the public clinic, 57.1% stated the public hospital and 35.7% stated that healthcare needs were mostly sourced through the private doctor. Just over seven percent (7.1%) of interviewees stated the private hospital. As it pertained to the specific healthcare provider, the public hospital most referenced was the Cornwall Regional Hospital, while the health centre most referenced was the Catherine Hall Health Centre. It should be noted that percentages exceeded 100.0% as some respondents offered multiple responses.

As it related to whether respondents suffered from specific medical conditions, 7.1% of interviewees indicated that they were asthmatic while 14.3% indicated that they suffered from sinusitis. No one interviewed (0.0%) indicated that they suffered from coughing, congestion/bronchial problems, chest pains or frequent bouts of diarrhoea. Approximately seventy-one (71.4%) percent of those interviewed indicated that they did not suffer from any of the specific conditions named. It should be noted that 7.2% of interviewees offered no response.

Respondents expressed some reluctance to disclose information pertaining to income. Of those interviewed, thirty-one percent (30.8%) of respondents refused to offer a response relating to their personal weekly income. Approximately fifteen percent (15.3%) of persons indicated that they did not have a weekly income, while 7.7% indicated that their weekly income was under the national minimum wage of $9,000.00 per week. Just over fifteen percent (15.4%) of interviewees indicated that their weekly income was $9,000.00 per week; a similar 15.4% stated that their weekly income was between $9,001.00 and $12,000.00, while 7.7% stated a weekly income ranging between $12,001.00 and $20,000.00. Approximately eight percent (7.7%) indicated that their weekly income was in excess of twenty thousand dollars ($20,000.00) per week.

Regarding the highest level of education completed, 100.0% of those interviewed offered a response. Of this number no one interviewed (0.0%) stated that they did not attend any type of learning institution. Approximately seven percent (7.2%) stated they completed primary/all age school, 14.3% stated that they started but did not complete high school, 35.7% completed high school, 21.4% college, 0.0% university and 21.4% HEART/Vocational Training Institution.

As it pertained to education, 50.0% of those interviewed stated that no one in the household was currently attending school while, 50.0% of interviewees indicated someone in the household was attending school. As it related to the school being attended 85.7% stated primary/all age while 57.1% stated high school. Of the persons interviewed no one in the household (0.0%) was attending infant/basic school, college, university, or HEART/a vocational training institute. It should be noted that percentages exceeded one hundred as multiple persons from households attend school.

When respondents were asked about the presence of recreational spaces in their community 21.4% of those offering a response indicated that a recreational space was present while 78.6% stated that no recreational space was present in the community. Recreational space named was:

- Green Space within community (informally used) (100.0%)

On the issue of respondents' awareness of a company named LCH Development Limited, 100.0% of interviewees offered a response and stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", all (100.0%) of survey participants offered a response and stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 100.0% of interviewees offered a response and indicated that they did not know what "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 100.0% of participants responded and stated that they were not aware of the project.

When asked if there have been any problems/issues on the proposed development site 100.0% of interviewees offered a response. Approximately fourteen percent (14.3%) of interviewees stated that they were unaware of the site having problems/issues in the past, while 85.7% of persons stated that there were no problems/issues with the proposed site.

As it related to respondents having any concerns pertaining to the proposed development project, 78.6% of interviewees indicated that they did not have any concern while 21.4% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- The availability of work opportunities for local community members (66.7%)
- Impact of the development project on the environment (33.3%)
- Community development projects/input by the project developers (33.3%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked about possible suggestions to address highlighted concerns, the following suggestions were put forward:

LCH Development Limited should:

- Give locals (community residents and Jamaican Nationals) first preference for employment opportunities (33.3%)
- Assist in building a community centre (community development) (33.3%)
- No suggestion offered (33.4%)

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 100.0% of interviewees offered a response. Of these individuals, 7.1% expressed uncertainty, 78.6% stated that they had no concerns, while 14.3% indicated that they were concerned about the height of the residential towers being 28-storeys.

Concerns highlighted were:

- The ability and stability of the soil to accommodate the weight of the building (100.0%)

- 28-stoerys in height was too tall (50.0%)

Percentages exceeded one hundred (100.0%) as respondents expressed multiple concerns.

Suggestions put forward to address highlighted concerns were:

LCH Development Limited should:

- Ensure that the building is structurally sound (50.0%)
- No suggestion offered (50.0%)

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity or recreation, 100.0% offered a response and stated that they did not depend on the site.

Similarly, on the issue of using the proposed marina area for any type of activity, 100.0% of interviewees offered a response stated that they did not depend on this area.

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity or recreation 100.0% of survey participants responded and stated that they did not know of anyone who used the proposed location.

On the issue of whether respondents thought the project would affect their life 100.0% of interviewees offered a response. Approximately seventy-one percent (71.4%) of respondents indicated that the project would not affect their life in any way, 14.3% were not sure if the project would affect their life, while 14.3% anticipated a positive impact from the project. No one (0.0%) anticipated a negative impact

For those anticipating some positive effect, they anticipated:

- Employment opportunity (50.0%)
- Home ownership opportunity (50.0%)
- Community/National development (50.0%)

Percentages exceeded 100 as some respondents anticipated multiple positive impacts.

Regarding whether respondents thought the project would affect their community 100.0% of interviewees offered a response. Just over fourteen percent (14.3%) stated that they were unsure if there would be an impact, 50.0% of individuals interviewed indicated that the project would not have any impact on the community while 35.7% anticipated a positive effect. No one interviewed (0.0%) anticipated a negative effect.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (60.0%)
- There will be community/national development (20.0%)
- Home ownership opportunity (20.0%)
- Easier access to commercial enterprises (20.0%)

Percentages exceeded 100.0% as multiple responses were offered.

As it pertained to whether respondents thought the project would affect the environment, 100.0% of persons interviewed offered a response. Approximately sixty-four percent (64.3%) of respondents stated that the mixed-use residential development project would not have an impact on the environment, 28.6% stated that they were unsure if there would be any impact, while 7.1% anticipated a negative effect. No one interviewed (0.0%) anticipated a positive effect.

For those anticipating a negative effect on the environment, the following was stated:

- Destruction of the mangroves (100.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact on the environment, the following suggestion was put forward:

- Do not disturb mangrove habitat (to include no land reclamation or building within the area) (100.0%)

As it related to housing 100.0% of interviewees offered responses. Approximately fifty-seven percent (57.2%) of respondents stated that they owned the house they lived in, 7.1% lived in rented homes, while 35.7% stated that they lived in family-owned homes. No one interviewed lived in lease or government owned housing or squatted in homes.

As it pertained to the land on which dwelling homes were located 100.0% of interviewees offered responses. Just under twenty-nine percent (28.7%) of respondents stated that they owned the land on which the house is located, 7.1% indicated that they squatted on the land, while 57.1% stated that their homes were built on family land, while 7.1% stated “other” and indicated that the home they lived in was rented but there was no arrangement made with respect to the land. No one interviewed (0.0%) had their homes on leased or government owned lands.

Regarding the type of wall that dwellings were made of 85.8% of interviewees indicated that the walls of their homes was made of concrete and blocks, 7.1% stated wood/board while 7.1% stated that walls were made of both concrete and blocks as well as wood/board. It should be noted that for respondents who indicated that the walls of their homes were made of both materials, this was mainly due to structural additions to increase habitable living space.

Regarding the type of roof that dwellings had, 21.4% of respondents indicated that the roof of their homes was metal sheeting, while 78.6% stated concrete.

As it pertained to the type of toilet facility present 100.0% of respondents offered a response and indicated that their homes had water closets

As it related to what the household used for lighting 100.0% of respondents offered a response and stated that electricity was used as the household lighting source.

Regarding the type of fuel used mostly for cooking 100.0% of respondents offered a response. Approximately ninety-three percent (92.9%) of persons interviewed indicated that gas was used mostly, while 7.1% stated that they mostly used wood for cooking.

On the issue of the main source of household domestic water supply 100.0% of respondents offered a response and confirmed that their household domestic water supply was the public piped water supply.

As it pertained to respondents’ having any problems with the domestic water supply 100.0% of respondents offered a response, and 21.4% of those who responded indicated that there were problems with the water supply while 78.6% indicated that there were no problems with the domestic water supply. For those persons who confirmed that there were problems with the domestic water supply all persons (100.0%) indicated that the water supply was irregular.

In response to how persons coped with problems related to domestic/household water supply, of those confirming that there were problems with supply,1000% stated that they bought water.

On the issue of access to a residential (fixed line/landline) telephone 100.0% of respondents offered a response. Approximately seventy-one percent (71.4%) of interviewees indicated that they did not have access to a residential telephone while 28.6% confirmed that they had access. Of the 71.4% of persons indicating that they did not have a fixed line at their residence 80.0% of these individuals indicated that they owned a mobile phone, while 10.0% stated that they did not own a mobile phone. Ten percent (10.0%) of these respondents offered no response.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 100.0% of respondents offered a response. Approximately forty-three percent (42.9%) stated that the community did not have fixed line service and 57.1% of interviewees stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 100.0% of respondents offered a response and indicated that the public garbage truck was the main garbage disposal method. These respondents also indicated that garbage collections were done once per week.

When asked about flooding, 100.0% of respondents offered a response and indicated that their community was not affected by flooding.

Regarding whether there were problems with frequent flooding at or near the proposed site 100.0% of respondents offered a response and further stated t the area was not affected by flooding.

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 92.9% of interviewees offered a response. Approximately fifteen percent (15.4%) of respondents stated that they did not know if the area was affected while 84.6% stated that the area was not affected by tidal changes. No one interviewed (0.0%) indicated that the area was affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 92.9% of interviewees offered a response. Just over ninety-two percent (92.3%) stated that no such area was located near to the proposed area while 7.7% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main place named was:

- The Bogue Lagoons & Fish Sanctuary

5.2.2.5 Spring Garden

Approximately four percent (4.2%) of respondents were from the Spring Garden community. Just under forty-three percent (42.9%) of respondents were male and 57.1% were female.

Age cohort distribution was as follows; 14.3% were 18-25 years of age, 14.3% were 26-33 years, 0.0% were age 34-41 years, 42.8% were age 42-50 years, 14.3% were age 51-60 years and 14.3% were older than sixty years of age.

Of those persons interviewed who offered a response (85.7%), 33.3% indicated that they were self-employed, while 50.0% stated that they had an employer and 16.7% stated they were unemployed. No surveyed individuals (0.0%) were retired. Additionally, 57.1% of interviewees when asked, confirmed that they were the head of their household while 42.9% indicated that they were not the household head.

Regarding the number of persons residing in households, 28.6% had three occupants, and 28.6% also had four persons living in the household, while 42.8% had more than five persons living in the household. No household surveyed (0.0%) had one, two or five household occupants.

In general, interviewees resided in their communities over the long term. Just over seventy-one percent (71.4%) of individuals resided in their communities for all their life, and 28.6% resided in their community more than fifteen years. No one interviewed (0.0%) resided in the community for fifteen years or less.

On the issue of where healthcare was mostly obtained, 28.6% stated the public clinic and 85.7% stated the public hospital. No one interviewed (0.0%) sought medical attention through the private doctor or private hospital. As it pertained to the specific healthcare provider, the public hospital most referenced was the Cornwall Regional Hospital, while the health centre most referenced was the Catherine Hall Health Centre. It should be noted that percentages exceeded 100.0% as some respondents offered multiple responses.

As it related to whether respondents suffered from specific medical conditions, 14.3% of interviewees indicated that they suffered from sinusitis. No one interviewed (0.0%) indicated that they suffered from asthma, coughing, congestion/bronchial problems, chest pains or frequent bouts of diarrhoea. Approximately eighty-six (85.7%) percent of those interviewed indicated that they did not suffer from any of the specific conditions named.

Respondents expressed some reluctance to disclose information pertaining to income. Of those interviewed, 42.8% of respondents refused to offer a response relating to their personal weekly income. Approximately twenty-nine percent (28.6%) of persons indicated that they did not have a weekly income> No one (0.0%) indicated that their weekly income was under the national minimum wage of $9,000.00 per week or that their weekly income was $9,000.00 per week. Approximately fourteen percent (14.3%) stated that their weekly income was between $9,001.00 and $12,000.00, while no one (0.0%) stated a weekly income ranging between $12,001.00 and $20,000.00. Approximately fourteen percent (14.3%) indicated that their weekly income was in excess of twenty thousand dollars ($20,000.00) per week.

Regarding the highest level of education completed, 100.0% of those interviewed offered a response. Of this number no one interviewed (0.0%) stated that they did not attend any type of learning institution. Approximately fourteen percent (14.3%) stated that they started but did not complete high school, 57.1% completed high school, 14.3% college, 14.3% university. None of the survey participants (0.0%) named primary/all age or HEART/Vocational Training Institution as the highest level of education completed.

As it pertained to education, 42.9% of those interviewed stated that no one in the household was currently attending school while, 57.1% of interviewees indicated someone in the household was attending school. As it related to the school being attended 75.0% stated primary/all age and 75.0% also stated high school as the school being attended. No one (0.0%) stated infant/basic, college, university or HEART/a vocational training institute as the school being attended. It should be noted that percentages exceeded one hundred as multiple persons from households attend school.

When respondents were asked about the presence of recreational spaces in their community 71.4% of those offering a response indicated that a recreational space was present while 28.6% stated that no recreational space was present in the community. Recreational space named was:

- Green Space within community (informally used) (100.0%)

On the issue of respondents' awareness of a company named LCH Development Limited, 100.0% of interviewees offered a response and stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", 100.0% of survey participants offered a response and all interviewees stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 100.0% of interviewees offered a response and indicated that they did not know what "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 100.0% of participants responded. Of these respondents 14.3% of those interviewed stated that they were aware of the project while 85.7% stated that they were not aware of the project.

Of the 14.3% of interviewees confirming awareness of the proposed project:

- 100.0% stated that they were aware that the development would include residential villas
- 100.0% stated that they were aware that the development would include four residential towers
- 100.0% stated that they were not aware that the development would include buildings being up to twenty-eight (28) storeys tall
- 100.0% stated that they were not aware that the development would include commercial spaces.
- 100.0% stated "word of mouth' as the medium by which they were made aware of the project.

When asked if there have been any problems/issues on the proposed development site 100.0% of interviewees offered a response. Approximately fourteen percent (14.3%) of interviewees stated that they were unaware of the site having problems/issues in the past, while 71.4% of persons stated that there were no problems/issues with the proposed site. Approximately fourteen percent (14.3%) of respondents indicated that there have been problems/issues at the proposed site in the past. Of this 14.3%, all individuals (100.0%) stated that the area was swampy reclaimed land.

As it related to respondents having any concerns pertaining to the proposed development project, 71.4% of interviewees indicated that they did not have any concern while 28.6% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- Loss of the mangrove habitat (50.0%)
- Proper disposal of sewage (50.0%)
- Traffic congestion (during construction and after construction) (50.0%)
- Affordability of the housing units to be constructed (50.0%)
- Flooding of other/adjacent areas post construction (50.0%)
- Access to the commercial spaces (e.g., Supermarket and mini food court) by the wider public (50.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked about possible suggestions to address highlighted concerns, the following suggestions were put forward:

LCH Development Limited should:

- Ensure houses are affordable for the working class (50.0%)
- Construct a new traffic corridor (bypass/overpass) that can accommodate the increased vehicular traffic (50.0%)
- Not build at that location (50.0%)
- Ensure that proper drainage systems are installed (50.0%)
- Construct a seawall/wave break (50.0%)

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 100.0% of interviewees offered a response. Of these individuals, 85.7% stated that they had no concerns, while 14.3% indicated that they were concerned about the height of the residential towers being 28-storeys.

Concern highlighted was:

- The ability and stability of the soil to accommodate the weight of the building (100.0%)

Although concern was expressed, no specific suggestions were made to address them.

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity or recreation, 100.0% offered a response. Of these respondents, 14.3% of individuals confirmed that they depended on the proposed site while 85.7% stated that they did not depend on the site.

The 14.3% of respondents indicated that the proposed site was used for:

- Playing football (soccer) (100.0%)

On the issue of using the proposed marina area for any type of activity, 100.0% of interviewees offered a response. Of these individuals, 14.3% confirmed that they depended on the proposed marina area while 85.7% stated that they did not depend on this area.

The 14.3% of respondents indicated that the proposed marina area was used for:

- Fishing (100.0%)

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity or recreation 100.0% of survey participants responded. Of these respondents 14.3% stated that they knew of persons who used the area, while 85.7% of respondents stated that they did not know of anyone who used the proposed location.

The purposes that these persons depended on/used the area for were stated as follows:

- Fishing (100.0%)

On the issue of whether respondents thought the project would affect their life 100.0% of interviewees offered a response. Of these persons 28.6% of respondents indicated that the project would not affect their life in any way, 28.6% were not sure if the project would affect their life and 42.8%. anticipated a positive impact from the project. No one interviewed (0.0%) anticipated a negative impact on their life.

For those anticipating some positive effect, they anticipated:

- Employment opportunity (100.0%)

Regarding whether respondents thought the project would affect their community 100.0% of interviewees offered a response. Of these respondents 42.9% of individuals interviewed indicated that the project would not have any impact on the community. Approximately fifty-seven (57.1%) percent of respondents anticipated that the project would impact their community. Just under forty-three percent (42.9%) of interviewees anticipated a positive effect and 14.2% anticipated a negative effect.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (100.0%)

For those anticipating a negative effect on the community, the following were stated:

- Reduced water supply (100.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, no suggestions were put forward.

As it pertained to whether respondents thought the project would affect the environment, 100.0% of persons interviewed offered a response. Just under eighty-six percent (85.7%) of respondents stated that the mixed-use residential development project would not have an impact on the environment, while 14.3% anticipated a positive effect. No one (0.0%) anticipated a negative impact on the environment.

For those anticipating a positive effect on the environment, the following was stated:

- Community Development (100.0%)

As it related to housing 100.0% of interviewees offered responses. Approximately seventy-one percent (71.4%) of respondents stated that they owned the house they lived in, while 28.6% stated that they lived in family-owned homes. No one interviewed (0.0%) lived in leased, rented or government owned housing, or squatted in homes.

As it pertained to the land on which dwelling homes were located 100.0% of interviewees offered responses. Just over fifty-seven percent (57.1%) of respondents stated that they owned the land on which the house is located, 14.3% indicated that they squatted on the land, while 28.6% stated that their homes were built on family land. No one interviewed (0.0%) had their homes on leased or government owned lands,

Regarding the type of wall that dwellings were made of 57.1% of interviewees indicated that the walls of their homes was made of concrete and blocks, 14.3% stated wood/board while 28.6% stated that walls were made of both concrete and blocks as well as wood/board. It should be noted that for respondents who indicated that the walls of their homes were made of both materials, this was mainly due to structural additions to increase habitable living space.

Regarding the type of roof that dwellings had, 71.4% of respondents indicated that the roof of their homes was metal sheeting, while 14.3% stated concrete and 14.3% of interviewees also stated that their roofs were made of multiple materials, and specified metal sheeting and concrete as the materials. This was due to structural additions to increase habitable living space.

As it pertained to the type of toilet facility present 100.0% of respondents offered a response and indicated that their homes had water closets.

As it related to what the household used for lighting 100.0% of respondents offered a response and stated that electricity was used as the household lighting source.

Regarding the type of fuel used mostly for cooking 100.0% of respondents offered a response and indicated that gas was used mostly for cooking.

On the issue of the main source of household domestic water supply 100.0% of respondents offered a response and confirmed that their household domestic water supply was the public piped water supply.

As it pertained to respondents' having any problems with the domestic water supply 100.0% of respondents offered a response, and 28.6% of those who responded indicated that there were problems with the water supply while 71.4% indicated that there were no problems with the domestic water supply. For those persons who confirmed that there were problems with the domestic water supply 50.0% indicated that the water supply was irregular. Fifty percent (50.0%) of individuals surveyed did not indicate the specific problem experience with domestic water supply.

In response to how persons coped with problems related to domestic/household water supply, of those confirming that there were problems with supply, 50.0% collected water from a spring/river. The remaining 50.0% of persons did not offer any specific information.

On the issue of access to a residential (fixed line/landline) telephone 100.0% of respondents offered a response. Of these respondents 85.7% of interviewees indicated that they did not have access to a residential telephone while 14.3% confirmed that they had access. Of the 85.7% of persons indicating that they did not have a fixed line at their residence 100.0% of these individuals indicated that they owned a mobile phone.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 100.0% of respondents offered a response. Approximately fifty-seven percent (57.1%) stated that the community did not have fixed line service while 42.9% of interviewees stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 100.0% of respondents offered a response and indicated that the public garbage truck was the main garbage disposal method and further indicated that garbage collections were done once per week.

When asked about flooding, 100.0% of respondents offered a response and indicated that their community was not affected by flooding,

Regarding whether there were problems with frequent flooding at or near the proposed site 100.0% of respondents offered a response. Approximately eighty-six percent (85.7%) of interviewees, stated that the area was not affected by flooding, while 14.3% stated that they did not know if the area was affected. No one interviewed (0.0%) stated that the area was affected by flooding

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 100.0% of interviewees offered a response. Just over fourteen percent (14.3%) of respondents stated that they did not know if the area was affected while 85.7% stated that the area was not affected by tidal changes. No one interviewed (0.0%) indicated that the area was affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 100.0% of interviewees offered a response. Just under eighty-five percent (85.7%) stated that no such area was located near to the proposed area while 14.3% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main places named were:

- The Bogue Lagoons & Fish Sanctuary
- The Mangroves

5.2.2.6 Reading

Approximately four percent (3.6%) of respondents were from the Reading community. Just under sixty-eight percent (66.7%) of respondents were male and 33.3% were female.

Age cohort distribution was as follows; 16.7% were 18-25 years of age, 16.7% were 26-33 years, 16.7% were age 34-41 years, 0.0% were age 42-50 years, 33.2% were age 51-60 years and 16.7% were older than sixty years of age.

Of those persons interviewed who offered a response (100.0%), 66.6% indicated that they were self-employed, while 16.7% stated that they had an employer, and no one interviewed (0.0%) stated they were unemployed. Approximately seventeen percent (16.7%) of individuals were retired. Additionally, 66.7% of interviewees when asked confirmed that they were the head of their household while 33.3% indicated that they were not the household head.

Regarding the number of persons residing in households, 16.7% of households had one occupant while 50.0% had two occupants, no household (0.0%) had three occupants and 33.3% had four persons living in the household. No household (0.0%) had five or more persons living in the household.

No one interviewed (0.0%) resided in their communities for all their life, while 40.0% resided in their community more than fifteen years. None of the survey participants (0.0%) stated that they lived in their community for between ten and fifteen years and for between five and ten years. Twenty percent (20.0%) resided in their community for between three and five years and 40.0% for under two years.

On the issue of where healthcare was mostly obtained, 16.7% stated the public clinic, 33.3% stated the public hospital and 66.7% stated that healthcare needs were mostly sourced through the private doctor. No one interviewed (0.0%) stated the private hospital. It should be noted that percentages exceeded 100.0% as some respondents offered multiple responses.

As it related to whether respondents suffered from specific medical conditions, 16.6% of interviewees indicated that they suffered from sinusitis, while 16.7% indicated that they suffered from congestion/bronchial problems. No one interviewed (0.0%) indicated that they suffered from asthma, coughing, chest pains or frequent bouts of diarrhoea. Approximately sixty-seven (66.7%) percent of those interviewed indicated that they did not suffer from any of the specific conditions named.

Of those interviewed, 16.6% of respondents refused to offer a response relating to their personal weekly income. Approximately seventeen percent (16.6%) of persons indicated that they did not have a weekly income, while 16.7% indicated that their weekly income was under the national minimum wage of $9,000.00 per week. Just under seventeen percent (16.7%) of interviewees also indicated that their weekly income was $9,000.00 per week, $9,001.00 and $12,000.00 per week and in excess of twenty thousand dollars ($20,000.00) per week. No one interviewed (0.0%) stated a weekly income ranging between $12,001.00 and $20,000.00 per week.

Regarding the highest level of education completed, 100.0% of those interviewed offered a response. Of this number none of the survey participants (0.0%) indicated that they did not attend any type of learning institution, attended primary/all age or attended college as the highest level of education. Just over thirty-three percent (33.3%) stated that they started but did not complete high school, 16.7% completed high school, 33.3% university and 16.7% HEART/Vocational Training Institution.

As it pertained to education, 66.7% of those interviewed stated that no one in the household was currently attending school while, 33.3% of interviewees indicated someone in the household was attending school. As it related to the school being attended 50.0% stated that the school being attended was infant/basic, 50.0% stated primary/all age. No one interviewed (0.0%) stated high school, college, university, or HEART/a vocational training institute was the school being attended.

When respondents were asked about the presence of recreational spaces in their community 16.7% of those offering a response indicated that a recreational space was present while 83.3% stated that no recreational space was present in the community. Recreational space named was:

- Clubhouse (within gated communities) (100.0%)

On the issue of respondents' awareness of a company named LCH Development Limited, 100.0% of interviewees offered a response. Of these persons 16.7% indicated that they heard of LCH Development Limited while 83.7% stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", 100.0% of survey participants offered a response and stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 100.0% of interviewees offered a response. Of these respondents 66.7% of respondents stated that they knew what the term meant while 33.3% indicated that they did not know what "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 100.0% of participants responded. Just over thirty-three percent (33.3%) of those interviewed stated that they were aware of the project while 66.7% stated that they were not aware of the project.

Of the 33.3% of interviewees confirming awareness of the proposed project:

- 100.0% stated that they were not aware that the development would include residential villas
- 50.0% stated that they were aware that the development would include four residential towers, while 50.0% indicated that they were not aware
- 50.0% stated that they were aware that the development would include buildings being up to twenty-eight (28) storeys tall, while 50.0% indicated that they were not aware
- 100.0% stated that they were not aware that the development would include commercial spaces.
- 50.0% stated "word of mouth' as the medium by which they were made aware of the project. The remaining 50.0% did not specify.

When asked if there have been any problems/issues on the proposed development site 100.0% of interviewees offered a response. Approximately thirty-three percent (33.3%) of interviewees stated that they were unaware of the site having problems/issues in the past, while 66.7% of persons stated that there were no problems/issues with the proposed site. None of the survey respondents (0.0%) indicated that there have been problems/issues at the proposed site in the past.

As it related to respondents having any concerns pertaining to the proposed development project, 16.7% of interviewees indicated that they did not have any concern while 83.3% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- Dust nuisance during the project construction phase (20.0%)
- Loss of the mangrove habitat (20.0%)

- The strain on the (existing) limited infrastructure in the area (e.g., water, public transportation) (20.0%)
- Traffic congestion (during construction and after construction) (20.0%)
- The development as proposed has a projected population too dense for the area (20.0%)
- Flooding of other/adjacent areas post construction (20.0%)
- Access to the commercial spaces (e.g., Supermarket and mini food court) by the wider public (40.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked about possible suggestions to address highlighted concerns, the following suggestions were put forward:

LCH Development Limited should:

- Wet the roads regularly during construction to mitigate dust nuisance (20.0%)
- Not build at that location (20.0%)
- Limit public access (20.0%)
- Allow public access to commercial enterprises (e.g., supermarket) (20.0%)
- Ensure that ingress and egress to and from the development merge with the main thoroughfare at already existing traffic signal intersections (D & G traffic signal intersection) (20.0%)
- Ensure proper land reclamation and compaction (20.0%)
- Enhance public transportation by developing an electric rail system (20.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 100.0% of interviewees offered a response. Of these individuals, 33.3% stated that they had no concerns, while 66.7% indicated that they were concerned about the height of the residential towers being 28-storeys.

Concerns highlighted were:

- The ability and stability of the soil to accommodate the weight of the building (50.0%)
- Risk of falling from heights (especially children) (25.0%)

- Accessing upper floor levels with heavy items (e.g., furniture) (25.0%)
- The capability of the emergency services to reach up to 28 floor levels (25.0%)
- The density of the development (25.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

Suggestions put forward to address highlighted concerns were:

LCH Development Limited should:

- Reduce the building height (25.0%)
- Not build on the site (25.0%)
- Reconfigure the residential towers to be less than 28-storeys while maintaining the same number of habitable housing units (25.0%)
- Have a roof-top helipad (on each tower) for emergency evacuation (25.0%)
- Reduce the size of the development (250%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity or recreation, 100.0% offered a response. Of these respondents, 33.3% of individuals confirmed that they depended on the proposed site while 66.7% stated that they did not depend on the site.

The 33.3% of respondents indicated that the proposed site was used for:

- Recreation (to include swimming, kayaking, paddle boarding) (100.0%)

On the issue of using the proposed marina area for any type of activity, 83.3% of interviewees offered a response. Of these individuals, 40.0% confirmed that they depended on the proposed marina area while 60.0% stated that they did not depend on this area.

The 40.0% of respondents indicated that the proposed marina area was used for:

- Recreation (to include swimming, kayaking) (50.0%)
- No response offered (50.0%)

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity or recreation 100.0% of survey participants responded. Approximately thirty-three percent (33.3%) stated that they knew of persons who used the area, while 66.7% of respondents stated that they did not know of anyone who used the proposed location.

The purposes that these persons depended on/used the area for were stated as follows:

- Recreation (to include swimming, kayaking, paddle boarding) (50.0%)
- Commercial boat tours (50.0%)

On the issue of whether respondents thought the project would affect their life 100.0% of interviewees offered a response. Of these respondents, 16.6% of respondents indicated that the project would not affect their life in any way, while 50.0% were not sure if the project would affect their life. Of the 33.4% of persons anticipating some effect on their lives, 16.7% anticipated a negative impact, and 16.7% anticipated both a positive and negative impact from the project.

For those anticipating some positive effect, they anticipated:

- Commercial amenities/resources in close proximity (100.0%)

For those anticipating a negative effect, they anticipated:

- Increased traffic congestion (50.0%)
- Strain on existing infrastructure (50.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Regulate traffic flow of the development with existing traffic signals (50.0%)
- Upgrade public transportation network/system (50.0%)

Regarding whether respondents thought the project would affect their community 100.0% of interviewees offered a response. Of the of individuals interviewed (16.7%) indicated that the project would not have any impact on the community. Approximately eighty-three (83.3%) percent of respondents anticipated that the project would impact their community. Fifty percent (50.0%) of interviewees anticipated a positive effect and 33.3% anticipated a negative effect.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (66.7%)

- There will be community/national development (66.7%)
- Increased community population (33.3%)

Percentages exceeded 100.0% as multiple responses were offered.

For those anticipating a negative effect on the community, the following were stated:

- Dust Nuisance (50.0%)
- Human impact associated with population increase/density (50.0%)

When asked about possible suggestions to mitigate/address the anticipated negative impact, the following suggestions were put forward:

- Reduce the population density of the proposed development project (50.0%)
- No suggestions (50.0%)

As it pertained to whether respondents thought the project would affect the environment, 83.3% of persons interviewed offered a response. Twenty percent (20.0%) of respondents stated that the mixed-use residential development project would not have an impact on the environment, while 20.0% also stated that they were unsure if there would be any impact. Sixty percent (60.0%) of interviewees anticipated an impact to the environment. Forty percent (40.0%) anticipated a negative effect while 20.0% anticipated a positive effect.

For those anticipating a positive effect on the environment, the following was stated:

- Community Development (100.0%)

For those anticipating a negative effect on the environment, the following were stated:

- Loss of wildlife and wildlife sanctuary/habitat (50.0%)
- Improper sewage disposal (50.0%)
- Loss/obstruction of view (50.0%)
- Marine contamination from the operations of the marina (50.0%)

Percentages exceeded 100.0% as multiple responses were offered.

When asked about possible suggestions to mitigate/address the anticipated negative impact on the environment, the following suggestion was put forward:

- Ensure proper management of the marina post construction (50.0%)

Some respondents (50.0%) offered no suggestion regarding how the anticipated negative impact could be addressed.

As it related to housing 100.0% of interviewees offered responses. Fifty percent (50.0%) of respondents stated that they owned the house they lived in, and 50.0% lived in rented homes. No one interviewed (0.0%) lived in leased, family owned, government owned housing or squatted in homes.

As it pertained to the land on which dwelling homes were located 100.0% of interviewees offered responses. Fifty percent (50.0%) of respondents stated that they owned the land on which the house is located, while 50.0% stated "other" and indicated that the home they lived in was rented but there was no arrangement made with respect to the land. No one interviewed (0.0%) squatted on or had their homes on, leased, family owned or government owned lands

Regarding the type of wall that dwellings were made of 100.0% of interviewees indicated that the walls of their homes was made of concrete and blocks.

Regarding the type of roof that dwellings had, 50.0% of respondents indicated that the roof of their homes was metal sheeting, while 50.0% also stated concrete as the roof material.

As it pertained to the type of toilet facility present 100.0% of respondents offered a response and indicated that their homes had water closets.

As it related to what the household used for lighting 100.0% of respondents offered a response and stated that electricity was used.

Regarding the type of fuel used mostly for cooking 100.0% of respondents offered a response and indicated that gas was used mostly.

On the issue of the main source of household domestic water supply 100.0% of respondents offered a response and confirmed that their household domestic water supply was the public piped water supply.

As it pertained to respondents' having any problems with the domestic water supply 100.0% of respondents offered a response, and 16.7% of those who responded indicated that there were problems with the water supply while 83.3% indicated that there were no problems with the domestic water supply. For those persons who confirmed that there were problems with the domestic water supply 100.0% stated that water pressure was low. However not specific information was given regarding how respondents coped with the problem of low water pressure.

On the issue of access to a residential (fixed line/landline) telephone 100.0% of respondents offered a response. Approximately sixty-seven percent (66.7%) of interviewees indicated that they did not have access to a residential telephone while 33.3% confirmed that they had access. Of the 66.7% of persons indicating that they did not have a fixed line at their residence 100.0% of these individuals indicated that they owned a mobile phone.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 100.0% of respondents offered a response. Approximately sixty-seven percent (66.7%) of respondents stated that they were not aware of fixed line service being in the community, while 16.6% stated that the community did not have fixed line service. Just under seventeen percent (16.7%) of interviewees stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 100.0% of respondents offered a response. Just over eighty-three percent (83.3%) of those interviewed indicated that the public garbage truck was the main garbage disposal method, while 16.7% indicated private collection.

Regarding the frequency of collections of the 83.3% of respondents who indicated that the garbage truck was the main method of garbage disposal, 100.0% indicated that garbage collections were done once per week.

When asked about flooding, 100.0% of respondents offered a response. Of these respondents 83.3% of respondents indicated that their community was not affected by flooding, while 16.7% stated that their community experienced frequent flood events. Of the 16.7% of survey participants confirming community flooding 100.0% stated that flooding occurred only in times of heavy rains.

Regarding the frequency of rain events resulting in community flooding, 100.0% of respondents stated a frequency of once in three months and further indicated that water levels were less than 0.3 metres (1.0 foot) in depth. No affected areas were named.

Regarding whether there were problems with frequent flooding at or near the proposed site 100.0% of respondents offered a response. Approximately seventy-five percent (66.7%) of interviewees, stated that the area was not affected by flooding, while 33.3% stated that they did not know if the area was affected. No one (0.0%) stated that the area was affected by flooding.

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 100.0% of interviewees offered a response. Of these respondents 66.6% stated that they did not know if the area was affected while 16.7% stated that the area was not affected by tidal changes and 16.7% indicated that the area was affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 100.0% of interviewees offered a response. Just over thirty-three percent (33.4%) of interviewees stated they did not know of any such area or site, 33.3% stated that no such area was located near to the proposed area while 33.3% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main places named was:

- The Montego Bay Marine Park

5.2.2.7 Freeport

Approximately two percent (1.8%) of respondents were from the Freeport community. Just under sixty-seven percent (66.7%) of respondents were male and 33.3% were female.

All persons interviewed (100.0%) in the Freeport community were older than sixty years of age. No one interviewed (0.0%) was between the ages of 18 and 60 years.

Of those persons interviewed who offered a response (100.0%), 66.7.7% stated that they had an employer while 33.3% indicated that they were retired. No one interviewed (0.0%) stated they were self-employed or unemployed. Additionally, when asked all survey participants confirmed that they were the head of their household.

Regarding the number of persons residing in households, just over thirty-three percent (33.4%) of households had one occupant while 33.3% had two occupants. A similar 33.3% of respondents had five persons living in the household. No household (0.0%) had three, four or more than five persons residing.

Survey participants resided in the Freeport community for between five and fifteen years. Fifty percent (50.0%) of resided in their communities for between five and ten years and 50.0% resided in the community for between ten and fifteen years. No one interviewed (0.0%) resided in the community for less than five years of for more than fifteen years.

On the issue of where healthcare was mostly obtained, none of the survey participants (0.0%) sought health care at the public clinic or public hospital. Approximately sixty-seven percent (66.7%) stated that healthcare needs were mostly sourced through the private doctor, while 33.3% of interviewees stated the private hospital.

As it related to whether respondents suffered from specific medical conditions, all respondents (100.0%) confirmed that they did not suffer from asthma, sinusitis, coughing, congestion/bronchial problems, chest pains or bouts of diarrhoea.

Pertaining to income, all survey participants (100.0%) indicated that their weekly income was in excess of twenty thousand dollars ($20,000.00) per week. No one interviewed (0.0%) stated a weekly income of less than $20,000.00 per week.

Regarding the highest level of education completed, all persons interviewed (100.0%) offered a response and stated university as the highest level.

As it pertained to education, 100.0% of those interviewed stated that no one in the household was currently attending school.

When respondents were asked about the presence of recreational spaces in their community all respondents (100.0%) indicated that a recreational space was present. Recreational spaces named were:

- Community Centre/Playing Field (33.3%)
- Clubhouse (within gated communities) (66.7%)

On the issue of respondents' awareness of a company named LCH Development Limited, 100.0% of interviewees offered a response. Of these persons 33.3% indicated that they heard of LCH Development Limited while 66.7% stated that they had not heard of that company name. When asked if they had heard of a project called "The Peninsula", 100.0% of survey participants offered a response. Approximately thirty-three percent (33.3%) of interviewees stated that they had heard of the project name while 66.7% stated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development", 100.0% of interviewees offered a response. Approximately sixty-seven percent (66.7%) of respondents stated that they knew what the term meant while 33.3% indicated that they did not know what "mixed use residential development" meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, 100.0% of participants responded. Of those interviewed, 66.7% stated that they were aware of the project while 33.3% stated that they were not aware of the project.

Of the 66.7% of interviewees confirming awareness of the proposed project:

- 100.0% stated that they were aware that the development would include residential villas
- 100.0% stated that they were aware that the development would include four residential towers
- 100.0% stated that they were aware that the development would include buildings being up to twenty-eight (28) storeys tall

- 50.0% stated that they were aware that the development would include commercial spaces, while 50.0% indicated that they were not aware
- 100.0% stated "word of mouth' as the medium by which they were made aware of the project.

When asked if there have been any problems/issues on the proposed development site 100.0% of interviewees offered a response. Approximately sixty-seven percent (66.7%) of interviewees stated that they were unaware of the site having problems/issues in the past, while 33.3% of persons stated that there were no problems/issues with the proposed site. No respondent (0.0%) indicated that there have been problems/issues at the proposed site in the past.

As it related to respondents having any concerns pertaining to the proposed development project, 33.3% of those interviewed expressed uncertainty while, 33.3% of interviewees indicated that they did not have any concern while 33.4% indicated that they had concerns with the project as proposed.

Concerns highlighted pertained to the following:

- Loss of the mangrove habitat (100.0%)
- Impact of the development project on the environment (100.0%)

Percentages exceeded 100.0% as some respondents expressed multiple concerns.

When asked about possible suggestions to address highlighted concerns, the following suggestion was put forward:

LCH Development Limited should:

- Consult with the government environmental regulatory agency (NEPA) (100.0%)

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, 100.0% of interviewees offered a response. Of these individuals, 66.7% stated that they had no concerns, while 33.3% indicated that they were concerned about the height of the residential towers being 28-storeys.

The concerns highlighted was:

- The capability of the emergency services to reach up to 28 floor levels (100.0%)

Although a concern was expressed, no suggestion was put forward to address the issue.

In response to whether there was dependence on/use of the proposed site (lands to include the beach area) for any type of business, activity, or recreation all survey participants (100.0%) responded and stated that they did not depend on the site.

Regarding dependence/use of the marina area for any type of business, activity or recreation, all respondents (100.0%) stated that they did not depend on this area.

When asked if they knew anyone who depends on/uses the proposed site for any type of business, activity or recreation 100.0% of survey participants responded and stated that they did not know of anyone who used the proposed location.

On the issue of whether respondents thought the project would affect their life 100.0% of interviewees offered a response. Approximately thirty-three percent (33.3%) of respondents indicated that the project would not affect their life in any way, while 66.7% anticipated a positive impact from the project.

For those anticipating some positive effect, they anticipated:

- Property appreciation (50.0%)
- Community/National development (50.0%)

Regarding whether respondents thought the project would affect their community 100.0% of interviewees offered a response. Just over thirty-three percent (33.3%) stated that the project would not have any impact on the community while 66.7% of interviewees anticipated a positive effect on the community.

For those interviewees anticipating a positive effect on the community, the following were stated:

- employment opportunities will be created (50.0%)
- There will be community/national development (50.0%)
- Property appreciation (50.0%)

Percentages exceeded 100.0% as multiple responses were offered.

As it pertained to whether respondents thought the project would affect the environment, 100.0% of persons interviewed offered a response. Of these 33.3% stated that they were unsure if there would be any impact while 66.7% anticipated a positive effect.

For those anticipating a positive effect on the environment, the following were stated:

- Community Development (100.0%)

As it related to housing 100.0% of interviewees offered responses. Approximately sixty-seven percent (66.7%) of respondents stated that they owned the house they lived in, while 33.3% lived in rented homes. No one interviewed (0.0%) lived in leased, family owned, or government owned housing or squatted in homes.

As it pertained to the land on which dwelling homes were located 100.0% of interviewees offered responses. Of these survey participants 66.7% of respondents stated that they owned the land on which the house is located while 33.3% stated that the land was leased and indicated that the home, they lived in was rented. No one interviewed (0.0%) had their homes on family owned or government owned lands or squatted on lands.

Regarding the type of wall that dwellings were made of, 100.0% of interviewees indicated that the walls of their homes was made of concrete and blocks.

Regarding the type of roof that dwellings had, 66.7% of respondents indicated that the roof of their homes was metal sheeting, while 33.3% stated concrete as the roof material.

As it pertained to the type of toilet facility present 100.0% of respondents offered a response and indicated that their homes had water closets.

As it related to what the household used for lighting 100.0% of respondents offered a response and stated that electricity was used as the household lighting source.

Regarding the type of fuel used mostly for cooking 100.0% of respondents offered a response and indicated that gas was used mostly for cooking.

On the issue of the main source of household domestic water supply 100.0% of respondents offered a response and confirmed that their household domestic water supply was the public piped water supply.

As it pertained to respondents' having any problems with the domestic water supply 100.0% of respondents offered a response and indicated that there were no problems with the domestic water supply.

On the issue of access to a residential (fixed line/landline) telephone 100.0% of respondents offered a response. Approximately sixty-seven percent (66.7%) of interviewees indicated that they did not have access to a residential telephone while 33.3% confirmed that they had access. Of the 66.7% of persons indicating that they did not have a fixed line at their residence 100.0% of these individuals indicated that they owned a mobile phone.

As it pertained to respondents' awareness of fixed line telephone service being in their community, 100.0% of respondents offered a response and stated that fixed line telephone service was present in the community.

Regarding the main method of garbage disposal for households 100.0% of respondents offered a response and indicated private collection was the main method used to dispose of garbage.

When asked about flooding, 100.0% of respondents offered a response and indicated that their community was not affected by flooding.

Regarding whether there were problems with frequent flooding at or near the proposed site 100.0% of respondents offered a response. Approximately thirty-three percent (33.3%) of interviewees, stated that the area was not affected by flooding, while 66.7% stated that they did not know if the area was affected.

On the issue of whether the proposed area was affected by tidal changes such as sea level rise or storm surge 1000% of interviewees offered a response. Of these respondents 66.7% stated that they did not know if the area was affected while 33.3% stated that the area was not affected by tidal changes.

Regarding whether there was any site nearby considered to be a protected area, historic area or area of national, historic or environmental importance, 100.0% of interviewees offered a response. Just over thirty-three percent (33.3%) of interviewees stated they did not know of any such area or site, while 66.7% indicated that there was an area/site considered to be a protected area or area of historic, national, or environmental importance.

The main places named were:

- The Montego Bay Marine Park
- The Bogue Lagoons & Fish Sanctuary

5.2.3 Stakeholder Consultations

During the period May 17 - 25, 2022, the Montego Bay Marine Park Trust and the National Fisheries Authority were contacted to garner stakeholder feedback in relation to the proposed project.

Following telephone and email communication, survey instruments were disseminated electronically as this option was preferred instead of in-person interviews. One (1) completed survey instrument was received from the Montego Bay Marine Park Trust. No responses were received from the National Fisheries Authority.

It should be noted that the Montego Bay Marine Park Trust and the National Fisheries Authority (Western/Montego Bay Region) have a small staff complement, therefore it was expected that stakeholder participation would be few in number.

5.2.3.1 Montego Bay Marine Park Trust

On the issue of awareness, The Montego Bay Marine Park Trust (MBMPT) indicated that the organisation had never heard of a company named LCH Development Limited. When asked if they had heard of a project called "The Peninsula" it was also indicated that they had never heard of any project by that name.

Regarding respondents understanding the term "Mixed-Use Residential Development the representative of the MBMPT stated that they knew what the term meant.

As it pertained to respondents' awareness of the proposal by LCH Development to construct a mixed-use residential development in the Reading Pen area of Montego Bay, it was stated that they were not aware of the project.

When asked if there have been any problems/issues on the proposed development it was stated that the MBMPT was unaware of the site having problems/issues in the past.

The Montego Bay Marine Park Trust indicated that they had concerns pertaining to the proposed development project.

Concerns expressed related to:

- Sewage disposal
- Loss of wildlife
- Loss of mangroves

When asked about possible suggestions to address highlighted concerns, the MBMPT suggested that:

LCH Development Limited should:

- Preserve a space for wildlife
- Reserve the mangroves around the shoreline
- Have (prospective) tenants agree to care for an eco-space
- Implement a recycling system

When asked if there were concerns about the residential towers being twenty-eight (28) storeys tall, uncertainty was expressed by the Montego Bay Marine Park Trust.

It was confirmed by the MBMPT, that the organisation, (which manages the protected areas comprising the Marine Park) used the proposed site (lands/beach area). It was explained that the beach area of the proposed site is within the Bogue Lagoons which is a protected area, and as such is a protected area for all marine life, bird life and mangroves.

On the issue of using the proposed marina area, no response was offered.

When asked if the organisation knew anyone who depends on/uses the proposed site for any type of business, activity or recreation no response was offered.

When asked about the possible impact of the proposed development on:

- The organisation in general
- The core functions of the organisation,
- The environment
- The Montego Bay Marine Park
- The Bogue Lagoons (Bogue Island Lagoons Special Fishery Conservation Area)

a similar response was offered. A negative impact was anticipated. It was expressed that the Montego Bay Marine Park Trust will be perceived as ineffective in preserving protected areas. It was suggested that the anticipated negative impact could be resolved if:

- LCH Development adheres to and supports the efforts of the Marine Park Trust in dealing with preservation, (public) education and protection against illegal fishing, commercial marine-based activities in the Bogue Lagoons.
- LCH Development supports the efforts of the Marine Park trust in dealing with construction (in/along the Bogue Lagoons), wastewater and noise pollution.

When asked about the possible impact of the proposed development on Airport Point (Montego Bay Marine Park Special Fishery Conservation Area), the Marine Park Trust indicated that the entity was not sure if there would be an impact.

No response was offered as it regarded whether the proposed development would affect fish and wildlife and associated ecosystems.

No responses were received as in relation to:

- Whether the proposed site was affected by flooding
- Whether the proposed site was affected by tidal change

6.0 IDENTIFICATION AND ASSESSMENT OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION MEASURES

6.1 SITE CLEARANCE/ CONSTRUCTION

6.1.1 Physical

6.1.1.1 Geotechnical

Based on the subsurface conditions obtained from the field exploration, Horizon Construction Jamaica Ltd recommended using deep foundation for all the structures of the new development. The presence of soft and susceptible to liquefaction layers near the surface may require the use of deep foundation to support all the structures.

Recommended Mitigation

It was recommended that Continuous Flight Auger (CFA) Piles be used; Table 6-1 presents the general allowable axial and lateral loads (pile lengths for piles with 40, 60 and 80 cm in diameter) recommended for this project.

Table 6-1 Recommended Axial/Lateral Loads for CFA Piles

Dia. [m]	Depth [m]	Allowable Axial [ton]	Allowable Lateral [ton]
0.4	24	90	6
0.6	24	140	12
	30	180	
0.8	24	190	22
	30	245	

The allowable axial/lateral loads for each boring was calculated from the ground floor elevation; Figure 6-1 presents axial capacity contour maps of the different diameters and length. Piles shall have a minimum separation of three (3) diameter between centres and be drilled with continuous flight augers using the CFA methodology. The piles shall be constructed in a sequence such that no adjacent piles are drilled nearer five diameters from those casted less than 12 hours.

Fluid mortar shall be pumped using the “tremie” methodology through the augers, filling the hole from the tip as the augers are withdrawn. The tip of the auger shall be at all times submerged into the fresh mortar during the pumping process. The drill rig must be equipped with instrumentation to continuously record the drilling and pumping key variables to ensure the construction of a sound pile.

The Continuous Recording System must record the pressure of mortar and the volume injected continuously, and the operator must adjust the rate of withdrawal of the auger to ensure that positive pressure in the mortar is maintained at all times and that the volume injected exceeds the theoretical volume.

Fluid mortar shall have a compressive strength f'c = 280 Kg/cm2, with at least 11-inch slump and maximum aggregate size of 4 mm (sand) with no gravel. It is recommended to carry out Pile Integrity Tests PIT (ASTM D5882) to minimum of 25% of the total amount of the production piles and Dynamic Load Tests with PDA (ASTM D4945) to at least 3% of the total of piles. An experienced geotechnical engineer shall supervise the construction of these piles.

For the design of the Jetty foundations, there were some limitations, of the Geotechnical study conducted by Horizon Construction Jamaica Limited (2022) such as:

1. All the borehole investigations were conducted on land. Consequently, the data was extrapolated in order to determine the soil conditions at the project area.
2. The maximum depth of the geotechnical investigations was 30m. No bedrock was found at this depth.

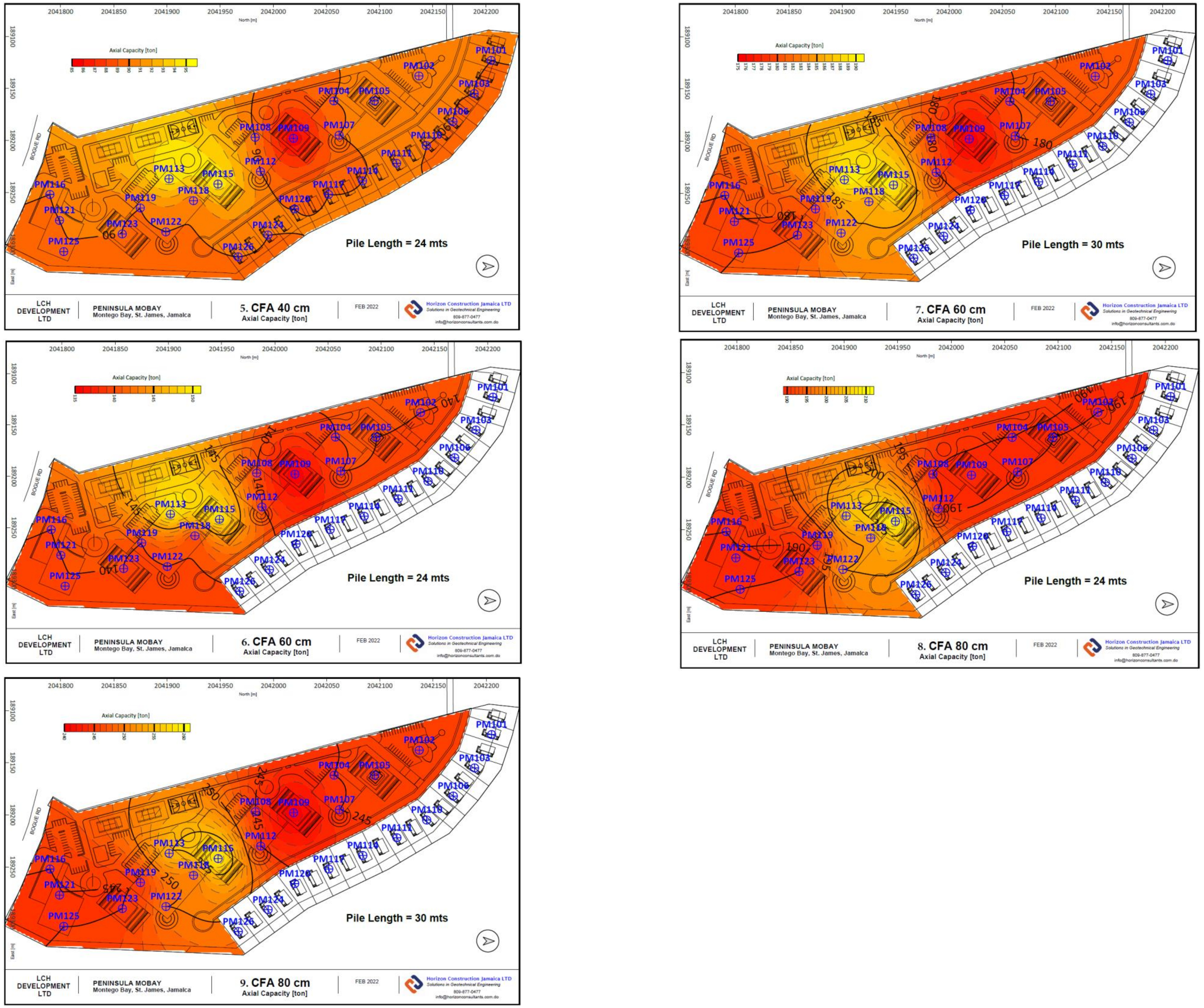


Figure 6-1 Axial capacity contour maps of the different diameters and length

6.1.1.2 Stormwater Discharge and Water Quality

Raw materials, for example marl used for filling and temporary roads, will be stored on site and used in various construction processes and may be prone to increased suspended solids from run-off as a result of rainfall events, and thus have the potential to increase marine water turbidity. Stored fuels, lubricants, hazardous substances, and the repair of construction equipment have the potential to leak hydraulic fuels, oils, etc and thereby have the potential to compromise water quality as well.

Plume Dispersion Model Results

The primary objective of this evaluation was to determine the impacts on water quality in the bay and project area based on site-specific runoff and stormwater discharge from adjacent drainage features. The evaluation considers the dispersion of total suspended solids and heavy metal concentration from the existing drainage features and likely site-specific outfalls.

In the construction phase, the existing drainage infrastructure and the temporary drains on the Peninsula were considered sources of contaminants in the bay. This scenario would be a worst-case scenario. The proposed development produces a significantly higher TSS reading during the construction phase relative to the operational phase. The scenario examined a 2 RP rainfall event over 24 hours, and the effects that the runoff would have on the marine environment were modelled with the respective plume dispersion models.

The runoff from the site-specific catchment was assumed only to contribute to the environment's total suspended solids as the sheet flows pick up loose silt sand and construction material then deposits into the nearshore area. This runoff forms a turbid plume as the turbidity from the ambient environment mixed with the added TSS from the site. The TSS concentration at the site is estimated to be 1000 mg /l based on the flow scenario, soil type, and the catchment's land use. It is also important to note that although the site-specific concentration of TSS is high, the runoff is relatively low compared with the drains in the area. The Discharge rate from the site is about 1m^3/ s at both the western and eastern sides of the proposed development.

The plume is generated at both sides of the Peninsula as the highest concentration of 360 mg/l at the shoreline. It then quickly dissipates to a 300m wide plume with TSS values ranging from 10 - 50 mg/l TSS returns to ambient conditions. The estimated turbidity of the plume is 15 - 65 NTU. This means the water is noticeably cloudy and slightly opaque, making that area unsightly and mildly dangerous to marine life in the short term. The TSS in the area dissipates within 12 hrs to match ambient standards. Therefore, the impacts of plumes will have no lasting impacts on the water quality as the turbidity dissipates within a day after the rainstorm. It is also important to note that this scenario does not take into account the implementation of best management practices and when implemented adequately, the TSS falls significantly.

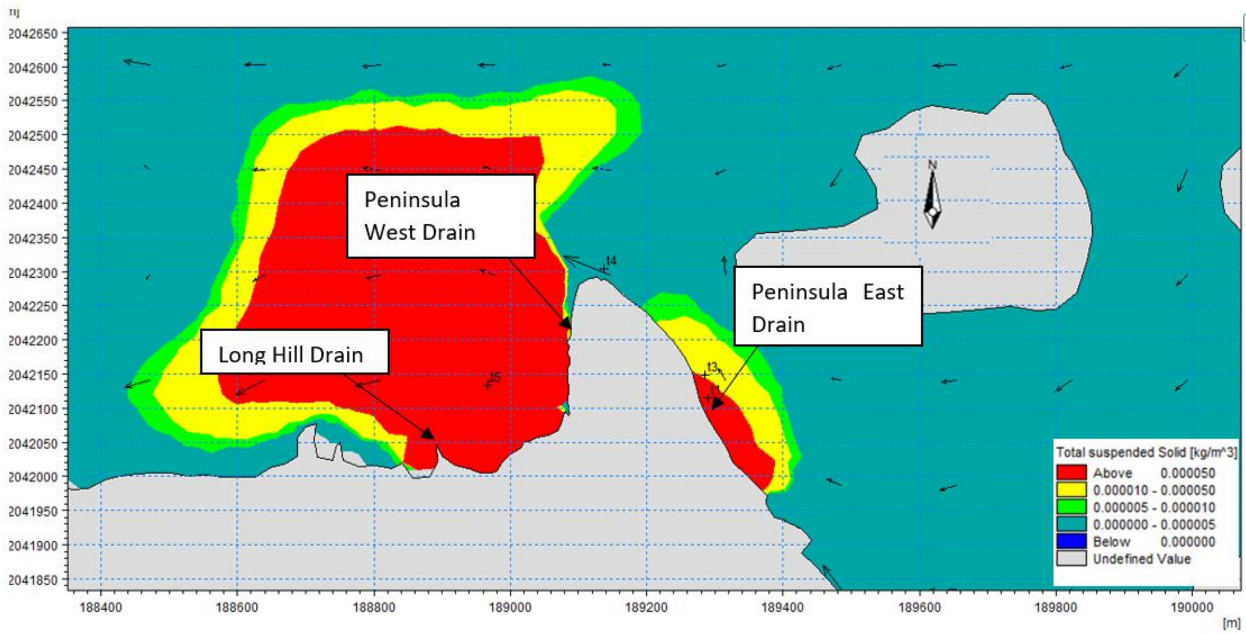


Figure 6-2 TSS plume at peak runoff during construction

Recommended Mitigation

i. The project site will put in sediment control measures such as turbidity barriers/silt screens and should be erected around the active work area to prevent the dispersion of sediments and contaminants throughout the water column.
ii. A central area will be designated for the storage of raw materials. This area should be lined in order to prevent the leakage of chemicals into the sediment.
iii. Fine grained materials (sand, marl, etc.) will be stockpiled away from drainage channels and low berms will be placed around the piles which themselves will be covered with tarpaulin to prevent them from being eroded and washed away. Silt fences may also be utilized to prevent siltation.
iv. Stoppage of works during adverse weather conditions
v. Raw materials that generate dust should be covered or wetted frequently to prevent them from becoming air or waterborne.
vi. Raw material and equipment should be stored on impermeable hard stands surrounded by berms to contain any accidental surface runoff.
vii. Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored. In addition, these containers should be surrounded by bunds to contain the volume being stored in case of accidental spillage.
viii. Refuelling of boats should only be done at anchor out at sea if the sea conditions are calm, otherwise, all refuelling should be done when docked at land. Appropriate refuelling equipment (such as funnels) and techniques should always be used.
ix. Appropriate minor spill response equipment (for containment and clean- up) will kept on site, including oil absorbent pads and disposal bags.

x. In terms of transporting equipment, the paths of the planned roadways will be used, rather than creating temporary pathways just for equipment access.
xi. Raw materials such as marl and sand should be adequately covered within the trucks to prevent any escaping into the air and along the roadway.
xii. Vehicle refuelling facilities must be situated on impermeable surfaces served by an oil trap, run-off collection system. Sediment basins and oil water separators should be constructed to intercept storm water before it is discharged.

6.1.1.3 Noise

Site clearance necessitates the use of heavy equipment to carry out the job, including bulldozers, backhoes, jackhammers, etc. These activities and required equipment possess the potential to have a direct negative impact on the noise climate.

Construction noise can result in short-term impacts of varying duration and magnitude. The construction noise levels are a function of the scale of the project, the phase of the construction, the condition of the equipment and its operating cycles, the number of pieces of construction equipment operating concurrently. To gain a general insight into potential construction noise impacts that may result from the project, the typical noise levels associated with various types of construction equipment are identified in Table 6-2.

Table 6-2 Typical construction equipment noise levels

Type of Equipment	Typical Sound Level at 50 ft. (dBA Leq.)
Dump Truck	88
Portable Air Compressor	81
Concrete Mixer (Truck)	85
Jackhammer	88
Scraper	88
Bulldozer	87
Paver	89
Generator	76
Piledriver	101
Rock Drill	98
Pump	76
Pneumatic Tools	85
Backhoe	85

Adapted from - Route 101A Widening and Improvements, City of Nashua Hillsborough County, New Hampshire; McFarland-Johnson, Inc. May 30, 2007

RECOMMENDED MITIGATION

i. Use equipment that has low noise emissions as stated by the manufacturers.
ii. Use equipment that is properly fitted with noise reduction devices such as mufflers.
iii. Operate noise-generating equipment during regular working hours (e.g. 7 am – 7 pm) to reduce the potential of creating a noise nuisance during the night.
iv. Construction workers operating equipment that generates noise should be equipped with noise protection. A guide is workers operating equipment generating noise of ≥ 80 dBA (decibels) continuously for 8 hours or more should use earmuffs. Workers experiencing prolonged noise levels 70 - 80 dBA should wear earplugs.

6.1.1.4 Air Quality

Site preparation comprises various activities such as excavation and land clearing (digging, loading and removal of material by trucks), as well as the storage of raw materials (for example sand and marl) that may potentially have a two-fold direct negative impact on air quality. The first impact is air pollution generated from the construction equipment and transportation of materials. The second is fugitive dust from the proposed construction areas and raw materials stored on or transported to site (potential for materials to become airborne). Fugitive dust has the potential to affect the health of construction workers, the resident population and the vegetation.

RECOMMENDED MITIGATION

i. Areas should be dampened every 4-6 hours or within reason to prevent a dust nuisance and on hotter days, this frequency should be increased.
ii. Minimize cleared areas to those that are needed to be used.
iii. Cover or wet construction materials such as marl to prevent a dust nuisance.
iv. Where unavoidable, construction workers working in dusty areas should be provided and fitted with N95 respirators.

6.1.1.5 Vibration

Various governmental agencies have criteria regarding architectural and structural damage, as well as annoyance and acceptability of vibration. In general, most of the criteria specify that for a Peak Particle Velocity (PPV) less than approximately 3.048 mms-1 (0.12 inches per second), the potential for architectural damage due to vibration is unlikely. A PPV of approximately 3.048 mms-1 (0.12 inches per second) to 12.7 mms-1 (0.50 inches per second) there is potential for architectural damage due to vibration, and for a PPV greater than approximately 12.7 mms-1 (0.50 inches per second) the potential for architectural damage due to vibration is very likely.

Vibrations from various types of equipment have been measured by the Federal Transit Administration (FTA) in the United States. The data in Table 6-3 provides a reasonable estimate for a wide range of soil conditions and were obtained from measurements on several projects including the Central Artery/Tunnel Project in Boston and from several published sources including the FTA Manual and Dowding's Textbook.

To predict the vibration at a receptor from the operation of the equipment listed in Table 6-3, the following equation is used:

$$\mathbf{PPV_{equipment} = PPV_{ref}\,(100/D_{rec})^{n}}$$

Where:

PPV_{ref} = reference PPV at 100 ft.
D_{rec} = distance from equipment to the receiver in ft.
n = 1.1 (the value related to the attenuation rate through ground)

Table 6-3 Equipment Vibration Emission Levels

Equipment Description	Vibration Type Steady or transient	Ref PPV at 100 ft.
Auger Drill Rig	Steady	0.011125
Backhoe	Steady	0.011
Bar Bender	Steady	N/A
Boring Jack Power Unit	Steady	N/A
Chain Saw	Steady	N/A
Compactor	Steady	0.03
Compressor	Steady	N/A
Concrete Mixer	Steady	0.01
Concrete Pump	Steady	0.01
Concrete Saw	Steady	N/A
Crane	Steady	0.001
Dozer	Steady	0.011
Dump Truck	Steady	0.01
Excavator	Steady	0.011
Flat Bed Truck	Steady	0.01
Front End Loader	Steady	0.011
Generator	Steady	N/A
Gradall	Steady	0.011
Grader	Steady	0.011
Horizontal Boring Hydraulic Jack	Steady	0.003
Hydra Break Ram	Transient	0.05
Impact Pile Driver	Transient	0.2
Insitu Soil Sampling Rig	Steady	0.011125
Jackhammer	Steady	0.003
Mounted Hammer hoe ram	Transient	0.18975
Paver	Steady	0.01
Pickup Truck	Steady	0.01
Pneumatic Tools	Steady	N/A
Scraper	Steady	0.000375
Slurry Trenching Machine	Steady	0.002125
Soil Mix Drill Rig	Steady	0.011125
Tractor	Steady	0.01
Tunnel Boring Machine (rock)	Steady	0.0058
Tunnel Boring Machine (soil)	Steady	0.003
Vibratory Pile Driver	Steady	0.14
Vibratory Roller (large)	Steady	0.059
Vibratory Roller (small)	Steady	0.022
Welder	Steady	N/A
Concrete Batch Plant	Steady	N/A
Pumps	Steady	N/A
Blasting	Transient	0.75
Clam Shovel	Transient	0.02525
Rock Drill	Steady	0.011125
3-ton truck at 35 mph	Steady	0.0002

Construction activities can result in various degrees of ground vibration; this is dependent on the type of equipment used and the methodologies employed. Vibration has the potential to interfere with persons normal routines/activities. This can become more acute if the surrounding community has no understanding of the extent and duration of the construction. This can lead to misunderstandings if the contractor is insensitive although they may believe they are in compliance with the required conditions/ordinances.

The closest receptors to the proposed development is the Friendly Irons Shooting Range located 40 m to the east and the commercial area located 90m to the south across the Bogue Main Road. The vibration impact was predicted on this structure with the use of ten (10) primary pieces of construction equipment/activities. Construction vibration impact readings are displayed in Table 6-4.

Results show that persons occupying the Friendly Irons Shooting Range located 40 m away would barely perceive any vibrations from the majority of the construction activities/equipment. However, the vibratory pile driver and the vibratory roller have the highest vibration emission of all the equipment listed. Vibration from this equipment is considered unacceptable for people exposed to it continuously (pile driver) and in the case of the roller, vibrations may become annoying to persons (see Table 6-5 for descriptive effects for different levels of vibration). From a building standpoint, there is no effect on the shooting range from vibration emissions from the majority of the construction equipment including the roller, however pile driving has the potential to cause damage to weak or sensitive structures.

For persons occupying the commercial area across the road, located 90 m away, vibrations from the majority of construction equipment would be imperceptible. Vibrations from the roller and pile driver would become annoying if continuous. From a building standpoint, there is no effect on the commercial buildings from vibration emissions from construction.

Table 6-4 Predicted vibration levels at closest receptors in PPV mm/sec

CONSTRUCTION EQUIPMENT	RECEPTOR VIBRATION (PPV mm/sec)	
	Friendly Irons Shooting Range (40 m)	Commercial Buildings south of development (90 m)
Pile Driver (Vibratory)	2.64	1.08
Vibratory Roller	1.11	0.45
Bulldozer	0.21	0.08
Excavator	0.21	0.08
Jack Hammer	0.06	0.02
Back Hoe	0.21	0.08
Loaded Dump Truck	0.19	0.08
Frontend Loader	0.21	0.08
Grader	0.21	0.08
Paver	0.19	0.08

The effects of construction vibration (both on humans and buildings) is summarized in Table 6-5.

Table 6-5 Effects of Construction Vibration

PEAK PARTICLE VELOCITY (mm/sec)	EFFECTS ON HUMANS	EFFECTS ON BUILDINGS
< 0.127	Imperceptible	No effect on buildings
0.127 – 0.381	Barely perceptible	No effect on buildings
0.508 – 1.27	Level at which continuous vibrations begin to annoy in buildings	No effect on buildings
2.54 – 12.7	Vibrations considered unacceptable for people exposed to continuous or long-term vibration.	Minimal potential for damage to weak or sensitive structures
12.7 – 25.4	Vibrations considered bothersome by most people, however tolerable if short-term in length	Threshold at which there is a risk of architectural damage to buildings with plastered ceilings and walls. Some risk to ancient monuments and ruins.
25.4 – 50.8	Vibrations considered unpleasant by most people	U.S. Bureau of Mines data indicates that blasting vibration in this range will not harm most buildings. Most construction vibration limits are in this range.
>76.2	Vibration is unpleasant	Potential for architectural damage and possible minor structural damage

Recommended Mitigation

iv. Sequence of operations:
   - Phase earth-moving and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be significantly less when each vibration source operates separately.
   - Avoid night-time activities. People are more aware of vibration during the night-time hours.

v. Avoid impact pile driving where possible in vibration-sensitive areas. Drilled piles or vibratory pile driving causes lower vibration.

vi. Have regular meetings or devise a communication strategy to inform the surrounding residents and businesses of construction activities.

6.1.2 Biological

6.1.2.1 Mangrove Community

Mangrove Loss

There will be no removal or clearing of mangrove trees along the eastern boundaries of the project property. There will however be some pruning of mangrove trees in these locations to ensure the building footprints do not encroach on the mangroves.

The proposed development may result in the loss of approximately 269.6 m^2 (0.0269 hectares) of mangrove forest as a result of the jetty construction toward the north-western property boundary (Figure 6-3).

The loss of 0.0269 hectares of mangrove forest equates to the release of 0.03 tonnes of carbon or 0.11 tonnes CO_2 equivalent per year (Siikamaki, et al., 2012) (Table 6-6). In other words, the mangroves to be lost are responsible for sequestering 0.11 tonnes of CO_2/yr.

Table 6-6 Carbon stock and burial by mangroves

	Per hectare on average, globally (Siikamaki, et al., 2012)		Proposed Project	
	t C	*t CO_2e*	*t C*	*t CO_2e*
Biomass	147.5	540.8	3.96	14.54
Soil	319.0	1169.7	8.58	31.46
Total stock	466.5	1710.5	12.54	46.01
Annual accumulation	1.15	4.22	**0.03**	**0.11**

t C (tonnes of Carbon); t CO_2e (tonnes of CO_2 equivalent)

RECOMMENDED MITIGATION

i. Rehabilitation of 269.6 m^2 of mangrove toward the east of the property where there is an existing area of thinning mangrove. This area should be filled with sand and then rehabilitated with mangrove saplings.
ii. An arborist with experience in the pruning of mangrove trees must be consulted and contracted by the developer, to conduct an assessment of the areas to be pruned and develop a pruning methodology to ensure the continued survival of the trees.
iii. Signage indicating no removal of main mangrove tree trunks, as well as conservation/educational signage along the impact areas.
iv. Perimeter fencing around pruned mangroves

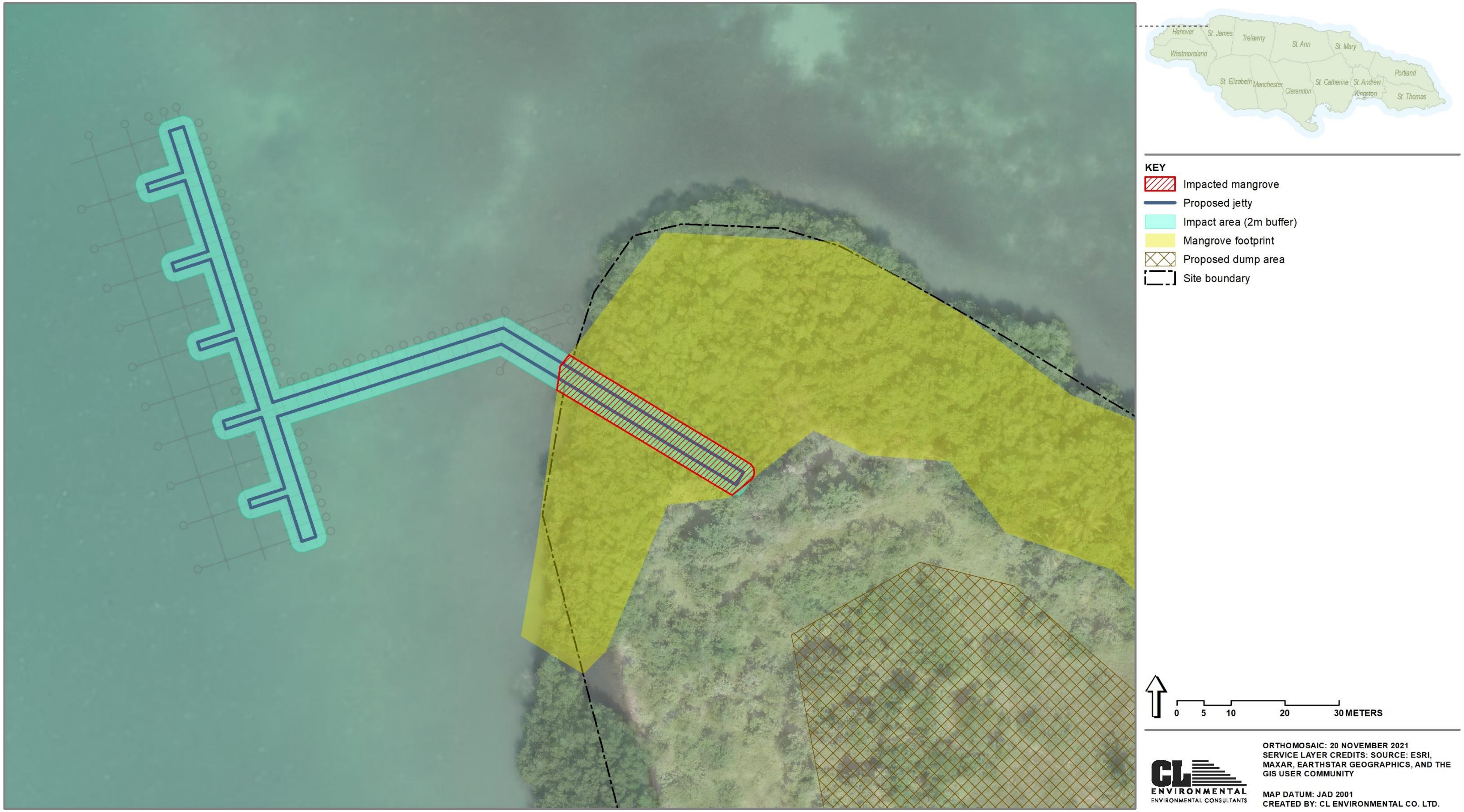


Figure 6-3 Mangrove potentially impacted by construction of jetty

6.1.2.2 Non-Mangrove Vegetation

None of the species encountered during this study have any special conservation status and none are listed as rare in Jamaica.

6.1.2.3 Fauna

None of the amphibians and reptiles encountered in the study have any special conservation status and none are listed as rare in Jamaica. None of the butterflies or arthropods encountered are considered to have special conservation needs.

None of the bats encountered has special protection status or is deemed endangered. During the study, no bat roosts, including trees, caves, or rock holes, were encountered in the project area.

Recommended Mitigation

Given the possibility of the presence of crocodiles within the project area, the contractors and construction crew should be aware of their surroundings. The site should be fenced, and signage should be placed around the site informing and educating construction crews about the possibility of crocodiles and what to do if one is observed. Any sighting of a crocodile in the area at any stage of the project should be reported to the National Environment and Planning Agency (NEPA).

Several of the trees should be incorporated into the development where possible. Trees should also be planted to encourage birdlife in the area after the development.

6.1.2.4 Marine Environment

The surrounding benthic community including seagrass, fish, urchins and other invertebrates may be impacted by sedimentation and smothering, habitat fragmentation/loss, increased water turbidity and suspended solids and some species loss. As a result, the following mitigation measures should reduce the potential impact to the biological environment.

Primary Mitigation Measures

1. During construction, the project site should include sediment control measures such as turbidity barriers/silt screens and should be erected around the entire work area to prevent the dispersion of sediments and contaminants throughout the water column. These should be placed so as to reduce/contain the resultant sediment plume during the activities. Construction activities should only continue when these barriers are fully operational, that is; placed correctly; calm to moderate sea conditions; without damage. These barriers are particularly important when operations occur near or may influence sensitive ecosystems and species such as coral reefs and seagrass beds and or filter feeding organisms and fish.

2. Weekly monitoring of water quality parameters such as temperature, salinity, pH, Dissolved Oxygen, light irradiance, turbidity and Total Suspended Solids (TSS) in and around the project area should be conducted during construction for the first 3 months of construction. Monitoring can be conducted fortnightly thereafter.

3. Conduct sediment dispersal calculation rates in seagrass beds within 200 meters of the jetty and at control stations, on a monthly basis, for comparison to background levels. Pre-construction sedimentation rates should therefore also be conducted and used as a baseline for comparison.

4. All activities should be limited to the minimal working area, and as such reducing the extent of the footprint. No activities and or placement of anchors or materials should be done placed outside the approved area.

5. Relocation of sensitive species should be done if; they are suitable for relocation (that is suitable substrate, health and over all viability), those species fall within the potential impact area; and if mobile invertebrates are in or around the potential impact area. Sensitive organisms and systems in and outside the impact area include; hard and soft corals, sponges, seagrass and mobile invertebrates such as urchins, sea cucumbers, starfish and conch. Detailed Seagrass Removal and Relocation Plans, if required, as well as a Post-Relocation Monitoring Plan, must be prepared for approval by NEPA.

6. Alternative mitigations should be proposed when relocation is unlikely to be successful.

7. Where possible, as little of the natural environment should be relocated or removed. Habitat fragmentation and species displacement should be temporary, with the placement of silt screens, construction materials and equipment as well as general human activity in the area.

8. Structures placed on the seafloor may cause habitat fragmentation and displace some species, however they may also serve to add ecological volume, providing substrate for organisms to settle and colonize and eventually may serve some ecosystem functions.

9. Any temporary floating structures and /or vessels should be placed in areas with less sensitive species where possible. Floating structures anchored or moored over seagrass beds or coral colonies should not be left for prolonged time periods as the resulting shading effects may cause deterioration in overall health of the seagrass bed and coral colonies.

Seagrass

Sections of the jetty and marine works may impact nearshore seagrasses. Seagrass in this area is sparse and any species loss is expected to be minimal.

Construction activities associated with the development and beach works may result in the mortality of seagrasses and associated biota within the project footprint. Seagrasses and associated biota around the project area but not directly within the footprint may also be affected by sedimentation and smothering from construction activities. The main potential impacts to the marine environment as a result of site preparation and construction activities are; Species loss/displacement, habitat loss/fragmentation, excess sedimentation and reduced water quality.

Recommended Mitigation: See Primary Mitigation Measures 1-9 above

Fish and Invertebrates

Site preparation and construction activities may result in the temporary loss and/or displacement of any fish/invertebrate species and habitat. The excess sedimentation may result in clogging of fish gills and may result in their death. There may be a reduction in food supply as a result of reduced water quality and the resultant changes in the plankton composition.

Recommended Mitigation: See Primary Mitigation Measures 1-4 above.

Sea Turtles

Site preparation and construction activities may result in the temporary displacement of any sea turtles that utilize the general area for foraging and nesting. Displacement may occur as a result of; silt screens and other barriers and equipment being utilized, this may prevent/limit access to various habitats and pathways (fragmentation).

Nesting turtles maybe particularly sensitive to varying and increased noise (Wendy E.D Piniak, 2016). Studies carried show that turtle have auditory cues however the impact of noise on their ecology is not fully known. The turtle activity in the area is carefully monitored. No turtles were seen during the survey, however mitigations should be implemented as they may forage in or nearby the proposed development.

Lighting used during any night-time construction activities has the potential to interfere with nesting and navigation of some species.

RECOMMENDED MITIGATION

i. Attempts should be made to schedule the majority of the construction period outside of turtle nesting season (May – October).

ii. All staff and workers should be sensitized to all sensitive ecosystems and species in the area, in particular turtles. The site should be inspected daily for any signs of turtle activity. If a nest is suspected or found, all activity nearby should stop until an expert can determine if there is a nest and how to relocate the eggs.

iii. The stakeholders, proponents and the NEPA should develop clear lines of reporting and communication in the event that action needs to be taken.

iv. Silt screens should be used to prevent sedimentation but should be removed promptly along with any other construction debris and material upon completion.

v. Night-time activities should be limited or avoided when possible. No lights should be pointed out to sea confusion and disorientation of turtles or any other species that maybe affected by lunar activity.

vi. Fixtures in direct line-of-sight from the beach should be shielded down-light only fixtures or recessed fixtures having low wattage "bug" type bulbs and non-reflective interior surfaces.

vii. Fixtures mounted as low in elevation as possible through use of low-mounted wall fixtures, low bollards and ground level fixtures.

viii. Floodlights, up-lights or spotlights for decorative and accent purposes that are directly visible from the beach or which indirectly or cumulatively illuminate the beach shall not be used.

ix. For high intensity lighting applications such as providing security and similar applications shielded low-pressure sodium vapour lamps and fixtures shall be used.

6.1.3 Socioeconomic/Cultural

6.1.3.1 Employment

The work force for the site will at peak time be approximately 1,000 trade men and labourers and during construction. This should create indirect and induced jobs during construction. This represents a significant level of employment within the study area and has the potential to be a significant positive impact. It is anticipated that some labourers will be from sourced from nearby communities.

Mitigation

No mitigation required.

6.1.3.2 Solid Waste Generation and Disposal

During this construction phase of the proposed project, solid waste generation may occur mainly from general construction activities including site clearance and excavation.

The USEPA estimates from surveys of non-residential construction that the average rate of solid waste generation is 22.95 Kg/square metre (or 1.6 to 8.5 lb/ft^2 (5.05 lb/ft^2))[3]. With an estimated 147,212.60 m^2 (1,584,583 ft^2) of building floor area, then the estimated construction solid waste is 3,629.71 tonnes. Figure 6-4 and Table 6-7 shows the typical breakdown of this waste.

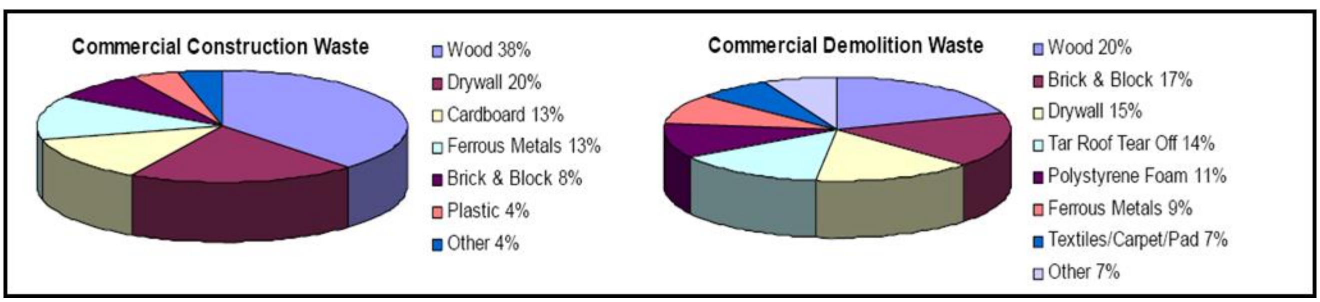


Figure 6-4 Composition of construction and demolition waste [4]

[3] Estimating 2003 Building Construction and Demolition Material, USEPA

[4] "Construction and Demolition Waste Management Toolkit," WasteCap Wisconsin, June 2005

Table 6-7 Estimated construction solid waste generation

BUILDING SIZE		1,584,583 ft2	1,584,583 ft2		
GENERATION RATE		**LOW 1.6 lb/ft²**	**HIGH 8.5 lb/ft²**		
MATERIAL	**COMPOSITION (%)**	**LBS**	**LBS**	**LOW TONNES**	**HIGH TONNES**
Wood	38	963,426.46	5,118,203.09	437.003	2321.576
Drywall	20	507,066.56	2,693,791.10	230.001	1221.882
Cardboard	13	329,593.26	1,750,964.22	149.501	794.2234
Ferrous	13	329,593.26	1,750,964.22	149.501	794.2234
Brick/Block	8	202,826.62	1,077,516.44	92.0005	488.7528
Plastic	4	101,413.31	538,758.22	46.0003	244.3764
Other	4	101,413.31	538,758.22	46.0003	244.3764
TOTAL	100	2,535,332.80	13,468,955.50	1150.01	6109.41
AVERAGE		8,002,144.15		**3,629.71**	

RECOMMENDED MITIGATION

i. A Solid Waste Management Plan will be done and is to be approved by the National Environment and Planning Agency (NEPA) and the National Solid Waste Management Authority (NSWMA).
ii. Skips and bins should be strategically placed within the campsite and construction site.
iii. The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour.
iv. The skips and bins at both the construction campsite and construction site should be emptied regularly to prevent overfilling.
v. Disposal of the contents of the skips and bins should be done at an approved disposal site – Retirement Disposal Site, St. James.

6.1.3.3 Wastewater Generation and Disposal

With every construction site comes the need to provide construction workers with sanitary conveniences. Portable toilets and the disposal of same have the potential to contaminate the marine environment in the event of accidental spillage.

Mitigation

i. Provision and maintenance of portable sanitary conveniences for the construction workers for control of sewage waste by a licenced contractor. A ratio of approximately 25 workers per chemical toilet should be used.
ii. Portable toilets should be located at a distance away from the shoreline to avoid discharge into the marine environment in the event of accidental spillage.

6.1.3.4 Vending and Food Hygiene

The establishment of a construction site may cause a proliferation of “cook shops” (food vendors) to provide the construction workers with meals. Improper food preparation and the failure to practice proper hygiene can result in certain pathogens entering the food supply and cause food borne illness. Food borne illness often presents itself as flu likes symptoms such as nausea, vomiting, diarrhoea or fever. This will also have a negative visual effect on the proposed construction site.

Mitigation

i. Provision of adequate supply of potable water.
ii. The monitoring of the various “cook shops” by public health authorities and the construction management team, to ensure proper hygiene is being followed.
iii. The provision of areas to adequately wash hands and utensils.

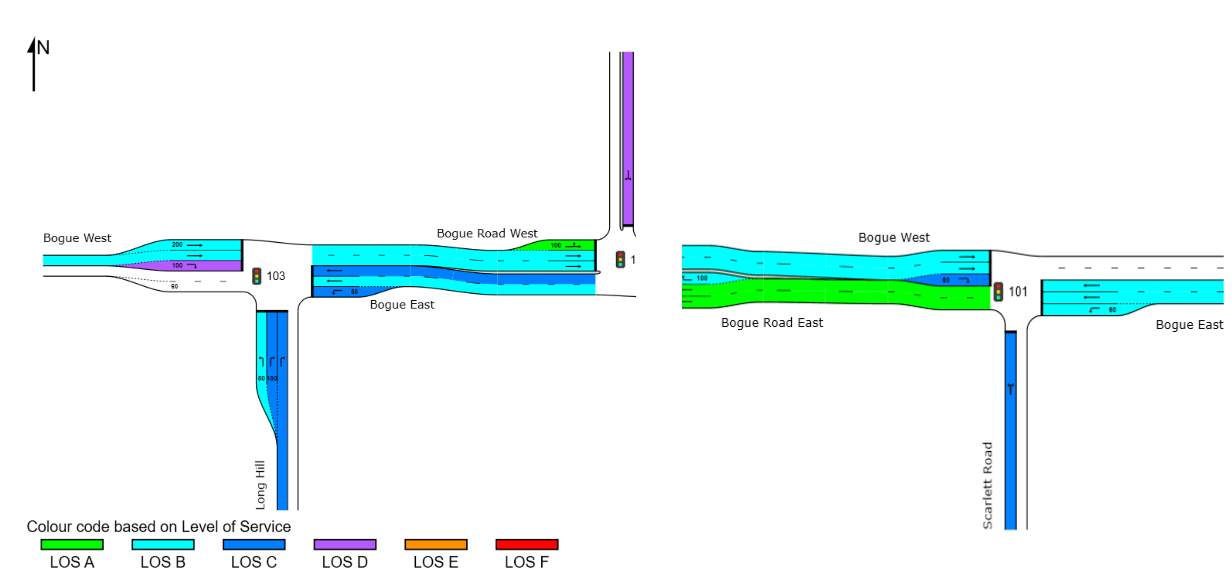
6.1.3.5 **Traffic**

Traffic Volumes

During the construction phase, it was estimated that approximately 64 trips would occur during the AM peak hour, with 20% of them being within the Heavy Vehicle (HV) category. The trips were then distributed using a 7:3 ratio between West (Montego Bay) and East (Long Hill and Hanover) respectively. Analysis of the Construction Phase conditions took into account the scenarios of including a signalized intersection at the entrance of the site and a no adjustment approach that would require motorists coming from the East to make a U-turn at the Bogue/Long Hill Intersection to access the site.

During Construction with signalized turn.

Analysis of the during construction phase, with the insertion of a signalized intersection, saw similar intersection delays as the existing stage, where delays in the high flow volume directions did not exceed 30.4 seconds. By introducing an additional intersection, it must be noted that the overall time to traverse the segment of road between the Scarlett road and Long Hill may be increased. However, the negative impacts of not having a controlled intersection far exceed the signalized delays. (See U-turn scenario).



Segment A	Segment B

Figure 6-5 Showing Level of Service of Roadway Network between Scarlett Road and Long Hill

Table 6-8 showing the movement performance at the Bogue/Long Hill Intersection for the AM peak Hour for during Construction scenario (signalized)

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Long Hill												
1	L2	13	0	0.02	15.9	LOS B	0.1	1	0.55	0.63	0.55	40.7
3	R2	729	4	0.71	30.4	LOS C	7	50.8	0.93	0.83	0.93	27.5
Approach		742	4	0.71	30.1	LOS C	7	50.8	0.92	0.83	0.92	27.8
East: Bogue East												
4	L2	408	5	0.61	27.4	LOS C	6.6	48	0.79	0.82	0.79	41.9
5	T1	421	8	0.45	21.4	LOS C	4.5	33.3	0.68	0.7	0.68	45.4
Approach		828	7	0.61	24.3	LOS C	6.6	48	0.73	0.76	0.73	43.6
West: Bogue West												
11	T1	770	6	0.38	10.3	LOS B	4.6	34	0.6	0.52	0.6	39.2
12	R2	37	3	0.24	39.9	LOS D	0.8	5.6	0.94	0.72	0.94	32.2
Approach		807	6	0.38	11.7	LOS B	4.6	34	0.62	0.53	0.62	38.4
All Vehicles		2377	5	0.71	21.8	LOS C	7	50.8	0.75	0.7	0.75	37.3

Table 6-9 showing the movement performance at the Bogue/Peninsula (Development Entrance) Intersection for the AM peak Hour for during Construction

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
East: Bogue Road East												
5	T1	827	6.6	0.3	3.3	LOS A	2.8	20.9	0.35	0.3	0.35	70
6	R2	45	12	0.15	15.4	LOS B	0.4	3	0.65	0.73	0.65	48.2
Approach		872	6.8	0.3	3.9	LOS A	2.8	20.9	0.36	0.33	0.36	67
North: Peninsula Road												
7	L2	6	67	0.08	40.1	LOS D	0.2	1.9	0.93	0.66	0.93	30
9	R2	2	50	0.08	39.9	LOS D	0.2	1.9	0.93	0.66	0.93	24.2
Approach		8	63	0.08	40	LOS D	0.2	1.9	0.93	0.66	0.93	29
West: Bogue Road West												
10	L2	16	13	0.13	15.5	LOS B	1.5	11	0.55	0.48	0.55	52.7
11	T1	1485	4.8	0.63	12	LOS B	10.5	76.3	0.76	0.68	0.76	63.3
Approach		1501	4.8	0.63	12	LOS B	10.5	76.3	0.75	0.68	0.75	63.1
All Vehicles		2381	5.8	0.63	9.1	LOS A	10.5	76.3	0.61	0.55	0.61	63.7

Table 6-10 Showing the movement performance at the Bogue/Scarlett Road Intersection for the AM peak Hour for during Construction

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Scarlett Road												
1	L2	51	19	0.38	28.2	LOS C	2.2	17.8	0.87	0.77	0.87	28.5
3	R2	85	19	0.38	28.2	LOS C	2.2	17.8	0.87	0.77	0.87	37.9
Approach		136	19	0.38	28.2	LOS C	2.2	17.8	0.87	0.77	0.87	35.2
East: Bogue East												
4	L2	75	23	0.07	10.5	LOS B	0.4	3.5	0.32	0.68	0.32	51.8
5	T1	823	6	0.57	19.8	LOS B	6	43.8	0.82	0.78	0.82	43
Approach		898	7	0.57	19	LOS B	6	43.8	0.78	0.78	0.78	44.1
West: Bogue West												
11	T1	1448	4	0.67	13.6	LOS B	11.2	81.6	0.89	0.8	0.89	48.8
12	R2	45	24	0.28	34.8	LOS C	0.8	6.6	0.91	0.72	0.91	33.4
Approach		1492	5	0.67	14.3	LOS B	11.2	81.6	0.89	0.8	0.89	48.1
All Vehicles		2526	7	0.67	16.7	LOS B	11.2	81.6	0.85	0.79	0.85	46.2

During Construction with forced U-turn

In the scenario, with the forced U-turn, significant negative impacts were observed at the Bogue/Long Hill Intersection. Delays of up to 162 seconds were noted for motorists in the right most lane of traffic heading westward. This is as a result of the slow-moving traffic that would be generated by vehicles attempting to make the U-turn. This manoeuvre and its resulting traffic also has a trickledown effect. The model output expresses am increase in degree of saturation in the aforementioned lane, this implies that its capacity for vehicle flow per signal cycle has dropped. As a result, motorists are expected to instinctively transfer lanes in attempt to reduce their waiting time, especially if heading west. This may occur at inopportune times and further impede the safe flow of traffic.

Delay times from the South on Long Hill Road also increased. This was noted with a drop in LOS for traffic heading to Montego Bay from LOS C to LOS F. This is attributable to the actuated signal attempting to compensate for vehicles making the U-turn.

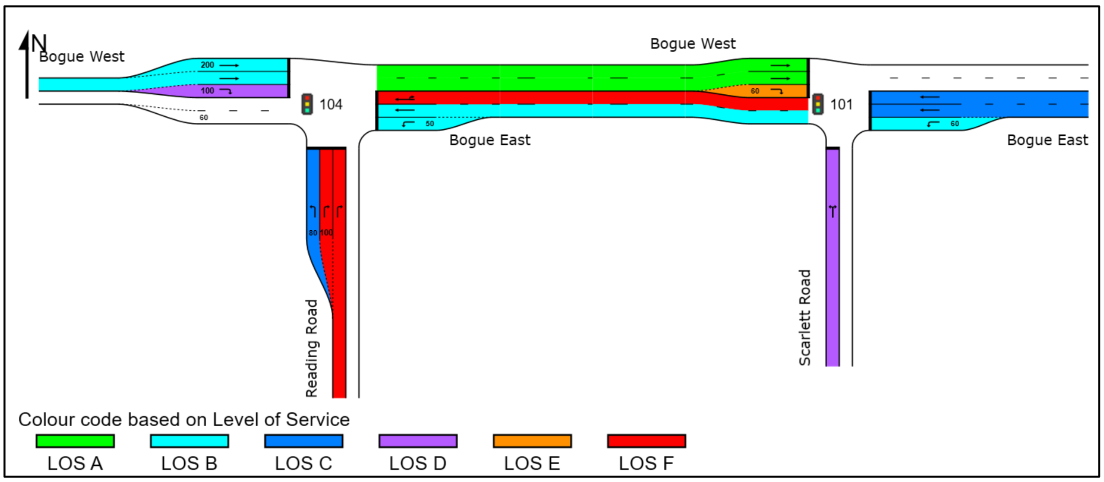


Figure 6-6 Showing Level of Service of Roadway Network between Scarlett Road and Long Hill with forced U-turn to access site.

Table 6-11 showing the movement performance at the Bogue/Long Hill Intersection for the AM peak during the construction phase.

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Reading Road												
1	L2	13	0	0.02	23.6	LOS C	0.2	1.7	0.57	0.63	0.57	37.5
3	R2	729	3.9	1.11	159.7	LOS F	22.8	165	1	1.33	2	9.2
Approach		742	3.8	1.11	157.3	LOS F	22.8	165	0.99	1.32	1.97	9.4
East: Bogue East												
4	L2	408	5.3	0.5	14.9	LOS B	4.1	30	0.32	0.71	0.32	48.9

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
5	T1	420	7.8	1.15	32.8	LOS C	6.4	48.5	0.4	0.61	0.57	36.6
6u	U	41	11	1.15	162.5	LOS F	6.4	48.5	1	1	2.12	8
Approach		868	6.8	1.15	30.6	LOS C	6.4	48.5	0.39	0.68	0.53	37.8
West: Bogue West												
11	T1	770	5.6	0.35	13.3	LOS B	6.5	48	0.55	0.48	0.55	36.8
12	R2	37	2.9	0.1	44.7	LOS D	1	7.2	0.83	0.71	0.83	30.9
Approach		807	5.5	0.35	14.7	LOS B	6.5	48	0.56	0.49	0.56	36.2
All Vehicles		2417	5.4	1.15	64.2	LOS E	22.8	165	0.63	0.81	0.98	22.2

RECOMMENDED MITIGATION

1. Increasing the number of lanes on Bogue Road between the Long Hill and Scarlett Road intersection to facilitate the acceptance of a higher flow capacity of vehicles. This would of course diminish the signal time needed to move similar volumes of traffic.
2. Implement designated short lanes to allow traffic to leave the Bogue Main Road and enter site without impeding the main road traffic.
3. A signalized intersection would be required to safely and effectively facilitate movement into the site during construction as opposed to an unaltered roadway.

Traffic Volumes Management

The sequence of construction is expected to include the following activities (amongst others) within its framework:

1. Site Preparation
   a. Hoarding
   b. Clearance/Earthwork
2. Coastal works
3. Installation of Machinery and equipment
4. Buildings
   a. Concrete Works
   b. MEP
   c. Finishing Works etc.
5. Roadworks

As such, it is expected that the development process will generate varying patterns of vehicle flow and movement over the period of construction. In some instances, such as site preparation, it can be expected that there will be large volumes of continuous heavy type vehicle traffic to accommodate for earth movement demands amongst other requirements. Similar types of movements can be expected in stages that include concrete transport and movement of boulders and rubble.

In other instances, the expected impact of high-volume movements is diminished and concerns are shifted to the accommodation of slow-moving vehicles. This is usually experienced in scenarios that require the use of oversized trucks to move equipment. This type of delivery requires more room for manoeuvring and often includes the usage of multiple lanes and wider turning radii.

Stages such is MEP installations and finishing works that usually run concurrently, generally tend to have a high labour and human capital demand. As such it can be expected that higher volumes of light vehicle traffic can be expected, especially in sites where there may be a myriad of sub-contractors working together.

RECOMMENDED MITIGATION

To minimize the negative impacts that the construction flows could have on the background traffic, events such as the delivery of materials and equipment can be scheduled in off peak hours. (Outside the regions of 7:00-9:30 AM and 3:00-6:00 PM). It should also be noted that accommodations should be made to allow for prompt entry to the site area, by the implementation of a short lane and a deep enough ingress to prevent queueing from bleeding in main lanes. Movements such as oversized truck movements will also need to communicate with the NWA and authorities within the parish for the requisite approval and planning.

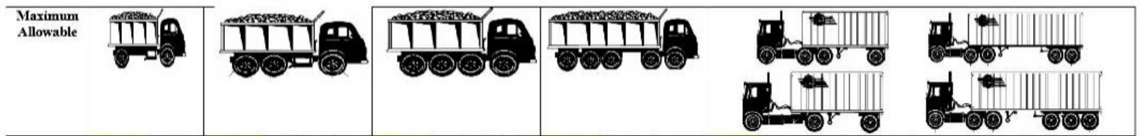
It is also required that signs be placed to warn oncoming motors of the hazards generate by the site such as but not limited to slow moving vehicles and open trenches. It may also be beneficial to implement speed decrease signs or flashing amber signals to prompt road users to slow upon approach to the site entry.

Overweight Vehicles

Large units including tankers, and trucks carrying building and operation machine parts will pose challenges because of their sizes and weight.

RECOMMENDED MITIGATION

All trucks are expected to adhere to the National Works Agency standards as per the expected loads per vehicle axle. (Figure 6-7). Special permits will be requested from the NWA as required two weeks in advance.



SPECIAL PERMIT REQUIREMENTS **vehicles exceeding Permit Column data can be issued ith a Special Permit once the vehicle does not exceed the relevant column etc**

Maximum Allowable	Permit	MAX Limit	Permit	MAX Limit	MAX Limit	Permit	MAX Limit	MAX Limit	Permit	MAX Limit	MAX Limit	Permit	MAX Limit	MAX Limit	MAX Limit	MAX Limit	MAX Limit	MAX Limit	MAX Limit
Overall Height (m)	3.6	4.15	3.6	4.15	4.15	3.6	4.15	4.15	3.6	4.15	4.15	3.6	4.15	4.15	4.15	4.15	4.15	4.15	4.15
Gross Weight (tons)	12.2	15	12.2	20	25	12.2	30	35	12.2	30	35	12.2	25	30	35	40	45	50	55
Length (m)	9.14	12.8	9.14	12.8	12.8	9.14	12.8	12.8	9.14	12.8	12.8	12.8	17.3	17.3	17.3	17.3	17.3	17.3	17.3
Width (m)	2.44	2.70	2.44	2.70	2.70	2.44	2.75	2.75	2.44	2.75	2.75	2.44	2.75	2.75	2.75	2.75	2.75	2.75	2.75
No. of Axles	2	2	3	3	3	4	4	4	5	5	5	3	3	4	4	5	5	6	6
No. of Tires	6	6	8	8	10	12	12	14	16	16	12	10	10	12	14	16	18	20	22

Please note that

1. Maximum allowable dual tire axle load is **10 tonnes** except super singles/ flotation
2. Maximum allowable single tire axle load is **5 tonnes** except super singles/ flotation
3. maximum allowances **must not exceed manufacturer ratings**, specifications for **vehicles and tires** etc
4. Special permits are required for tucks that exceed one or more of the following criteria:

   a. ***Overall Length of 9.14m (rigid) or 12.8 m (articulated/trailer)***
   b. ***Overall width of 2.44 m,***
   c. ***Gross weight of 12,273 kg,***
   d. ***overhang of 50% of wheelbase,***
   e. ***height of 3.6 m from ground***

Figure 6-7 National Works Agency weight limit requirements for heavy vehicles

Summary

During the construction phase, the model depicted minimal impact on the flows experienced at the observed intersections. Delays remained relatively consistent and within ranges for satisfactory user conditions. However, to allow for this level of performance significant physical alterations in the form of the construction of a signalized intersection would have to be made to accommodate this.

Although this alternative will require additional expenditure, it proves to be the optimal layout as the forced U-turn option significantly increases delays at the Bogue/Long Hill intersection and may prove to be a dangerous manoeuvre on a roadway commonly associated with speeding.

Table 6-12 Summary of Bogue/Long Hill Intersection Scenarios

Bogue/Long Hill Intersection	Fr West: Bogue Road				Fr South: Long Hill				Fr East: Bogue Road			
	Straight		Right		Left		Right		Straight		Left	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing	10.3	B	39.9	D	15.9	B	30.3	C	21.8	C	28.4	C
Construction Phase	10.3	B	39.9	D	15.9	B	30.4	C	21.4	C	27.4	C

Table 6-13 Summary of Bogue/Scarlett Road Intersection Scenarios

Bogue/Scarlett Road Intersection	Fr West: Bogue Road				Fr South: Scarlett Road				Fr East: Bogue Road			
	Straight		Right		Left		Right		Straight		Left	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing	7.1	A	40.9	D	29.9	C	29.9	C	20.2	C	10	B
Construction Phase	13.6	B	34.8	C	28.2	C	28.2	C	19.8	B	10.5	B

Table 6-14 Summary of Bogue Road/ Peninsula Intersection Scenarios

Bogue/The Peninsula Intersection	Fr West: Bogue Road				Fr North: The Peninsula				Fr East: Bogue Road			
	Straight		Left		Left		Right		Straight		Right	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Construction Phase	12	B	15.5	B	40.1	D	39.3	D	3.3	A	15.4	B

6.1.3.6 Maritime Traffic

Construction activity on the jetty may have the potential to negatively impact fishing and other maritime activities taking place at sea due to vessels, machinery and equipment in the water being used during the construction process. Accident potential is also increased due to presence of vessels, structures and equipment at sea.

RECOMMENDED MITIGATION:

The use of highly visible marker buoys demarcating an exclusion zone should be used to keep out other marine traffic and fishers from the work area to prevent potential accidents.

6.1.3.7 Health and Safety

Construction activities have the potential for accidental injury, whether major or minor. For example, construction works may entail workers being suspended in the process and this has the potential for increased construction accidents. Fugitive dust has the potential to affect the health of construction workers. This may also include fire safety, safe access routes, clearly defined pedestrian pathways, electrical hazards, eye hazards and radiation hazards. In addition, disasters such as earthquakes, floods and hurricanes are real possibilities.

Recommended Mitigation

i. The provision of lifelines, personal safety nets or safety belts and scaffolding for the construction workers (if necessary)
ii. Ensuring that workers wear personal protective equipment (hard hats, reflective vests, safety shoes, eye protection etc.)
iii. Where unavoidable, construction workers working in dusty areas should be provided and fitted with N95 respirators.

iv. Areas should be dampened every 4-6 hours or within reason to prevent a dust nuisance and on hotter days, this frequency should be increased.

v. There should be onsite first aid kits and arrangement for a local nurse and/or doctor to be on call for the construction site.

vi. Make prior arrangements with staff at the Cornwall Regional hospital and/or health centre to accommodate any eventualities.

vii. Make prior arrangements with the closest police and fire stations (Freeport) to accommodate any eventualities.

viii. Material Safety Data Sheets (MSDS) should be stored onsite.

ix. A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to the construction workers.

x. Trench Excavation
   - A trench 1.2m or more in depth must have a means of egress (ladders/ stairways/ramps) and should be located at 8m intervals.
   - Excavated materials must be stored 0.6m or more from the open trench (not to be measured from the crown of the spoil).
   - Spoil should be placed so that the channels rainwater and other runoff water away from the excavation.
   - Take precautions regarding Tension Cracks
     - Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench.
     - Sliding or sloughing may occur as a result of tension cracks. [5]

xi. Ensure that construction safety nets (catch nets) are installed that will catch personnel, debris, and small tools

xii. Designing and implementing an Emergency Response Plan (ERP) in the event of any emergency. This should include:
   - Hurricane
   - Earthquake
   - Flooding
   - Fire
   - Civil Unrest and Riots
   - Bomb Threats and Acts of Sabotage
   - Acts of Terrorism and Armed Attacks
   - Petroleum and Hazardous Material Stockpiling
   - Security and Safety Information
   - Medical Emergency Information
   - Technological Emergencies

6.1.3.8 Aesthetics

Construction activities may decrease the aesthetic appeal of the area; however, this will be for a short-term period during construction. In particular, trucks leaving the construction site have the potential to deposit marl and mud onto the main road, making the main road aesthetically unappealing and in the process, affecting the conditions of other vehicles traversing the main road.

[5] Worker Health and Safety Guidelines as per OSHA #510 Construction Industry Standard 29 CFR Part 1926.

Recommended Mitigation

- Good housekeeping activities and adherence to other mitigative measures.
- An area of gravel should be placed on site (just before exiting onto the main road) to help remove mud/marl from truck wheels.
- A wheel wash area on site (just before exiting onto the main road) should be implemented to rid wheels of as much mud/marl as possible

6.1.3.9 Historical Artefacts

Care should be taken during construction activities. Any vestiges of cultural material unearthed on should be collected and examined. It should be noted that in case archaeological features are found within the project area, the JNHT will evaluate and record the features and collect any such cultural material found.

6.2 OPERATION

6.2.1 Physical

6.2.1.1 Runoff and Flooding

From the flood plain model, it was observed that flooding due to pluvial and fluvial processes was more prevalent in areas south of the Peninsula. Site-specific flooding is not significant and was mainly a result of existing elevations. The highest inundation level was due to storm surge, with flood levels up to 2.5m during a 50-year storm. It is expected that construction grading activities to channels that flow offsite will subside the observed inundation levels for both the pluvial flood and coastal flooding. Based on onsite generated flows, for a 10 year return period, flow estimates range from 2.1 – 3.1 cm/s and as such, downstream pipe diameters or dimensions should be sized to accommodate such.

Recommended Mitigation

A 2.8m floor level elevation is recommended for buildings closer to the south of the property to protect from only rainfall flood damage (Figure 6-8). The final recommended floor level is 3.3m to account for both rainfall flooding and storm surge.

The Guidelines for Preparing Hydrologic and Hydraulic Reports for Drainage systems and proposed developments prepared by the NWA recommend that floor levels be 0.4m above the 100 year return period flood level.

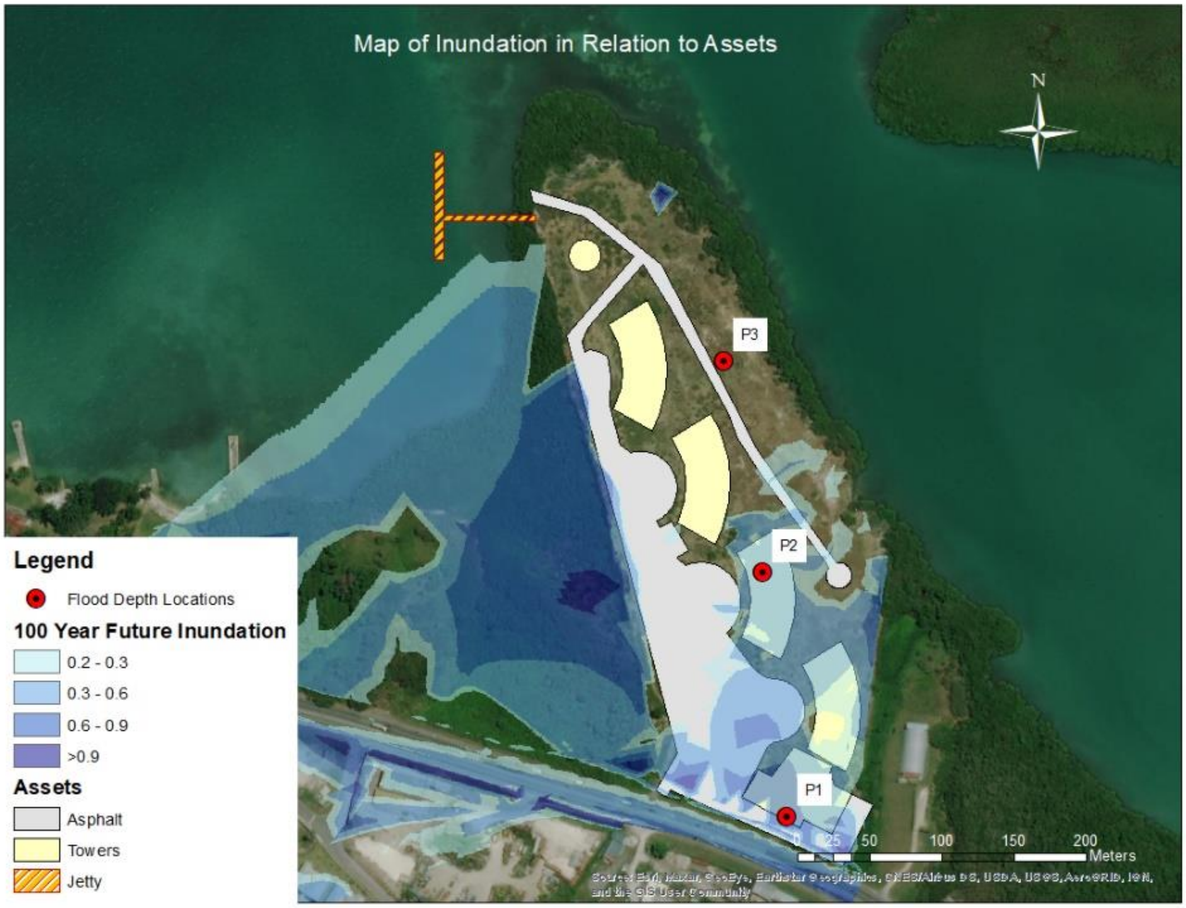


Figure 6-8 Inundated areas about the location of proposed assets

Site-Specific Runoff Generation

Architectural drawings highlighting the proposed layout of the development provided a reasonable basis for the expected land use of the site. In addition, the site was determined to be situated upon soils between types B and C of the hydrologic soil group set. This was due to the site's proximity to majority loamy, silty and clayey materials, which tend to display moderate to low infiltrative properties.

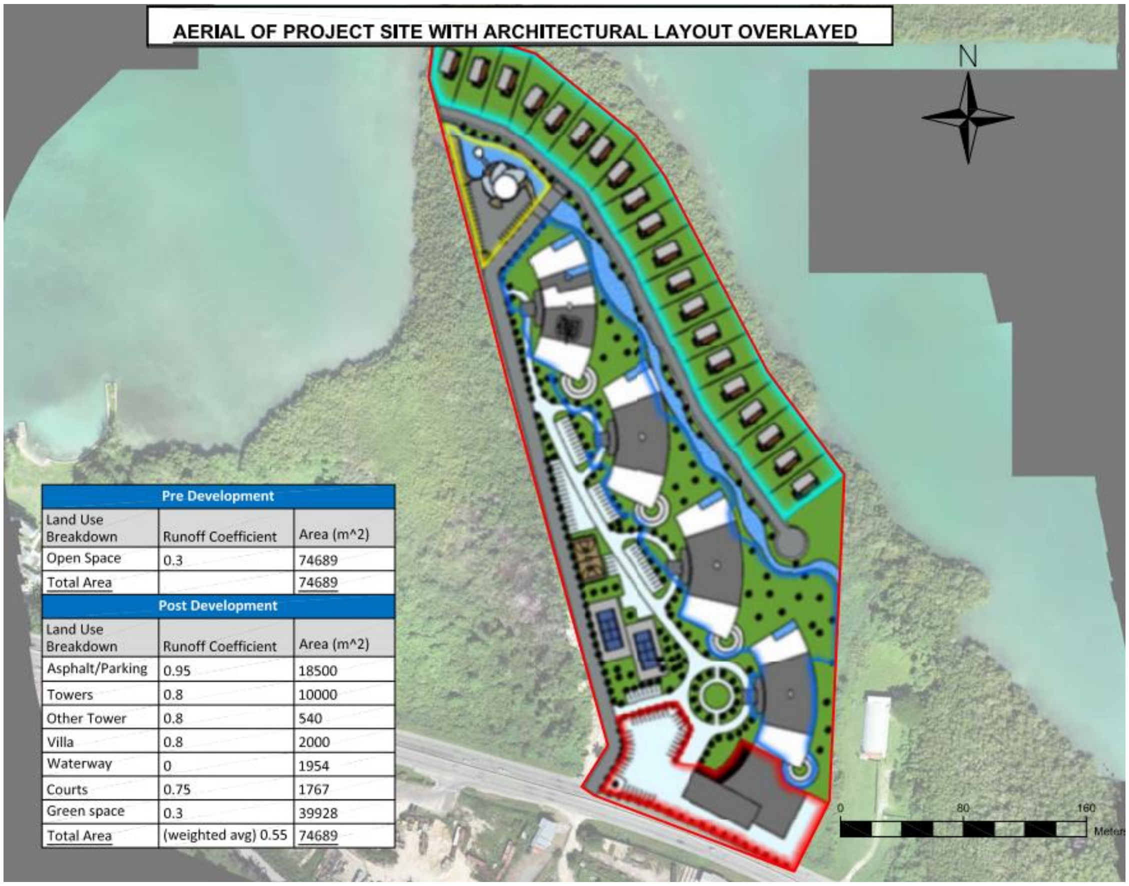


Figure 6-9 Site land use distribution based on architectural drawings

After development, 53% of the site is expected to be green space. Using the SCS method for runoff calculation, the peak flows of a future 2-yr rainfall event for the pre- and post-development scenarios were determined to be 0.72 to 1.37 (cubic metres per second) cms. By employing the rational method, pre- and post-development peak flows were determined to be 0.56 and 1.03 cms, respectively. It must be noted that the SCS method provides a more conservative range of site generated flows because of its interpretation of infiltration and conveyance on some surfaces.

Table 6-15 Site generated flows in relation to Rainfall Event return period

Return period (years)	Rational Method		SCS Method	
	Pre-Development	Post Development	Pre-Development	Post Development
2-Year	0.56	1.03	0.72	1.37
10-Year	1.11	2.03	2.06	3.07
25-Year	1.43	2.61	2.88	4.04
50-Year	1.66	3.04	3.66	4.94
100-Year	1.90	3.47	4.30	5.69

The two methods highlight the expected increase in runoff conveyance due to the impervious surface area on the site. However, with the Peninsula's location downstream of the watershed and relative elevation to adjacent land, the alteration of the site has minimal impact on flooding of assets external to the site.

It was anticipated that activities within catchment B, South of the Bogue Main Road, would directly impact runoff conveyed to regions adjacent to the site. As such flows, generated within the catchment B upstream of the Peninsula site were determined. Analysis of these upstream flows revealed areas south of the main road that were heavily inundated. It is expected that any adjustments to the drainage infrastructure or landscape in this area to reduce inundation, will have a direct impact on the flows seen to the west or east of the Peninsula.

(A) (B)

Figure 6-10 Evidence of inundated regions south of the Peninsula along Scarlett Road ((A) abandoned factory opposite the Alva Warehouse (B) Inundated area along the MVP Smokehouse)

Within a 2-year rainfall event in the vicinity of the industrial area and more specifically, the Red Stripe/D&G warehouse, the model predicted high flood depths of up to 0.9m. The trend of significant inundation was further observed along the roadway with depths ranging from 0.3 - 0.9m along the Scarlett roadway and grassy areas between the various properties. Analysis of the 25-year rainfall event revealed flood depths up to 1.5m in proximity to the Red Stripe/D&G warehouse. There was also a general increase in areas inundated, with flood depths ranging from 0.3 – 1.5m along the roadway. It was observed in both scenarios that the eastern end of the Scarlett roadway was generally more inundated, with flooding depths tapering off towards the Tara Estates community.

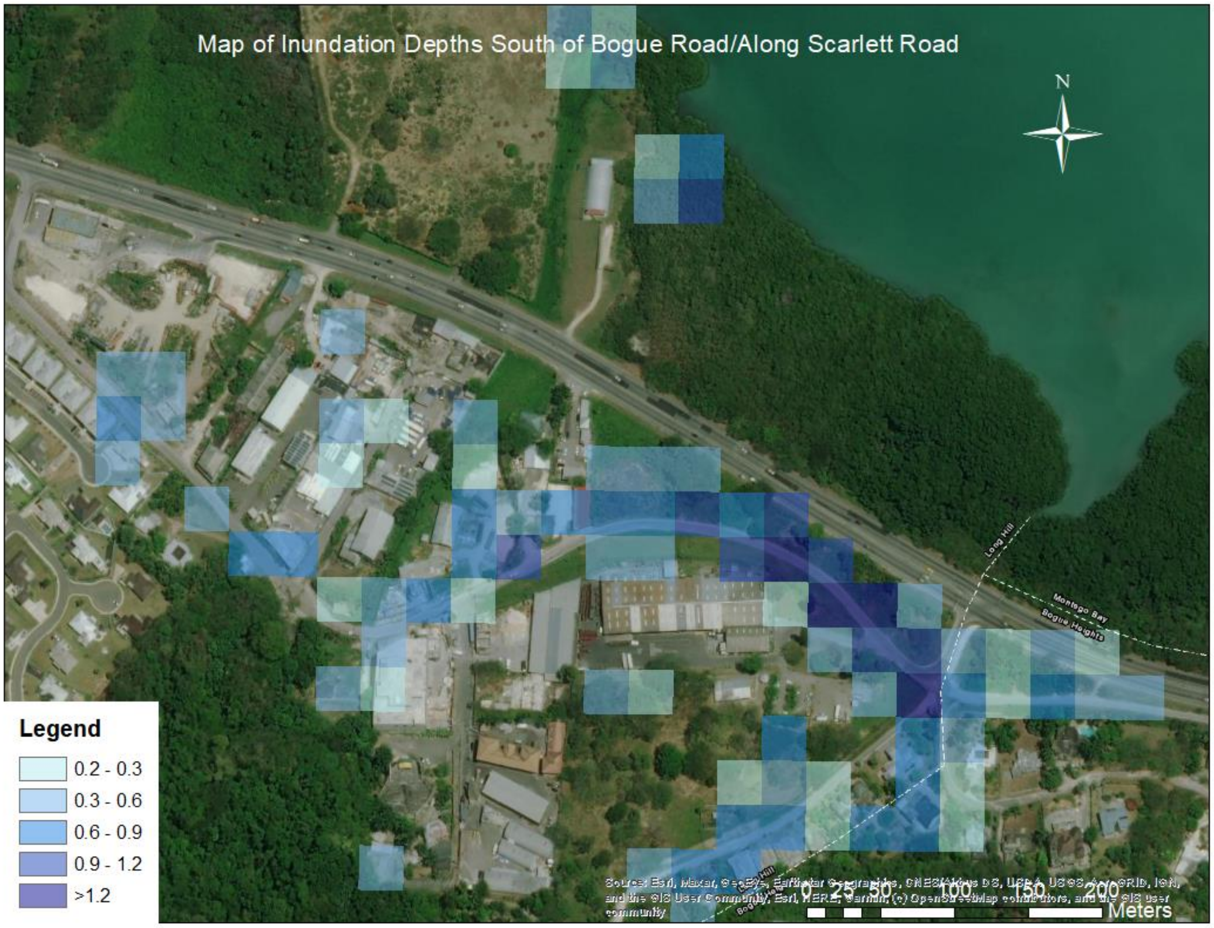


Figure 6-11 25-year return period inundation along Scarlett Road

RECOMMENDED MITIGATION

The implementation of the planned drainage infrastructure should be focused on managing upstream and onsite flows to prevent them from interfering with activities and assets within the footprint of the development.

According to NWA guidelines for Preparing Hydrologic and Hydraulic Design Reports, the recommended design period for minor drainage systems is a 10-year return period. As such based on the site generated flows in Table 6-15, small channels, and swales for collecting runoff onsite for conveyance to larger external drainage systems should be able to convey 3.1 cms of runoff.

6.2.1.2 Stormwater Discharge and Water Quality

Plume Dispersion Model Results

The primary objective of this evaluation was to determine the impacts on water quality in the bay and project area based on site-specific runoff and stormwater discharge from adjacent drainage features. The evaluation considers the dispersion of total suspended solids and heavy metal concentration from the existing drainage features and likely site-specific outfalls.

In the project's operational phase, the impacts of the residents living in the development were examined. The contamination points examined were the existing drainage infrastructure along the coastline and the stormwater drainage system for the development. This scenario examined the impacts of TSS, Heavy metals, and oil and grease generated during the project's lifetime. The scenario examined a 2 RP rainfall event over 24 hours and examined the runoff effects on the marine environment with the respective plume dispersion models.

The site-specific catchment's runoff will change significantly between the construction and operational phases, as the bare earth is covered with green areas and impervious areas (both of which are resistant to erosion). This reduces the TSS concentration from 1000 mg /l to 50 mg /l matching the ambient concentrations of the drains in the area. The plume is generated at both sides of the Peninsula as the highest concentration of 50 mg/l at the shoreline. It quickly dissipates to a 200m wide plume with TSS values ranging from 10 - 30 mg/l TSS returns to ambient conditions (Figure 6-12). The plume observed is similar to the ambient plume for TSS due to the minimal impact the site will have on TSS during the operational site. The TSS in the area dissipates within 3 hrs to match ambient standards. Therefore, the construction of the proposed development will have no lasting impacts on the TSS in the bay.

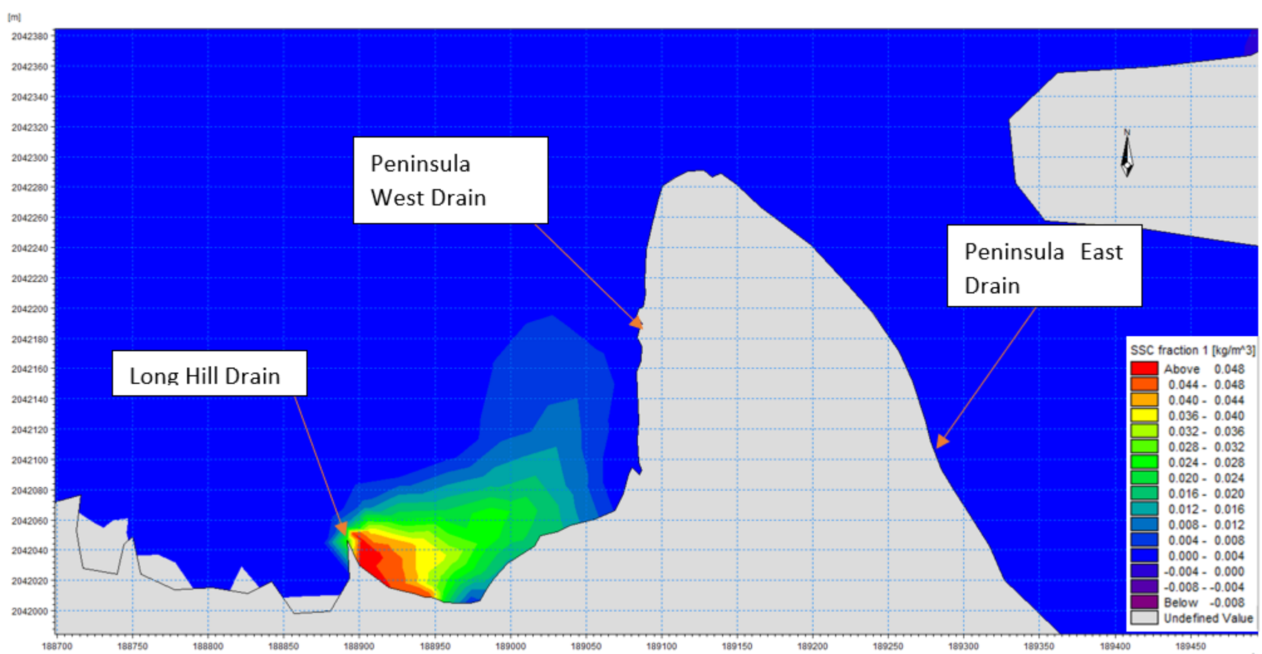


Figure 6-12 TSS plume at peak runoff during the operational phase

During the site's operations, a build-up of heavy metals is expected to occur due to the vehicle traffic from the residents and service staff. During a rainfall event, total heavy metal concentrations of approximately 1.5mg/l are expected to be found in the runoff from the site. This conservative estimate is primarily due to the heavy usage of vehicles in the area and is the by-product of such. The contaminant is placed at the outfall of the site drainage the plume generated is shown in Figure 6-13. The plume generated is 150m wide with concentrations ranging from 0.5 mg/l to 0.1mgl of heavy metals. The heavy metals quickly dissipate into the bay and return to ambient levels within 12 hours of a rainfall event (see Figure 6-14)

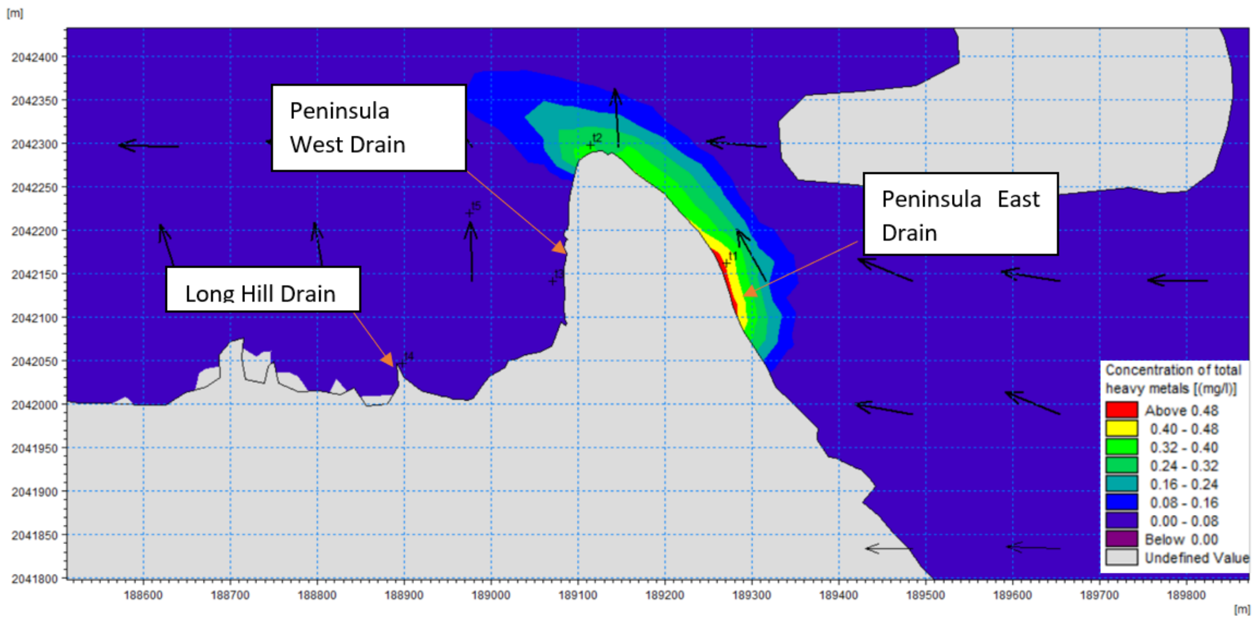


Figure 6-13 Heavy Metal plume at peak runoff during the operational phase of the project

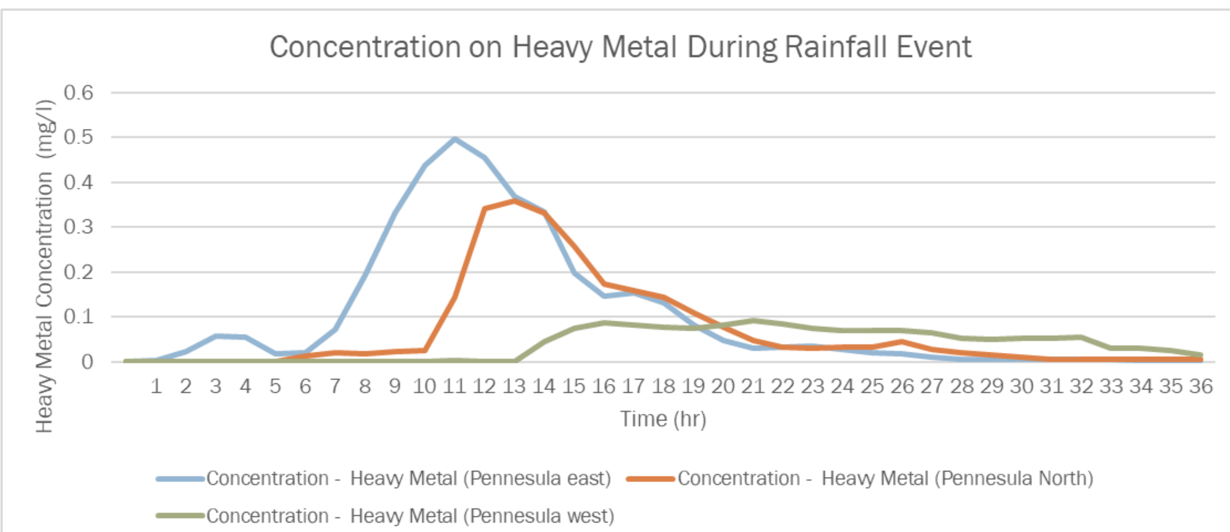


Figure 6-14 Heavy Metal plume at peak runoff during the operational phase of the project

Oil and grease are other pollutants captured in the stormwater runoff during minor rainfall events. The source of the oil and grease is assumed to be an impact of vehicles leaking oils when parked. This oil will be washed from the parking area and washed into the marine environment via the stormwater outlet. The plume generated is represented in Figure 3.59 with the highest concentration of oils to the east of the peninsula development and then spread north-westerly of the project site. The plumes generated quickly spread, forming low concentration suspended emulsions on the water surface. This would form a very light oil sheen on the top layer of the water column that form globules that quickly spread from the source. Due to the low concentrations of expected oil and grease, any effects experienced is expected to be minor and short-lived. The plumes generated in actuality will be much less impactful as most of the parking in the development is within the building is covered. As such, concentrations at the pollutant source will be less than in the model.

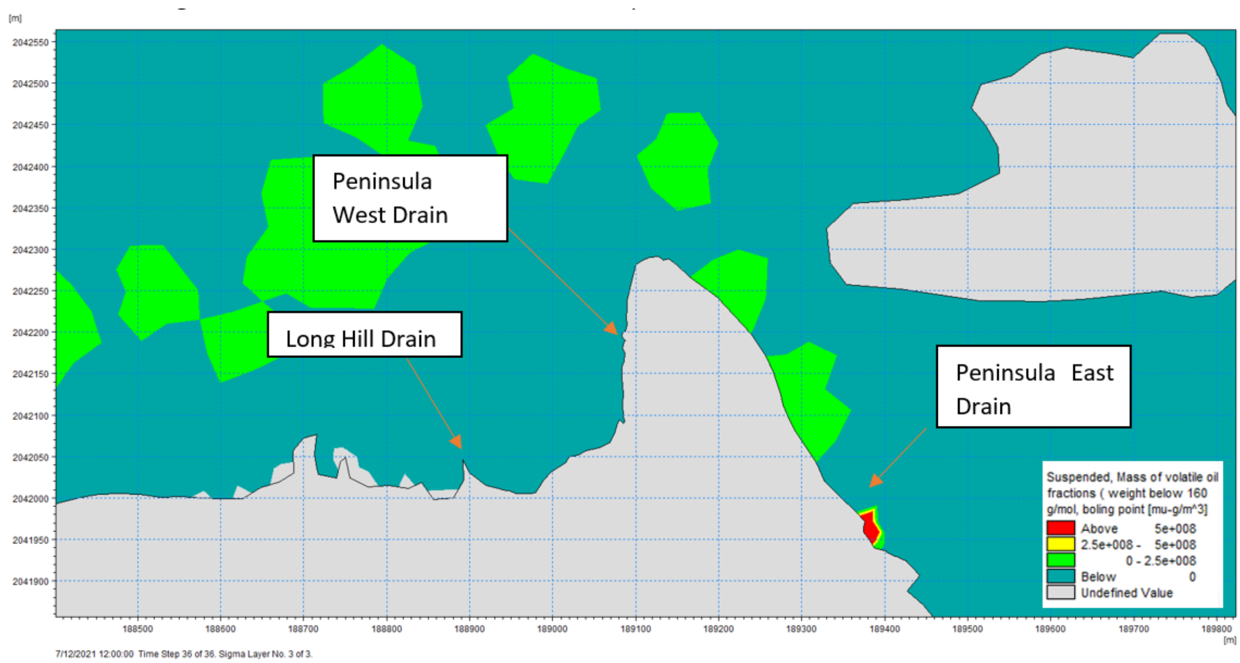


Figure 6-15 Oil and Grease plume at peak runoff during the operational phase of the project

Recommended Mitigation

Silt traps should be integrated into the stormwater drainage network during the operational phase to filter suspended sediment inflows conveyed to the bay via the site. This is beneficial as the change in site surface area may increase the area's hydraulic carrying capacity of flows.

It is expected that oil, grease, and heavy metal concentrations will generally be in low concentrations. They generally come from low concentration sources such as parking lots and roofs. The exception is that of extenuating circumstances such as spills. In this regard, mitigation steps should include using absorptive and adsorptive materials to remove pollutants from a surface before being impacted by runoff for treatment. Grease traps and interceptors are recommended to remove oils from domestic waste generated onsite.

To reduce the effects of contaminants being released in the bay, the following mitigation activities are recommended:

i. The installation of turbidity curtains to trap suspended sediment within a controlled area during construction.

ii. Stoppage of works during adverse weather conditions,
iii. Utilise barriers such as silt fences, berms and trenches at strategic points on the site to filter and control runoff.
iv. Implementing Silt traps stormwater drainage
v. Implementing cleaning stations for clean oil and grease
vi. Oil Spill Contingency Plan

6.2.2 Biological

6.2.2.1 Seagrass and other benthic habitats

Jetty pilings provide some ecological volume in the water column. These hard structures will provide substrate for colonization of sessile organisms which should change in composition over time. Fish may also benefit from the pilings as these will act FADs (Fish Aggregation Devices). These fish will benefit from some protection from overfishing since the development is within a SFCA.

The jetty, along with vessels can result in shading of benthic species, such as seagrass. This may reduce the ability of seagrass to colonize these areas. Seagrass in the general area is sparse and this impact is likely to be minimal.

Propeller-induced currents from boats may also reduce some larval settlement. This impact is expected to be minimal.

The operation of vessels and water sport activities may impact the benthic communities in and around the area. This may include groundings, propeller and anchor damage, spills of toxic/hazardous fuels and materials. There is also a risk of increased solid waste during operations on land and from vessels.

Increased marine vessels may result in activities which are prohibited in the protected area such as fishing.

Recommended Mitigation

i. Marine vessel pathways/channels and usage areas should be clearly defined and marked with surface marker buoys.
ii. Refuelling of boats should only be done at anchor out at sea if the sea conditions are calm, otherwise, all refuelling should be done when docked at land. Appropriate refuelling equipment (such as funnels) and techniques should always be used.
iii. Appropriate minor spill response equipment (for containment and clean- up) should be available by each vessel owner, including oil absorbent pads and disposal bags.
iv. All spills or incidents should be reported.
v. Solid waste should be collected and stored away from the marine environment. Bins should be sufficient and covered to reduce access by rodents and feral animals.
vi. Additional patrolling by the MBMP may be required. Reporting of illegal activities by staff and users to the MBMP should be encouraged

vii. Signage in and around the areas to include both marine and terrestrial sensitive species, allowable activities and reporting guidelines should be placed around the property.

6.2.3 Natural Hazards

6.2.3.1 Wind

The projected wind speeds generated show increases of 20.7% for the 100yr wind speeds to 25.7% for 10yr wind speeds. This means that in some instances, wind speeds are likely to increase by up to 17.5m/s more than the present climate. The results depicted that the project area experienced large fields of high winds during extreme weather events ranging between 70-90 m/s for future 100-yr RP events (CEAC Solutions Co. Ltd., 2022).

6.2.3.2 Sea Level Rise

IPCC projections show SLR increasing by 0.5m by 2050 and 0.98m by 2100 for Caribbean islands. The effect of these significant increases in sea level would affect large sections of project area (CEAC Solutions Co. Ltd., 2022).

6.2.3.3 Wave Climate, Storm Surge and Hydrodynamic Assessment

Ocean Currents

The results of the modelling showed that current speeds under the operation conditions will vary between 0.02 to 0.09 m/s for the bottom currents while for the surface currents it varied between 0.04 m/s to 0.16 m/s from western direction. Currents speeds were observed to be faster at the surface in comparison to bottom currents (CEAC Solutions Co. Ltd., 2022).

The marina/jetty placement is not anticipated to cause any significant effect on circulation within the bay due to the nature of the foundation i.e. Piles.

Operational and Swell Waves

Day-to-day or operational waves were modelled using data from the NOAA Wave Watch weather service database. Based on the wave predictions, operational and swell waves in the present climate are of an average height of approximately 0.04m and 0.12m, respectively, in the nearshore area. Whereas, under future climate, the operational wave averages increase to 0.1m while swell wave averages increase to 0.15m. Operational waves were propagating from predominantly the Eastern (E) direction while future climate swell waves are predicted to approach the marina from the North (N) and North-Western (NW) direction. It must be noted that wave heights are more significant at the northern-most section of the Peninsula (CEAC Solutions Co. Ltd., 2022).

Hurricane Waves

The results of the modelling showed that present extreme waves for 100 Yr. Return Period ranged between 1.36-1.96m arriving at the shoreline from varying directions. While for the future 100 Yr. the heights of the waves ranged between 1.5 - 2.2 m. During the hurricane conditions, the southwest (SW) direction posed the least threat to the shoreline while the northwest (NW) and west (W) direction pose a greatest threat. It was observed that the project area would be completely inundated due to it low lying nature therefore it would be recommended that protection measures be undertaken (CEAC Solutions Co. Ltd., 2022).

Storm Surge

The analysis deduced that the site would be fully inundated by storm surge under 50 and 100 Yr Return Period, present and future climate. It was estimated that the worst-case scenario storm surge inundation (100 Yr. Return Period) would cause damage within the project area. The storm surge inundation depth at the shoreline ranged from **1.0- 1.35m** for the 50-yr and 100-yr Return Period Future climate storm for the CEAC/TAOS model while the Mike Coupled model showed inundation depths of **1.3 – 1.66m** for the 50-yr to 100-yr Return Period events. Overall, the Mike Model showed greater inundation depths than the TAOS model with a 30% difference for the 50-yr event and 23% for the 100-yr event (CEAC Solutions Co. Ltd., 2022).

6.2.3.4 Long term Coastal Erosion

It can be concluded that the shoreline in the area is relatively stable, with a slight erosion rate of 0.1 m/year for the past 19 years. However, factoring in sea-level rise, the annual erosion rates are predicted to increase to 0.2m factoring in SLR and the sediment size in front of the project area. At this rate, the movement of the 25-year shoreline will not affect the major structural elements of the project area (CEAC Solutions Co. Ltd., 2022).

From the analysis of the long-term evolution of the shoreline, the shore appears to be relatively stable. However, it must be noted that the Northern and Eastern shorelines have receded from the 2002 shoreline. This may be due to a combination of reduction in sediment transport and an increase in sea level. As such, it is recommended that the client considers shore stabilization works such as T-Groynes. This would trap the sediments moving NW and stabilize the coastline (CEAC Solutions Co. Ltd., 2022).

6.2.3.5 Storm Induced Erosion

The project site is susceptible to short-term erosion which has been proven by the receding shoreline. The model predicted that the existing site conditions, when simulated against future 25, 50 and 100yr RP storm events, would experience erosion of the beach face. The berm was predicted to erode approximately 25m for the future 25yr RP storm events; whereas, landward erosion to the extent of 35m was predicted for the future 50yr RP storm events, due to the exposure of higher wave heights and water elevations. Lastly, 100yr RP storm events produce the most significant landward erosion with 40m inland. The general trend of the hurricane scenarios are landward movements of the shore as the heavy waves erode the berm of the land, flattening the beach profile and moving the sediments via cross-shore erosion (CEAC Solutions Co. Ltd., 2022).

It is important to note that the bay is relatively well sheltered, and the shoreline is protected by mangroves. As such, the extent of erosion will only be experienced during hurricane scenarios producing waves from the northwest, IF the mangrove forest protecting the shoreline is damaged. It is difficult to quantify the extent of erosion that would be experienced with the existing mangrove forest due to its complexity. Erosion should still be expected during the passage of a hurricane, however the extent will be reduced due to the protection that the mangroves provide.

To protect the project area from the threat of storm-induced erosion, it is recommended that the client considers the design and construction of a coastal protection structure such as a revetment. This should be considered in addition to the raising of floor elevations above the 100yr SS elevation to 3.3m (CEAC Solutions Co. Ltd., 2022).

6.2.3.6 Recommended Mitigation (Natural Hazards)

1. The minimum recommended **floor level** is **3.3m** (accounts for SLR) and the *road levels* are recommended to be at an elevation of *2.6m above MSL*. These floor level elevations will mitigate against damage due to both storm surge and rainfall flood events.
2. It is recommended that the client considers shore stabilization works such as T-Groynes. This would trap the sediments moving NW and stabilize the coastline against long-term erosion.
3. To protect the project area from the threat of storm-induced erosion, it is recommended that the client considers the design and construction of a coastal protection structure such as a revetment. This should be considered in addition to the raising of floor elevations above the 100yr SS elevation to 3.3m.
4. The project area is projected to experience high winds ranging between 70-90 m/s during extreme weather events. Due to the severe damage that these types of wind speeds can cause to structures it is recommended that hurricane proofing to the buildings be implemented, such as roof strapping and wind shutters, to reduce the likelihood of damage.
5. It is expected that oil, grease, and heavy metal concentrations will generally be in low concentrations except for during spills. In this regard, mitigation steps should include using absorptive and adsorptive materials to remove pollutants from a surface for treatment before being impacted by runoff.
6. Grease traps and interceptors are recommended to remove oils from domestic waste generated onsite

Marina/Jetty

1. The risks associated with unknown subsurface geotechnical conditions are high. Geotechnical information is limited to land-based boreholes. At least three boreholes over the jetty project area footprint should be acquired to a minimum 10 meters penetration.
2. It is recommended that hydrographic surveys be conducted at the entrance to the bay to determine whether or not dredging is required.
3. All construction to be completed according to drawings. Notably, the minimum deck height of the jetty is to be 1m above MSL to be operational in swell conditions and the minimum depth of mooring is to be 3m.
4. Construction monitoring to be done by registered professionals.
5. Turbidity barriers to be used to contain suspended sediments during construction.
6. Operational considerations should be given to assigning a hurricane shelter for the vessels and an oil spill contingency plan.

6.2.4 Socioeconomic/Cultural

6.2.4.1 Water Supply and Consumption

Potable water for the development will be sourced from the National Water Commission (NWC). Water consumption is estimated to be approximately 1,022 m^3/day. There is the potential for the development to further burden the water supply in the area in the event of drought conditions.

Mitigation

In order to alleviate any potential burden on water supply in the area particularly during times of drought, it is recommended that various storage and conversation measures be put in place at the development such as:

v. Low flow fixtures
vi. Dual flush toilets
vii. Faucets fitted with aerators
viii. Electronic spigots and flush valves

6.2.4.2 Solid Waste Generation and Disposal

The operation of the development has the potential of significantly increasing the solid waste in the area.

Mitigation

vi. Provision of solid waste storage bins and skips.
vii. Provision of adequately designed bins and skips to prevent access by vermin.
viii. Monitor beach garbage.
ix. Contracting a private contractor to collect solid waste in a timely fashion to prevent a build-up.
x. Ensure that the solid waste collected is disposed in an approved disposal site - Retirement Disposal Facility, St. James.

6.2.4.3 Health and Safety

The operation of the proposed development will involve workers and residents who may become ill or have accidents. In addition, disasters such as earthquakes, floods, storm surge and fires are real possibilities.

Mitigation

iv. Have first aid kits located in various sections of the development
v. Design and implement an emergency response plan.
vi. Arrange mutual assistance and make prior arrangements with:
   a. Health care facilities (Cornwall Regional Hospital) and associated doctors and nurses to accommodate any eventualities.
   b. Freeport Fire Station
   c. Freeport Police Station

6.2.4.4 Traffic

Trip Generation

Operational traffic volumes were determined using ITE Trip Generation Manual: 10th edition. The manual provides an estimate of trips generated per unit based on the general land usage of a development. It was advised by the NWA that the ITE's rates generally tend to be more conservative for usage in Jamaica.

Table 6-16 Display Trip Generation rates based on the land use and building quantities.

Item	Land Use Code	Type	In (%)	Out (%)	Rooms	Quantity	Rate	Trips (per hr)
Ultra-Luxe Tower	232/222	*High-Rise Residential Condominium/Townhouse*	*21*	*79*	*224*	*1*	*0.31*	*69.44*
Standard Tower	232/222	*High-Rise Residential Condominium/Townhouse*	*21*	*79*	*280*	*3*	*0.34*	*285.6*
Villa Lots	260	*Recreational Homes*	*49*	*51*	*1*	*21*	*0.29*	*6.09*
Supermarket	850	*Supermarket*	*52*	*48*	*1*	*15*	*6.67*	*100.05*
Office Space	710	*General Office Building*	*88*	*12*	*1*	*25.5*	*1.47*	*37.485*
Restaurant	931	*Quality Restaurant*	*80*	*20*	*1*	*3*	*4.47*	*13.41*
Tennis Court	490	*Tennis Court*	6	*4*	*1*	*1*	*1.6*	*1.6*
Multi-purpose court			6	*4*	*1*	*1*	*1.6*	*1.6*
Marina	420	*Marina*	*64*	*36*	*1*	*1*	*0.19*	*0.19*
								515.465

The trip volume generated was approximately 515 trips/ hour for the peak operating case. These volumes were however adjusted to reflect the trips terminating and originating from the site. The volumes were also adjusted to account for the fact that a number of the trips produced or terminated by the development would have been associated with origins within the development footprint. It was also assumed that 95% of the traffic would be Light Vehicular traffic. This inference was based on traffic type volumes determined from the existing traffic counts.

Table 6-17 Traffic flow breakdowns based of trip generation for proposed development.

ROUTE SPLIT				
	IN		OUT	
Direction	C	T	C	T
From West	19	1	52	3
From East	56	3	155	8

Model Output

The overall impact of the operational phase was expected to be quite significant due to the quantity of residential units to be generated by the development. On the Bogue main road, the level of Service was observed to be similar to those observed during the signalized construction phase. The main and most significant loss of performance however was noticed on Long Hill. Motorists needing to turn right onto Bogue Rd would have to wait approximately 7 seconds longer on average.

An increase of degree of saturation to 0.81 also highlighted that volume of vehicles making that right turn was approaching the available capacity of the signal cycle and as such the quantity of vehicles was approaching a volume that the signal could not handle in a signal cycle.

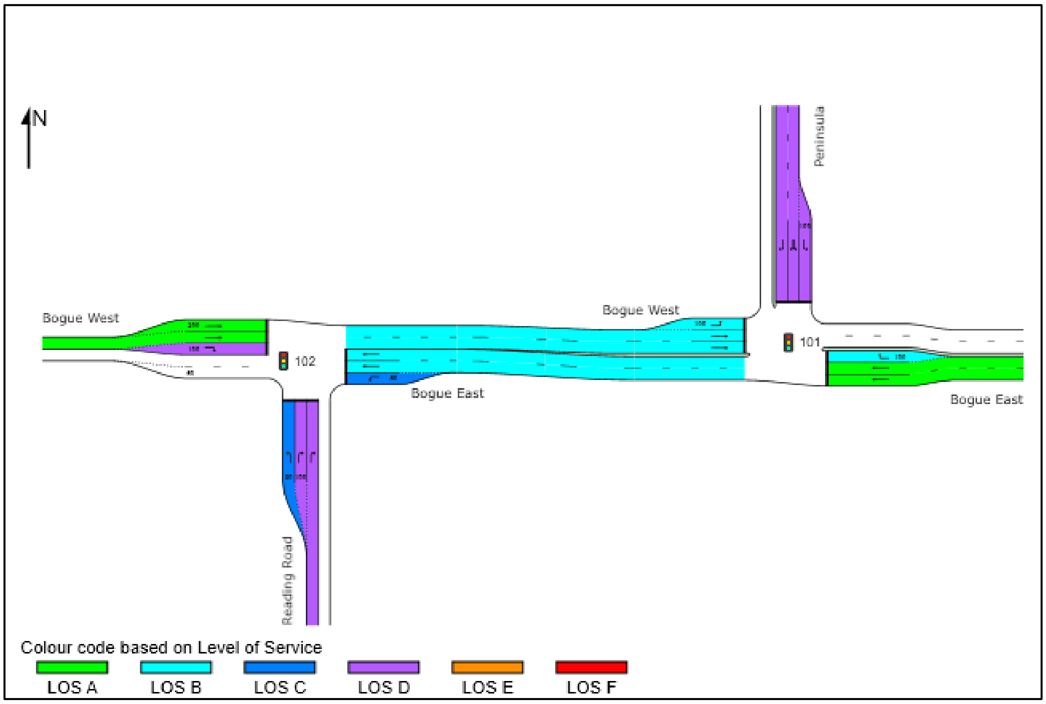


Figure 6-16 Level of Service Recorded at the Bogue/Long Hill Intersection

Table 6-18 Movement performance at the Bogue/Long Hill Intersection for the AM peak during the operational phase.

Movement Performance - Vehicles											
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Long Hill												
1	L2	13	0	0.02	20.4	LOS C	0.2	1.3	0.61	0.64	0.61	38.8
3	R2	733	4	0.81	37.1	LOS D	8.5	61.3	0.98	0.85	0.98	25
Approach		746	4	0.81	36.8	LOS D	8.5	61.3	0.97	0.85	0.97	25.3

East: Bogue East												
4	L2	436	5	0.54	23.3	LOS C	6.5	47.9	0.65	0.79	0.65	43.9
5	T1	450	8	0.39	18.8	LOS B	4.8	35.8	0.59	0.67	0.59	46.9
Approach		886	7	0.54	21.1	LOS C	6.5	47.9	0.62	0.73	0.62	45.4
West: Bogue West												
11	T1	773	6	0.34	8.9	LOS A	4.6	33.9	0.53	0.46	0.53	40.3
12	R2	37	3	0.27	45.9	LOS D	0.9	6.4	0.95	0.72	0.95	30.6
Approach		810	6	0.34	10.6	LOS B	4.6	33.9	0.55	0.47	0.55	39.2
All Vehicles		2441	5	0.81	22.4	LOS C	8.5	61.3	0.7	0.68	0.7	37.2

Table 6-19 Movement performance at the Bogue/Peninsula Intersection for the AM peak during the operational phase

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
East: Bogue East												
5	T1	815	5	0.3	4.5	LOS A	3.5	25.8	0.37	0.33	0.37	55.9
6	R2	62	5	0.2	11	LOS B	0.3	2.5	0.37	0.65	0.37	49.8
Approach		877	5	0.3	5	LOS A	3.5	25.8	0.37	0.35	0.37	55.4
North: Peninsula												
7	L2	172	5	0.35	41.9	LOS D	1.9	14.2	0.92	0.76	0.92	25.5
9	R2	58	6	0.24	41.2	LOS D	1.3	9.4	0.9	0.74	0.9	35.2
Approach		229	5	0.35	41.7	LOS D	1.9	14.2	0.92	0.76	0.92	28.6
West: Bogue West												
10	L2	21	5	0.02	15	LOS B	0.2	1.7	0.47	0.65	0.47	47
11	T1	1485	5	0.73	15.8	LOS B	13.5	98.5	0.81	0.73	0.81	39.7
Approach		1506	5	0.73	15.8	LOS B	13.5	98.5	0.8	0.73	0.8	39.9
All Vehicles		2613	5	0.73	14.4	LOS B	13.5	98.5	0.67	0.6	0.67	44.6

Table 6-20 Movement performance at the Bogue/Scarlett Road Intersection for the AM peak during the operational phase

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Scarlett Road												
1	L2	53	18	0.36	33.9	LOS C	2.8	23	0.85	0.77	0.85	26.2
3	R2	85	19	0.36	33.9	LOS C	2.8	23	0.85	0.77	0.85	35.8
Approach		138	19	0.36	33.9	LOS C	2.8	23	0.85	0.77	0.85	32.9
East: Bogue East												

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
4	L2	75	23	0.06	10.2	LOS B	0.5	3.9	0.27	0.67	0.27	52
5	T1	838	5.7	0.51	21.4	LOS C	7.3	53.5	0.76	0.76	0.76	41.4
Approach		913	7.1	0.51	20.5	LOS C	7.3	53.5	0.72	0.75	0.72	42.7
West: Bogue West												
11	T1	1612	4.2	0.71	17.9	LOS B	16.9	122.6	0.91	0.83	0.91	46.1
12	R2	49	22	0.31	44.2	LOS D	1.2	9.7	0.95	0.74	0.95	30.8
Approach		1661	4.8	0.71	18.7	LOS B	16.9	122.6	0.91	0.82	0.91	45.4
All Vehicles		2712	6.3	0.71	20.1	LOS C	16.9	122.6	0.84	0.8	0.84	44

Operational Phase Conditions (10 Years @ 3% annual growth)

Application of a 3% annual growth to the base traffic volumes significantly reduced the observed performance and increased delays experienced on the assessed roadway segment. It was observed that the level of service from Long Hill eastbound dropped from a class ‘D’ to ‘F’ over a 10-year operational period. It was also observed that capacity of Bogue/Long Hill intersection was exceeded for the aforementioned traffic movement direction, with a degree of saturation above 1, which implies that the signal would not be able to manage the approaching flows in a single cycle.

The delays experienced by vehicles leaving Long Hill, were attributed to flows being backed up by the signal at the Peninsula Intersection/Entrance in conjunction with a cumulative effect of each signal needing to manage larger flows without an increase in signal cycle capacity. The exceeded capacity observed at the Peninsula intersection has somewhat of a cumulative effect, wherein the delays are transferred to all flows contributing to it. This can also be seen by the reduced level of service for vehicles approaching from Hanover.

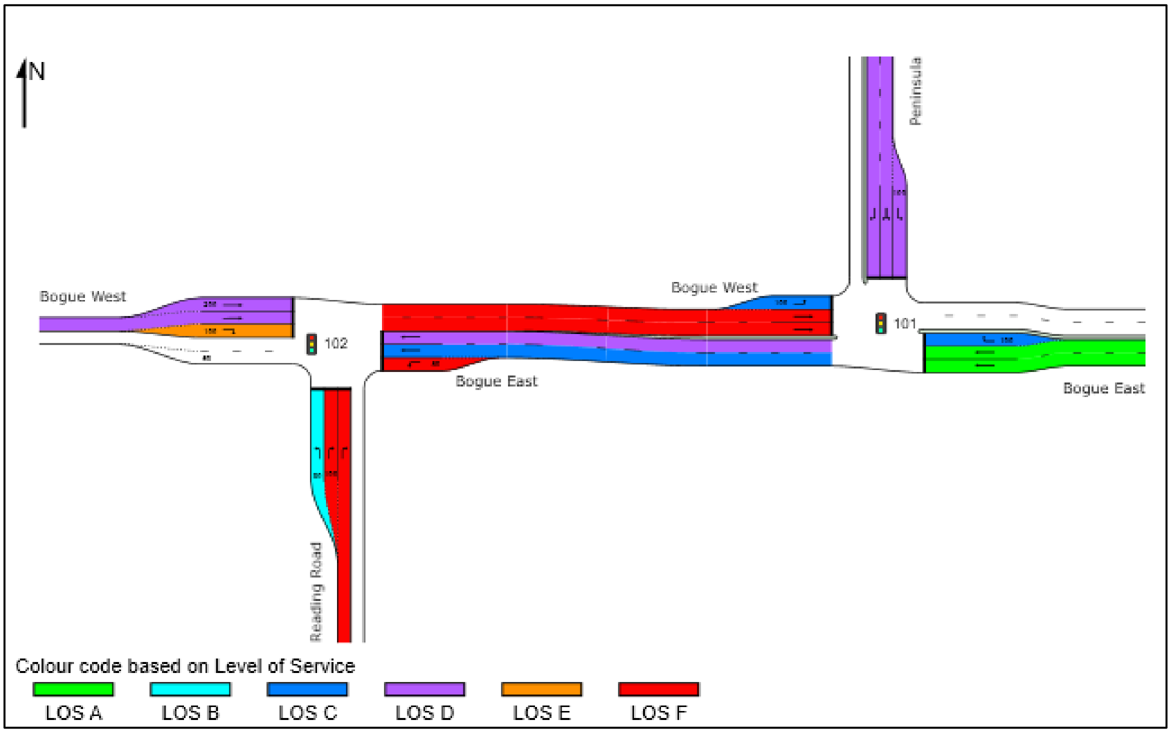


Figure 6-17 Level of service for the road segment between the Bogue/Long Hill Intersection and the Peninsula.

Table 6-21 Movement performance at the Bogue/Long Hill Intersection for the AM peak during the operational phase (10years @ 3% annual growth)

Movement Performance - Vehicles												
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Long Hill												
1	L2	18	0	0.02	17.4	LOS B	0.3	1.8	0.47	0.62	0.47	40.1
3	R2	985	4	1.08	131.7	LOS F	29.9	216.3	1	1.29	1.86	10.8
Approach		1002	4	1.08	129.7	LOS F	29.9	216.3	0.99	1.28	1.83	11.1
East: Bogue East												
4	L2	586	5	1.07	118.3	LOS F	31.7	231.9	1	1.12	1.72	20.2
5	T1	605	8	0.67	34.2	LOS C	11.5	85.5	0.76	0.76	0.76	39.2
Approach		1191	7	1.07	75.6	LOS E	31.7	231.9	0.88	0.94	1.23	26.8
West: Bogue West												
11	T1	1039	6	0.97	44.2	LOS D	17.5	128.1	0.77	0.87	1.01	22.9
12	R2	50	3	0.43	63	LOS E	1.7	12	0.98	0.74	0.98	26.8
Approach		1088	6	0.97	45	LOS D	17.5	128.1	0.78	0.87	1.01	23.1

All Vehicles		3281	5	1.08	82	LOS F	31.7	231.9	0.88	1.02	1.34	19.7

Table 6-22 Movement performance at the Bogue/Peninsula Intersection for the AM peak during the operational phase (10years @ 3% annual growth)

Movement Performance - Vehicles											
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
East: Bogue East												
5	T1	815	5	0.31	7.3	LOS A	5.2	37.9	0.41	0.36	0.41	48.5
6	R2	62	5	0.16	27.6	LOS C	1.1	8.1	0.82	0.71	0.82	40.6
Approach		877	5	0.31	8.8	LOS A	5.2	37.9	0.44	0.39	0.44	47.3
North: Peninsula												
7	L2	209	5	0.29	47.8	LOS D	3	21.6	0.87	0.77	0.87	33
9	R2	71	6	0.2	46.9	LOS D	2	14.3	0.85	0.75	0.85	23.9
Approach		280	5	0.29	47.6	LOS D	3	21.6	0.86	0.76	0.86	31.3
West: Bogue West												
10	L2	26	5	0.03	23.3	LOS C	0.4	3.1	0.55	0.67	0.55	42.4
11	T1	1995	5	1.1	142.3	LOS F	61.6	448.6	1	1.68	1.96	17.7
Approach		2021	5	1.1	140.8	LOS F	61.6	448.6	0.99	1.67	1.94	17.9
All Vehicles		3178	5	1.1	94.5	LOS F	61.6	448.6	0.82	1.22	1.41	21.1

Table 6-23 Movement performance at the Bogue/Scarlett Road Intersection for the AM peak during the operational phase (10years @ 3% annual growth)

Movement Performance - Vehicles											
Mov	Turn	Demand Flows		Deg.	Average	Level of	Aver. Back of Queue		Prop.	Effective	Aver. No.	Average
ID		Total	HV	Satn	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Cycles	Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Scarlett Road												
1	L2	72	18	0.42	41.8	LOS D	5.1	41.1	0.85	0.78	0.85	23.6
3	R2	114	19	0.42	41.8	LOS D	5.1	41.1	0.85	0.78	0.85	33.2
Approach		186	19	0.42	41.8	LOS D	5.1	41.1	0.85	0.78	0.85	30.2
East: Bogue East												
4	L2	101	23	0.08	10.4	LOS B	0.8	6.3	0.24	0.67	0.24	51.9
5	T1	1126	6	0.69	29.1	LOS C	15.2	111.7	0.82	0.81	0.82	35.3
Approach		1227	7	0.69	27.6	LOS C	15.2	111.7	0.77	0.8	0.77	37.1
West: Bogue West												
11	T1	2166	4	0.83	25.4	LOS C	28.1	203.8	0.94	0.87	0.94	42.1
12	R2	66	22	0.33	50	LOS D	1.6	13.6	0.84	0.73	0.84	29.3
Approach		2232	5	0.83	26.2	LOS C	28.1	203.8	0.94	0.87	0.94	41.6
All Vehicles		3645	6	0.83	27.6	LOS C	28.1	203.8	0.87	0.84	0.87	39.6

Condition Summary

Table 6-24 Summary of Bogue/Long Hill Intersection Scenarios

Bogue/Long Hill Intersection	Fr West: Bogue Road				Fr South: Long Hill				Fr East: Bogue Road			
	Straight		Right		Left		Right		Straight		Left	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing	10.3	B	39.9	D	15.9	B	30.3	C	21.8	C	28.4	C
Operational Phase	8.9	A	45.9	D	20.4	C	37.1	D	23.3	C	18.8	B
Operational Phase 10 years	44.2	D	63	D	17.4	B	131.7	F	34.2	C	118.3	F

Table 6-25 Summary of Bogue/Scarlett Road Intersection Scenarios

Bogue/Scarlett Road Intersection	Fr West: Bogue Road				Fr South: Scarlett Road				Fr East: Bogue Road			
	Straight		Right		Left		Right		Straight		Left	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing	7.1	A	40.9	D	29.9	C	29.9	C	20.2	C	10	B
Operational Phase	17.9	B	44.2	D	33.9	C	33.9	C	21.4	C	10.2	B
Operational Phase 10 years	25.4	C	50	D	41.8	D	41.8	D	29.1	C	10.4	B

Table 6-26 Summary of Bogue Road/ Peninsula Intersection Scenarios

Bogue/The Peninsula Intersection	Fr West: Bogue Road				Fr North: The Peninsula				Fr East: Bogue Road			
	Straight		Left		Left		Right		Straight		Right	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Existing	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Operational Phase	15.8	B	15	B	41.9	D	41.2	D	4.5	A	11	B
Operational Phase 10 years	142.3	F	23.3	C	47.8	D	46.9	D	7.3	A	27.6	C

There were slight increases in delays in the operational phase (initial) which were within an acceptable range for user satisfaction. However, the delays became significant as a result of traffic conditions that were predicted for the operational phases 10 years after completion. The LOS fell into the Class F range for some intersection approaches and in some instances, flows began to exceed signal capacity.

The performance of the Bogue Main Road is expected to remain within satisfactory bounds during construction and within the initial operational years of the development. However, it is expected that future conditions are expected to significantly stress the capacities of the road network. It was also highlighted that that Long Hill approach towards Bogue Road is the most susceptible to the effects of traffic volume increases.

6.2.4.5 Maritime Traffic

The existence of the jetty may have the potential to negatively impact other maritime activities taking place. There is also the potential for accidental collision with the structure during the night-time.

Mitigation

After construction is completed, permanent turtle-friendly lighting and light positioning should also be placed on the jetty so that they are visible to marine vessels at night-time.

7.0 IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

The discussion and analysis of alternatives in this report should consider other practicable strategies that will promote the elimination of negative environmental impacts identified. This section is a requirement of the National and Environment and Planning Agency (NEPA) and is critical in consideration of the ideal development with minimal environmental disturbance.

The following project alternatives have been identified and are discussed in further detail below:

- Alternative 1 - The "No-Action" Alternative
- Alternative 2 - The Project as Proposed in the EIA
- Alternative 3 – The Project as Proposed in the EIA, with a recreational beach along the eastern property boundary.

7.1 ALTERNATIVE 1 – THE "NO-ACTION" ALTERNATIVE

Under the No-Action Alternative, the existing property at Reading Pen would remain as is.

The **advantages** of the No-Action Alternative include:

Physical

- No nuisance from construction activities (dust, noise etc.).
- No potential sedimentation of marine environment during construction nor pollutant runoff during operations.
- No potential spillage of fuel/oil/lubricants in the marine environment during construction

Biological

- Mangroves and associated fauna remain undisturbed
- No increased sedimentation and pollutant impact on the mangroves

Human/Social

- No maritime accident potential from the physical presence of the jetty
- No increased water usage, wastewater and solid waste generation/disposal
- No increased traffic delay times due to construction activity and added vehicle volume.

The **disadvantages** of the No-Action Alternative include:

Biological

- No provision of added ecological volume from jetty pilings resulting in more available space for recruitment and colonization of hard coral and other sessile fauna.
- No creation of Fish Aggregation Devices (FADs) by the presence of the jetty pilings and the shaded areas provided.

Human/Social

- No additional real-estate investment opportunity
- No additional economic benefits to the community and economy
- No increased employment and creation of indirect and induced job opportunities

7.2 ALTERNATIVE 2 – THE PROJECT AS PROPOSED IN THE EIA

LCH Development Ltd. has acquired approximately 7 hectares (17.5 acres) of land at Reading Pen, St. James and is desirous of constructing a mixed-use residential development comprising 1,750 habitable rooms as well as commercial amenities.

The biological, physical and socioeconomic impacts and mitigation measures for the project as proposed are discussed in detail throughout this report.

The **advantages** to this alternative include:

Biological

- Provision of added ecological volume from jetty pilings resulting in more available space for recruitment and colonization of hard coral and other sessile fauna.
- Creation of Fish Aggregation Devices (FADs) by the presence of the jetty pilings and the shaded areas provided.

Human/Social

- Additional real-estate investment opportunity
- Additional economic benefits to the community and economy
- Increased employment and creation of indirect and induced job opportunities

The **disadvantages** to this alternative include:

Physical

- Nuisance from construction activities (dust, noise etc.).
- Potential sedimentation of marine environment during construction nor pollutant runoff during operations.
- Potential spillage of fuel/oil/lubricants in the marine environment during construction

Biological

- Mangrove habitat loss and disturbance of mangrove associated fauna
- Increased sedimentation and pollutant impact on the mangroves

Human/Social

- Maritime accident potential from the physical presence of the jetty
- Increased water usage, wastewater and solid waste generation/disposal
- Increased traffic delay times due to construction activity and added vehicle volume.

7.3 ALTERNATIVE 3 – THE PROJECT AS PROPOSED IN THE EIA, WITH A RECREATIONAL BEACH ALONG THE EASTERN PROPERTY BOUNDARY.

The Project as Proposed in the EIA does not have any recreational swimming beach. A swimming beach would add value to the property and further recreational offerings.

The **advantages** to this alternative include:

- Added property value
- Recreational beach use for residents and their visitors

The **disadvantages** to this alternative include:

- Additional development costs for beach nourishment activities
- Removal of additional mangroves along eastern boundary to accommodate beach works
- Poor aesthetic water quality within the lagoon not conducive for recreational swimming

7.4 THE PREFERRED ALTERNATIVE

The preferred alternative is Alternative 2 - The Project as Proposed in the EIA

8.0 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

An Environmental Management System (EMS) is an important tool which can be used to assist operations managers in meeting current and future environmental requirements and challenges. It can be used to measure a company's operations against environmental performance indicators, thereby helping the company to reach its environmental targets. A good management system will integrate environmental management into a company's daily operations, long-term planning and other quality assurance systems.

It is therefore recommended that several parameters be monitored during and after the project implementation to record any negative construction impacts and to propose corrective or mitigation measures. The suggested parameters include but are not limited to the following:

1) Water Quality to include but not be limited to:
    a. Nitrates
    b. Phosphates
    c. BOD
    d. Fats, oil and grease
    e. pH
    f. TSS
    g. Turbidity
    h. TDS
    i. Faecal Coliform
2) Noise
3) Seagrass
4) Mangroves
5) Traffic
6) Maritime Operations
7) Solid Waste Generation and Disposal
8) Sewage Generation and Disposal
9) Equipment Maintenance
10) Health and Safety

8.1 DRAFT MANGROVE AND SEAGRASS MANAGEMENT PLANS

While the Environmental Monitoring Plan (Section 8.2) entails seagrass and mangrove related monitoring practices during construction, the draft plans below give more specifics with regard to seagrass and mangrove monitoring and management.

8.1.1 Mangrove Management Plan

The Mangrove Management Plan will include a combination of existing and replanted mangrove survey/monitoring exercises and water quality monitoring during and after construction. The activities will be conducted by qualified and trained mangrove ecologists.

Existing Mangrove Surveys

Belt transects will be used to assess the existing mangrove community and record the following features:

- Tree species and numbers within sample area
- Tree heights(m) for up to 10 of each species present
- Diameter at breast height (DBH)in cm, for up to 10 of each species present
- Density of mangrove seedlings within 1 m^2.
- Visible fauna

Water level data loggers will also be deployed on the forest floor, secured in place on the substrate surface to record water temperature and pressure of water above the device (in PSI), which may be converted into depth. This provides evidence on the influence of water on the forest over a specified time.

Other observations to be made included: overall health and appearance and signs of human disturbance. The location of each transect will be recorded using a GPS.

Replanted Mangrove Sapling Surveys

Mangrove saplings will be sourced from a mangrove nursery and planted in designated and suitable rehabilitation sites by qualified mangrove ecologists. Tidal channels for water flow into the rehabilitation site will be constructed if needed. Parameters to be monitored for each species planted will include percentage survival of planted saplings, number of seedlings dead/alive, height of saplings, number of leaves on saplings, number of pneumatophores and number of prop roots.

Water Quality Monitoring

Temperature, pH, salinity, conductivity, dissolved oxygen, turbidity, total dissolved solids, nitrate and phosphate will be measured *in situ* using a Hydrolab DataSonde DS-5 multiprobe and laboratory analysis at the mangrove survey/monitoring locations. The results of the data collected will be compared with National Environment and Planning Agency (NEPA) water quality standards.

Phasing and Monitoring Frequency

The Mangrove Monitoring Programme will be implemented:

- During construction period
- Post-construction (5 years assuming replanting/afforestation)

The proposed frequency of monitoring is outlined below based on the various phases.

<u>During Construction</u>

- Visual/roving observations for drainage of oil, lubricants and excess sediments into mangrove swamp
- Monthly water quality monitoring.

<u>Post-Construction</u>

- Quarterly replanted mangrove monitoring for the first 2 years, then biannual thereafter. Water quality monitoring is also to be conducted alongside the replanted mangrove monitoring, at each relocation site, using the same frequency.

<u>Mangrove Replanting Works</u>

Any mangrove replanting works to be conducted as a mitigation measure will be done in accordance with the NEPA Mangrove Restoration and Monitoring protocols (Table 8-1 and Table 8-2).

Table 8-1 NEPA-appointed Mangrove Restoration Summary Form – Weekly log of Restoration Activity

<table>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="2">Persons Conducting Restoration:

Authorized by:</td><td colspan="2">GPS Location of Restoration Site/s: (State format):</td><td colspan="2">Date of Restoration:</td></tr>
<tr><td colspan="2">Site no:</td><td colspan="2">Week No:</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Brief summary of weekly restoration activities as implemented:</td></tr>
<tr><td colspan="2">No. of Tidal Channels Constructed or Remediated:</td><td colspan="3">Grids Planted per week (This should be accompanied by gridded map of the restoration site):</td></tr>
<tr><td colspan="2">Average Depth of Tidal Channels:</td><td>No. of Grids</td><td colspan="2">GPS Location of Grids</td></tr>
<tr><td colspan="2">Total No of Seedlings Planted: ()

Source: Nursery () Wild Stock ( )

Species: Red: () Black: () White: ( ) Button: ( )</td><td></td><td colspan="2"></td></tr>
</table>

Comments and Observations:

Table 8-2 NEPA-appointed Replanted Mangrove Monitoring Summary Form (post-relocation monitoring)

Persons Conducting Monitoring: **Authorized by:**	**GPS Location of Planting Site/s** *(State format)*:	**Date of Monitoring:** **Growth and Survival Trend Graph:**
Monitoring Period: () *Time Zero () Time Zero Plus 60 days () Time Zero Plus 180 days () Time Zero Plus 365 days* *() Year 1 Plus 180 days () Year 1 Plus 365 days () Year 2 Plus 180days () Year 2 Plus 365days* *() Year 3 Plus 180 days () Year 3 Plus 365days () Year 4 Plus180 days () Year 4 Plus 365days*		
Percentage Survival of Planted Seedlings: *Red () Black ()* *White () Button ()*	**Average No. of Seedlings:** *Live () Dead ()*	**Average Height of Planted Seedlings:** *Red () Black ()* *White () Button ()*
Average No. of Volunteer Seedlings: *Red () Black ()* *White () Button ()*	**Species Composition of Planted Seedlings** *(Percentage)* *Red () Black () White ( ) Button( )*	
Average No. of Leaves of Planted Seedlings:	**Average No. of pneumatophores:**	**Average No. of prop roots:**
Water Quality: *Temperature: Salinity: pH:*		
Date and Extent of Remedial Planting *if any (details should be outlined on the remediation monitoring form):*		
Comments, Observations, Ecological Trends:		

8.1.2 Seagrass Management Plan

The Seagrass Management Plan will include a combination of seagrass survey/monitoring exercises and water quality monitoring before, during and after construction. The activities will be conducted by qualified and trained marine scientists and SCUBA divers.

Seagrass Surveys

Ten or more 0.25m^2 quadrats, divided into 10cm x 10cm grids, will be placed randomly within the Seagrass Beds to be assessed. Within each quadrat, seagrass percentage cover, shoot density and leaf blade length of 10 random blades will be recorded. Other observations to be made included: epiphytic cover, bioturbation, overall health and appearance, and other organisms located within the seagrass beds. The location of each quadrat assessed will be recorded using a GPS.

Water Quality Monitoring

Temperature, pH, salinity, conductivity, dissolved oxygen, light irradiance, turbidity and total dissolved solids will be measured *in situ* using a Hydrolab DataSonde DS-5 multiprobe at the seagrass monitoring locations, plus other locations in and around the project area. A total of no less than four (4) water quality monitoring locations will be chosen. Water quality readings will also be taken on the inside and outside of silt screens deployed (during construction). The results of the data collected will be compared with National Environment and Planning Agency (NEPA) marine water quality standards.

Phasing and Monitoring Frequency

The Seagrass Monitoring Programme will be implemented:

- During construction period
- Post-construction (5 years assuming relocation)

The proposed frequency of monitoring is outlined below based on the various phases.

During Construction

- Quarterly (every 3 months) seagrass surveys until the end of construction
- Fortnightly water quality monitoring, in particular turbidity monitoring (for the 1st 6 months).

Post-Construction

- Quarterly relocated seagrass monitoring for the first 2 years, then biannual thereafter. Water quality monitoring is also to be conducted alongside the relocated seagrass monitoring (if any), at each relocation site, using the same frequency.

Seagrass Removal and Replanting Works (if any)

Any seagrass removal and replanting works to be conducted as a mitigation measure will be done in accordance with the NEPA Seagrass Relocation and Monitoring protocols (Table 8-3 and Table 8-4).

Table 8-3 NEPA-appointed Seagrass planting Summary Form – Weekly log of planting activities

<table>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">Persons Conducting Planting:

Authorized by:</td><td colspan="2">GPS Location of Planting Site (State format):</td><td colspan="2">Date of Planting:</td></tr>
<tr><td colspan="2" rowspan="2">Site no:</td><td colspan="2" rowspan="2">Week No:</td></tr>
<tr></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="2">Average Seagrass Harvested per day (m^2):</td><td colspan="3">No. of Grids Harvested per week:</td></tr>
<tr><td colspan="2">Total Seagrass Harvester Per week(m^2):</td><td colspan="3">No. of Grid Planted Per week:</td></tr>
<tr><td colspan="2" rowspan="2">Total Seagrass Harvester Per week by species (m^2):
Thalassia sp: Syringodium sp:

Halodule sp:</td><td colspan="2">Name of Harvested Grid</td><td>Name of Equivalent Planting Grid</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">Total Seagrass Planted to Date (This should include all seagrass planted up to the end of the week stated above):</td><td colspan="3">Overall weather conditions:</td></tr>
<tr><td colspan="5">Comments and Observation:</td></tr>
</table>

Table 8-4 NEPA-appointed Seagrass Monitoring Summary Form (post relocation monitoring)

<table>
<tr><th></th><th></th><th></th></tr>
<tr><td rowspan="3">Persons Conducting Monitoring:

Authorized by:</td><td rowspan="2">GPS Location of Planting Site (state format):</td><td>Date of Monitoring:</td></tr>
<tr><td rowspan="2">Survival Trend Graph:</td></tr>
<tr><td>Site no:
Depth:</td></tr>
<tr><td colspan="3">Monitoring Period: Monitoring Period: () Time Zero () Time Zero Plus 60 days () Time Zero Plus 180 days () Time Zero Plus 365 days
() Year 1 Plus 180 days () Year 1 Plus 365 days () Year 2 Plus 180days () Year 2 Plus 365days
() Year 3 Plus 180 days () Year 3 Plus 365days () Year 4 Plus180 days () Year 4 Plus 365days</td></tr>
<tr><td>Average Leaf Length (cm):</td><td>Percentage Cover Surviving:</td><td>Total Area replanted (m^2):</td></tr>
<tr><td colspan="3">Bioturbation Presence/Absence/Type of Animals noted:</td></tr>
<tr><td colspan="3">Water Quality Data:
Temperature: Total suspended solids: Nutrients {Nitrates and Phosphates}: Salinity:
Temperature: pH: Dissolved Oxygen: BOD: Feacal coliform: PAR:</td></tr>
<tr><td colspan="3">Incidence and Extent of Erosion: N/A</td></tr>
<tr><td colspan="3">Date and Extent of Remedial Planting if any (details should be outlined on the remediation monitoring form):
N/A</td></tr>
<tr><td colspan="3">Comments, Observations, Ecological Trends:</td></tr>
</table>

8.2 DRAFT ENVIRONMENTAL MONITORING PLAN

8.2.1 Site Preparation and Construction Phase

- Undertake weekly water quality monitoring (for the first 3 months, then fortnightly thereafter) for temperature, salinity, pH, Dissolved Oxygen, light irradiance and turbidity in and around the project area, or at a frequency agreed to with NEPA to ensure that the construction works are not negatively impacting on water quality.
  Any organization with the capability to conduct monitoring of the listed parameters should be used to perform this exercise. It is recommended that a report should be given to NEPA at the end of each monitoring exercise. This is estimated to cost approximately **J$140,000** per weekly turbidity monitoring exercise.
- Daily inspections to ensure that construction activities are not being conducted outside of regular working hours (e.g. 7 am – 7 pm). In addition to environmental noise monitoring, a noise survey should be undertaken to determine workers exposure and construction equipment noise emission. Noise monitoring to be conducted monthly at the site and settlements near to site.
  The project engineer / site supervisor should monitor the construction work hours. NEPA should conduct spot checks to ensure that the hours are being followed. The noise survey is estimated to cost approximately **J$300,000** per monitoring exercise.
- Daily monitoring to ensure that fugitive dust from raw materials are not being entrained in the wind and creating a dust nuisance.
  The project engineer / site supervisor should monitor the construction work hours. NEPA should conduct spot checks to ensure that this stipulation is being followed.
- Conduct daily inspections to ensure that flagmen where necessary are in place and that adequate signs are posted along the roadways where heavy equipment interact with existing roads. This is to ensure that traffic have adequate warnings and direction.
- Undertake daily assessment of the quantity of solid waste generated and keep records of its ultimate disposal. Additionally, solid waste generation and disposal of the campsite should also be monitored.
- Weekly assessment to determine that there are adequate numbers of portable toilets and that they are in proper working order. This will ensure that sewage disposal will be adequately treated.
- Daily monitoring of vehicle refuelling, and repair should be undertaken to ensure that these exercises are carried out on hardstands. This is to reduce the potential of water/soil/sand contamination from spills. Spot checks should be conducted by NEPA.
- Traffic and maritime operations should be monitored to ensure approved management plans at critical areas are being followed. NEPA and NWA and other relevant authorities should perform spot checks to ensure compliance. Monitoring should be conducted daily to ensure major disruption is avoided. Reports should be made to NWA on a fortnightly basis.

- Undertake daily inspections to ensure that workers are wearing adequate personal protective equipment (PPE), such as hard hats, hard boots, air protection, safety glasses, reflective vests and fall protection is necessary. Ensure that safety signage is in place.
- Health, safety and emergency response plans should be prepared prior to site preparation and construction phases.
- Where possible, construction crews should be sourced from within the study area. This will ensure that the local community will benefit from the investment.
- Seagrass in the vicinity of the monitoring sites should be monitored quarterly or at a frequency agreed to with NEPA.
- Mangrove swamp water quality will also be monitored to ensure there is no drainage of oil, lubricants and excess sediments into the mangrove swamp.

8.2.2 Operational Phase

- Water quality monitoring should be done at least fortnightly after construction. If three to six results demonstrate that the site or parts of the site have stabilised, the sampling frequency and sampling locations may be reviewed and reduced or discontinued as per and approved monitoring plan. This is estimated to cost approximately **J$ 140,000** per monitoring exercise.

8.2.3 Reporting Requirements

8.2.3.1 Water Quality

A report shall be prepared by the Contracted party. It shall include the following data:

i. Dates, times and places of test.
ii. Weather condition.
iii. A defined map of each location with distance clearly outlined in metric.
iv. Test Method used.
v. Parameters measured
vi. Results
vii. Conclusions

The report will be submitted to the Client or his designate within two weeks of the monitoring being completed.

The Client shall distribute the report within four (4) weeks of testing being completed to NEPA.

In the event that the water quality does not meet the required criteria, investigations shall be carried out and corrective actions were necessary taken and a re-test shall be scheduled at the earliest possible time and a new report submitted.

If three (3) to six (6) results demonstrate that the site or parts of the site have stabilised, the sampling frequency and sampling locations may be reviewed and reduced or discontinued as per approved monitoring plan.

Reports will be maintained on file for a minimum of three years.

8.2.3.2 Particulates

A report shall be prepared by a Contracted Party during construction. The report will summarize the results of the particulates monitoring. This report will provide information relative to $PM_{2.5}$ and PM_{10} concentrations.

i. Dates, times and places of test.
ii. Test Methods used.
iii. Copies of instrument calibration certificates.
iv. A defined map of each sampling location with distance clearly outlined in metric
v. Particulates measured to be compared with the NEPA Air Quality PM_{10} Standards and US EPA $PM_{2.5}$ Standards.
vi. Evaluation of data, discussions and statement giving a professional opinion of the emissions impact on the employees.

The report shall be submitted to the Client within four weeks after completion of testing.

The Client shall distribute the report within four (4) weeks of testing being completed to NEPA.

In the event that emissions do not meet the required criteria, investigations shall be carried out and corrective actions were necessary taken and a re-test shall be scheduled at the earliest possible time and a new report submitted. Reports will be maintained on file at the plant for a minimum of three years.

8.2.3.3 Noise

A report shall be prepared by a Contracted Party during construction. The report will summarize the results of the noise monitoring. This report shall include the following data:

i. Dates, times and places of test.
ii. Test Method used.
iii. Copies of instrument calibration certificates.
iv. Noise level measurements in decibels measured on the A scale (Leq), Lmin and Lmax.
v. Noise levels measured in low, mid and high frequency bands (dBL)
vi. A defined map of each location with distance clearly outlined in metric
vii. Evaluation of data, discussions and statement giving a professional opinion of the noise survey.

The report shall be submitted to the Client within four weeks after completion of testing.

The Client shall distribute the report within four (4) weeks of testing being completed to NEPA.

In the event that emissions do not meet the required criteria, investigations shall be carried out and corrective actions were necessary taken and a re-test shall be scheduled at the earliest possible time and a new report submitted. Reports will be maintained on file for a minimum of three years.

8.2.3.4 Seagrass

A report shall be prepared by the Contracted party. It shall include the following data:

1. Percentage cover of various seagrass species
2. Shoot density
3. Leaf blade length
4. Presence of fish nets, pots, invasive and rare species.
5. Dates, times and places of test.
6. Weather condition.
7. A defined map of each survey location with distance clearly outlined in metric.
8. Other Data

Any rare, endangered, commercially important (lobster and conch) and invasive organisms (lionfish) observed will also be noted and photographed, as well as the presence/absence of seagrasses. Any obvious sedimentation, anchor damage, marine debris and other direct impacts will also be recorded.

The report will be submitted to the Client or his designate within two weeks of the monitoring being completed.

The Client shall distribute the report within four (4) weeks of testing being completed to NEPA.

Reports will be maintained on file for a minimum of three years.

9.0 CONCLUSION AND RECOMMENDATIONS

This proposed development is slated to increase the real estate investment opportunities of the island, thereby creating jobs in the process and economic benefits. On the contrary, the degradation, loss and adverse effects of natural habitats as well as impacts on the marine water quality and traffic delay times are some of the potential negative impacts of the project. These concerns are highlighted through studies and public interviews conducted for the purposes of this report.

The implementation of the recommended mitigation measures detailed in this report, as well as the various environmental management and monitoring programmes, will assist in reducing these negative impacts.

10.0 REFERENCES

Adams, C. D., 1972. *Flowering plants of Jamaica.* s.l.:University of the West Indies.

Aho, K. & Beck, E., 2011. Effects of epiphyte cover on seagrass growth rates in two tidal zones. *Dartmouth Undergraduate Journal of Science,* p. 43–44..

Borum, J., Duarte, C. M., Krause-Jensen, D. & Greve, T. M., 2004. *European seagrasses: An introduction to monitoring and management. The M&MS project.,* s.l.: s.n.

Brandt, L. & Koch, E., 2003. Periphyton as a UV-B filter on seagrass leaves: A result of different transmittance in the UV-B and PAR ranges. *Aquatic Botany,* 76(4), p. 317–327.

C.L. Environmental Co. Ltd., 2016. *EIA for the NFE North Holdings Ltd. Montego Bay Micro-LNG Receiving Terminal,* s.l.: s.n.

C.L. Environmental Co. Ltd., 2020. *Princess Hotels and Resorts Development at Cove, Hanover,* s.l.: s.n.

CEAC Solutions Co. Ltd., 2022. *Peninsula Montego Bay - Hazard Assessment Report,* Kingston: CEAC Solutions Co. Ltd..

CEAC Solutions Co. Ltd., 2022. *Peninsula Traffic Impact Assessment,* s.l.: s.n.

CEAC Solutions Co. Ltd., 2022. *The Peninsula Jetty Design Report, Montego Bay Marina (DRAFT),* Kingston: CEAC Solutions Co. Ltd..

Chin, A., 2014. *A Comparative Study of Mangrove Forests on the North Coast of Jamaica with Reference to the Port Royal Mangroves,* s.l.: UWI Mona.

Davenport, A. G., Georgiou, P. M. & Surry, D. A., 1985. *Hurricane Wind Risk Study for the Eastern Caribbean, Jamaica and Belize with Special Consideration to influence of Topography,* Ontario: Boundary Layer Wind Tunnel Laboratory, University of Western Ontario, Faculty of Engineering Science.

Dawes, C., 1998. *Marine Botany (2nd ed.). ,* Toronto: John Wiley and Sons Inc..

Downer, A. & Sutton, R., 1990. *Birds of Jamaica.* Cambridge: Cambridge University Press.

Emanuel, K., 2013. Downscaling CMIP5 climate models shows increased tropical cyclone activity over the 21st century. *Proceedings of the National Academy of Sciences,* 110(30), pp. 12219-12224.

Emanuel, K., Sundararajan, R. & Williams, J., 2008. Hurricanes and global warming: Results from downscaling IPCC AR4 simulations. *Bulletin of the American Meteorological Society,* pp. 89, no. 3: 347-367..

Fisheries Division, Ministry of Agriculture and Lands, 2008. *Draft Fisheries Policy.* s.l.:s.n.

Garraway, E. & Bailey, A. J., 2005. *Butterflies of Jamaica.* s.l.:Mcmillan Caribbean.

Government of Jamaica, 1975. *The Fishing Industry Act.* s.l.:s.n.

Government of Jamaica, 2011. *The Second National Communication of Jamaica to the United Nations Framework Convention on Climate Change.* [Online] Available at: http://www.energycommunity.org/documents/snc2jamaica.pdf

Hogarth, P., 2007. *The Biology of Mangroves and Seagrasses. 2nd Edition. ,* s.l.: Oxford University Press, 2007.

Hogarth, P., 2015. *The Biology of Mangroves and Seagrasses.* 3rd ed. New York: Oxford University Press.

Horizon Construction Jamaica Limited, 2022. *Peninsula Mobay Foundation Recommendations,* Kingston: Horizon Construction Jamaica Limited.

Horizon Construction-Jamaica Limited, 2022. *Peninsula Mobay Geotechnical Report, Montego Bay, St. James, Jamaica (1078-21),* Kingston: Horizon Construction-Jamaica Limited.

Jackson, D., 1994. *The ecology of Prycrptotermes corniceps in Port Royal Mangal with some reference to Incisitermes schwarzi,* s.l.: Jackson, D. The ecology of Prycrptotermes corniceps in Port Royal Mangal wi University of the West Indies.

Jackson, G., 2019. *A baseline assessment of water quality and seagrasses within the Kingston Harbour and Port Royal Cay.,* s.l.: s.n.

Jamaica Tourist Board, 2020. *Annual Travel Statistics 2020,* Kingston: Research & Market Intelligence Unit – Jamaica Tourist Board.

Jones, J., 2016. *Investigating the Use of Statistical Models for Projecting Future North Atlantic Tropical Cyclone Frequency.* s.l.:s.n.

Knutson, T. R. et al., 2013. "Dynamical downscaling projections of 21st century Atlantic hurricane activity: CMIP3 and CMIP5 model-based scenarios. *J Clim.*

Koopmans, D. et al., 2020. High Net Primary Production of Mediterranean Seagrass (Posidonia oceanica) Meadows Determined With Aquatic Eddy Covariance.. *Frontiers in Marine Science,* Volume 7, p. 118.

Masson-Delmotte, V. P. Z. H.-O. P. D. R. J. S. P. R. S. A. P. e. a., 2018. *"Global warming of 1.5 C." An IPCC Special Report on the impacts of global warming of 1,* s.l.: s.n.

McFarlane, J., 2021. *A Comparative Analysis between the mangrove forest sites in South and West Falmouth, Trelawny, Jamaica,* Kingston: UWI Mona.

Murakami, H., n.d. *Future Changes in Tropical Cyclone Activity Projected by the New High-Resolution MRIAGCM.* s.l.:s.n.

Murakami, T. J. Y. a. T. Y., 2012. *PREDICTION OF MAXIMUM POSSIBLE STORM SURGES IN ISE BAY UNDER A FUTURE CLIMATE.* s.l., s.n., pp. no. 33: currents-47..

National Environment and Planning Agency, n.d. *Protected Areas System Master Plan: Jamaica 2013 – 2017, Final Submission to the Protected Areas Committee,* s.l.: s.n.

Natural Resources Conservation Authority, 1997. *Coral Reef Protection and Preservation Policy and Regulations.* [Online].

Nelson, W. G., 2017. Development of an epiphyte indicator of nutrient enrichment: Threshold values for seagrass epiphyte load. *Ecological Indicators,* Volume 74, p. 343–356.

Oppenheimer, M. B. G. ,. J. H. R. v. d. W. A. M. A. A.-E. R. C. M. C.-J. R. D. T. G. J. H. F. I. B. M. B. M. a. Z. S., 2019. *Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities,* s.l.: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate.

Orth, R. J. & Van Montfrans, J., 1984. Epiphyte-seagrass relationships with an emphasis on the role of micrograzing: A review.. *Aquatic Botany,,* Volume 18(1–2), pp. 43-69.

Osborne, P., 2012. *Tropical Ecosystems and Ecological Concepts. 2nd ed. ,* s.l.: Cambridge University Press.

Protected Areas Committee, 2012. *Protected Areas System Master Plan: Jamaica,* s.l.: s.n.

Raffaele, J., 1998. *A Guide to the Birds of the West Indies.* s.l.:Princeton University Press.

Saunders, M. A. & Lea, A. S., 2008. Large contribution of sea surface warming to recent increase in Atlantic hurricane activity. *Nature,* 451(7178), pp. 557-560.

Short, F., 2016. Impacts of climate change on submerged and emergent wetland plants.. *Aquatic Botany.*

Siikamaki, J., Sanchirico, J. & Jardine, S., 2012. *Global Economic Potential for reducing carbon dioxide emissions from mangrove forests,* California: Standford University,.

Social Development Commission, 2010. *Reading Community Profile,* s.l.: Social Development Commission.

Solomon, S., 2007. *Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC.* Vol. 4. ed. s.l.:Cambridge University Press.

South China Construction and Engineering Ltd., 2022. *Stormwater Drainage Design Report,* s.l.: s.n.

United Nations, 1952. *Manual I: Methods for estimating total population for current dates.* Sales No. 52.XIII.5 ed. s.l.:United Nations Publications.

Villarini, G. & Vecchi, G. A., 2012. Twenty-first-century projections of North Atlantic tropical storms from CMIP5 models. *Nature Climate Change,* 2(8), pp. 604-607.

11.0 APPENDICES

Appendix 1 – Terms of Reference

TERMS OF REFERENCE
For An
ENVIRONMENTAL ASSESSMENT

For

Mixed-Use Development

At

Reading Pen, St. James

By

LCH Development Limited
Montego Bay, St. James

Date: 23 February 2022
Submitted By: C.L. Environmental Company Limited
Prepared by: Carlton Campbell

Terms of Reference for an Environmental Assessment
Proposed Mixed Use Development at Reading Pen, St. James

Table of Contents

LIST OF FIGURES

PROPOSED PROJECT

The proposed development will be located at 2 Reading Pen, Montego Bay, St. James (Figure 1).

The Peninsula in Reading Montego Bay seeks to offer luxury living with supreme amenities to promote a lifestyle of wellbeing. The 17.5 acre (≈7.08 ha) waterfront property entails 5 zones.

Zone 1: The Villas at The Peninsula

- 15 3000 sq. ft. modern 3 bedroom villas along the waterfront with large glazing and open-concept space to allow light from the morning sunrise.
- Garage space, staff quarters, pool, and deck with pergola
- 2 levels

Zone 2: The Peninsula Bay

- 7000 sq. ft. fine dining restaurant with panoramic views of the sea.
- 5000 sq. ft. clubhouse and lounge
- 3400 sq. ft. karaoke lounge
- 6 guest apartments
- Mini marina that has at least 8 berths for residents that own boats. Also, for the docking of restaurant patron

Zone 3: The Towers at the Peninsula

• 4 high rise towers approx. 336 ft. tall. Each tower offers a different product to support residences in the sky.

Each building is tiered to suit the clientele needs.

- Towers 1 and 2 are geared to support the working sector and their families that would like to work remotely. In addition to the usual amenities such as the pool deck and bar, fitness centre, kids lounge and adult entertainment lounges, there will also be office lounges and meeting rooms available to suit their needs.

- Tower 3 is geared towards the young at heart that have retired and wants to relax in the sun, sand, and sea at their leisure. In addition to the pool deck, outdoor/ indoor lounges, the amenities in this tower include special fitness activities and areas of leisure to support a mature clientele.

- Tower 4 is the ultra-lux high-rise residence topped with a sky villa. Additional square footage in each unit creates a boutique setting with fewer units with a large variety of top-class amenities. a mini theatre, a trendsetting games room, bar and lounges with catering services and a full-service spa, to name a few, will be available in this tower.

Modern clad multi-storey parking garages will support the towers with sufficient parking spaces and storage spaces for each unit with the amenities on the roof. This will include large swimming pools adorned with cabanas, kid's swimming pools, restrooms, BBQ pergolas and outdoor activity decks.

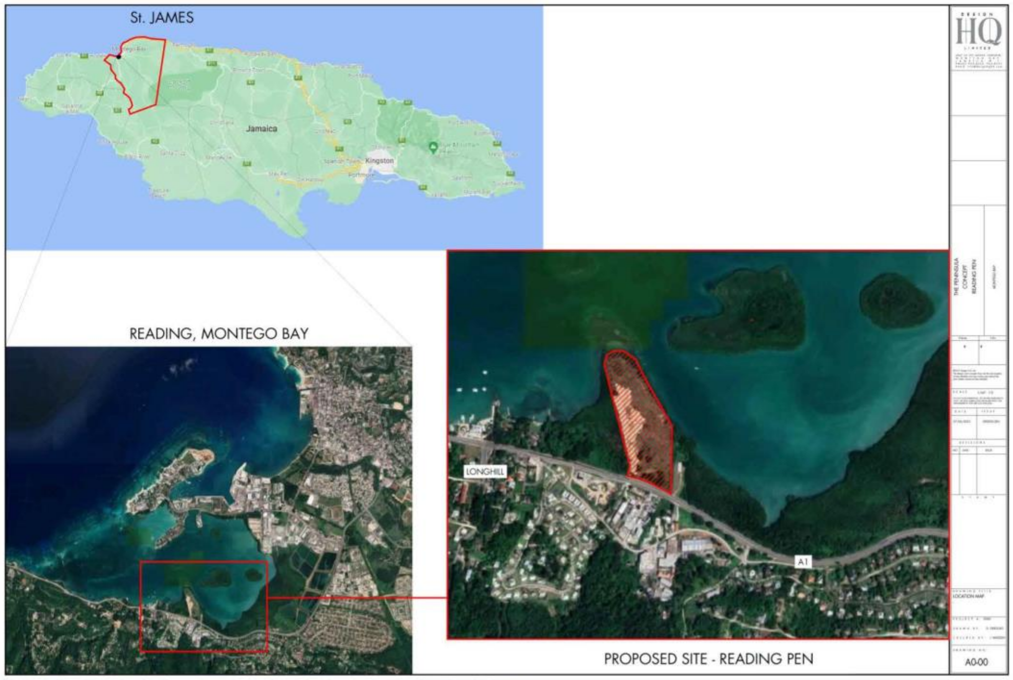


Figure 1 Location Map for the proposed mixed-use development at Reading Pen, St. James

Zone 4: The Commercial spaces

- Supermarket and Deli with a mini food court in a 15,000 sq. ft. building. The entrance area to this building has a covered courtyard with a large canopy for patrons to enjoy outdoor seating set around planter boxes and landscaping with vending kiosks.
- Shops and offices in a three-storey building to support the residences in the complex and the surrounding areas. These spaces are intended to be a doctor's office, pharmacy, high-end retail, and executive offices.

Zone 5: The General Ground Amenities and Project Management and Back of house buildings

- The amenities on the ground will include two tennis courts and one basketball court. The property will also have recreational parks with jogging/walking trails and gazebos.
- Towards the east of the towers, there will be a meandering water feature with outdoor landscaped lounges and gazebos. The ponds are excavated spaces lined with heavy-duty pond liners to be filtered with fountain and pump systems.
- The development will also have backup generator systems.

All 5 zones culminate in one setting to create an epic living environment.

Figure 2 illustrates the master plan of the proposed development.

The project will employ green energy solutions with a planned lush landscape to blend with the existing natural character of the area. Water supply and sewage will tie into NWC infrastructure

Figure 2 Master Plan for the proposed mixed-use development at Reading Pen, St. James

Foreword

The purpose of this document is to establish the Terms of Reference (TOR) for the Environmental Assessment (EA) for a Mixed-Use Development at Reading Pen, St. James. An EA seeks to identify the impacts the proposed project is likely to have on the area in which the physical development will be carried out as well as the impact of the environment on the proposed development. It also outlines mitigation measures necessary to reduce the negative impacts of the project.

The EA will be prepared using a participatory approach involving key stakeholders. The EA report must be produced in accordance with the agreed TOR issued by the National Environment and Planning Agency (NEPA) to the Proponent.

Where the need arises to modify the TOR, the required amendments/modifications are to be made and submitted to the Agency. Approval for the TOR must be obtained from the Agency, in writing, prior to the commencement of the EA study.

The National Environment and Planning Agency and the Natural Resources Conservation Authority (NRCA) reserves the right to reproduce, transfer and disclose any and all contents contained in the submitted Environmental Assessment report without the written consent of the proponent, consultants and/or its agents.

The Terms of Reference to conduct the Environmental Assessment (EA) are as follows:

1.0 EXECUTIVE SUMMARY

Provide a brief statement on the content of the EA report. The executive summary should provide a comprehensive overview and objectives for the project proposal, natural resources, justification for the project, etc. In addition, it should include relevant background information and provide a summary of the main findings, including but not limited to main impacts and mitigation measures, analyses and conclusions, key elements of the environmental monitoring and management plan and project alternatives in the report.

2.0 INTRODUCTION

The introduction should provide a background and seek to explain the need for and the context of the project and the EA. It should also provide the delineation and justification of the boundary of the study area, general methodology, assumptions, and constraints of the study. Additionally, a profile of the project proponent, implementing organization, project consultants, etc. should also be provided. The study area shall include at least the area within a 2km radius of the boundaries of the proposed project area.

3.0 LEGISLATION AND REGULATORY CONSIDERATION

This section should provide details of the pertinent regulations, standards, policies, and legislations governing environmental quality, safety and health, cultural significant finds, protection of sensitive areas, protection of endangered species, tourism enterprises, siting, and land use control at the local and national levels. The examination of the legislation should include at a minimum the Natural Resources Conservation Authority Act 1991, Natural Resources Conservation Regulations 1996, amended 2015, Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013, Beach Control Act,, Jamaica National Heritage Trust Act, Wild Life Protection Act, Fisheries Act 2018, National Solid Waste Management Authority Act, the Town and Country Planning Act, Building Act and Codes and Standards promulgated there under, Planning Guidelines – Development Orders and Plans and all appropriate international convention/protocol/treaty where applicable. Describe traditional land use and advise of any prescriptive rights including public access rights.

4.0 PROJECT DESCRIPTION

The report should provide a comprehensive description of all proposed terrestrial and marine project component, including information necessary to identify and assess the potential environmental impacts of the project. This should include but not be limited to:

- An overall master plan of the site including current, proposed, and future use of the lands showing the various components and design elements of the proposed development
- Location Map and total site area
- Objectives and information on, rationale for the project
- History and Project Background, the nature, location/existing setting, timing, duration, frequency, general layout, as well as the impact on the carbon footprint of the energy sector are to be discussed
- Existing site and its characteristics (landward & seaward)
- Description of the surrounding areas
- Site maps illustrating areas to be impacted and areas to be preserved in their existing state
- Construction methods, works, duration and maintenance schedule, which must include methodology for the proposed cutting/trenching, coastal protection works and marina.
- Detailed description of the project, project objectives and phases (where applicable), including all applicable timelines for the various aspects of the project (from pre to post development). The description should also provide details of the design concept, design components, material(s) to be used, total number, size, of rooms/residences, types of villas, and commercial areas; design height of structures above sea level and Jamaica Civil Aviation Authority approval of same; and supporting services such as administrative, "back-of-house" facilities, standby power generation, and amenities to serve the proposed development such as pools, restaurants etc. This should be supported using maps, diagrams, and other visual aids where appropriate.
- Detailed description of all activities and features which will introduce risks or generate an impact (positive or negative) on the environment including but not limited to mangrove removal, seagrass and/or coral relocation and shading; collection, beach works, transfer, and disposal of waste (solid waste and sewage); provision of potable water and electricity; and dredging/excavation if required.
- Details of the methods, equipment, and machinery to be employed to undertake each aspect of the project including coral/seagrass relocation, dredging/excavation if required, transportation of material, disposal of spoils (if applicable), storage of material, installation of pylons, construction of units, installation of required infrastructure and secondary activities such as

refuelling of vessels, proposed location(s) for equipment storage (staging area) and establishment of a site office.

- The study area should be clearly delineated and referenced. Considering the types of resources located in the area and the magnitude of the associated impacts, the study area should be large enough to include all valued resources that might be significantly affected by the project.
- Details of any design that demonstrates the incorporation of Smart Green city Strategies.
- Detailed drainage report which should be designed for a 1 in 100-year event
- Details regarding access points and accessibility during pre-construction, construction, and post-construction, to the proposed work site(s)
- Subdivision approval, zoning, and overall design considerations/requirements (setbacks, density, height, parking areas/garages etc).
- Sewerage Treatment and disposal and engagement with the NWC regarding connection to the sewerage network.
- Estimated duration and schedule of the project for construction
- Details of any required decommissioning of the works and/or facilities.

5.0 DESCRIPTION OF ENVIRONMENT

This section should include a detailed description of the proposed sites (marine and terrestrial) and surrounding environment. Baseline data should be generated in order to give an overall evaluation of the existing environmental conditions. The study area should be large enough to include all valued resources that might be significantly affected by the project. This information will form the basis upon which impacts of the project will be assessed. The following aspects should be described in this section, broken down into the following:

- Physical Environment
- Biological Environment
- Socio-economic and Cultural/Heritage

5.1 Physical Environment:

- Topography, soils, climate/meteorology, drainage (including gullies), classification of coastal sediments, geology (including but not limited to rock type and formation, susceptibility to erosion, seismicity, and faults), geomorphology of the site and impacts on current landscape, aesthetic appeal and hydrology should be examined. Special emphasis should be placed on storm water runoff and drainage patterns within and outside of the mangrove coastline. A Geotechnical study should also be conducted within the proposed project area (on land).
- Hydrodynamic (current) modelling will be executed to include but not limited to:
    a. Collection and analysis of bathymetric data
    b. Analysis and incorporation of tidal fluctuations
    c. Analysis of sediment loading in project area generated from storm water runoff and discharge
    d. Analysis of circulation patterns (dry and wet rainfall seasons).
- Wave modelling will be executed including but not limited to:
    a. Scenarios to be considered:

        - Hurricane (25-, 50- and 100-year Return Periods)
        - Operational
        - Swell
    b. Collection and analysis of bathymetric data
    c. Determination of deepwater and nearshore wave climate
    d. Detailed hydrological assessment to be conducted.
- Detailed hydrological assessment of the proposed project area will be conducted to include:
    a. Identify and clearly map locations of natural and manmade drainage features within the project area. These are to include sinkholes, rivers, gullies, and drainage infrastructure
    b. Estimation of peak flows under the 10-, 25-, 50- and 100-year Return Periods
    c. Flushing/circulation analysis of immediate coastal area against generated stormwater runoff.
- Water Quality of the marine and freshwater environment (Figure 3). Baseline water quality should include study areas and associated environs and control sites. These should be accurately mapped, and a spatial and temporal comparison of the data should be done in order to determine any possible source(s) of pollutants. Baseline data will be collected for both wet and dry season. Water quality should include but not be limited to the following parameters:
    - Physical parameters: Temperature, salinity, conductivity, pH, dissolved oxygen, turbidity, Total Suspended Solids and Total Dissolved Solids.
    - Chemical Parameters: Nitrate, Phosphate, Total Petroleum Hydrocarbons.
    - Biological Parameters: Biochemical Oxygen Demand, Faecal Coliform, Enterococcus.
    - Results from the water quality sampling should be compared to NRCA water quality standards.

- Analysis of Marine Sediments should include but not be limited to the following parameters:
    - Arsenic
    - Cadmium
    - Mercury
    - Lead
    - Total Petroleum Hydrocarbons
- Analysis of Sediment Loading in project area (Figure 4)
- Noise levels of undeveloped site and the ambient noise in the area of influence (Figure 5).
- Particulate Matter (PM10 and PM2.5) of the undeveloped site and in the area of influence (Figure 5).
- Sources of existing pollution (coastal, surface and groundwater) and extent of contamination.

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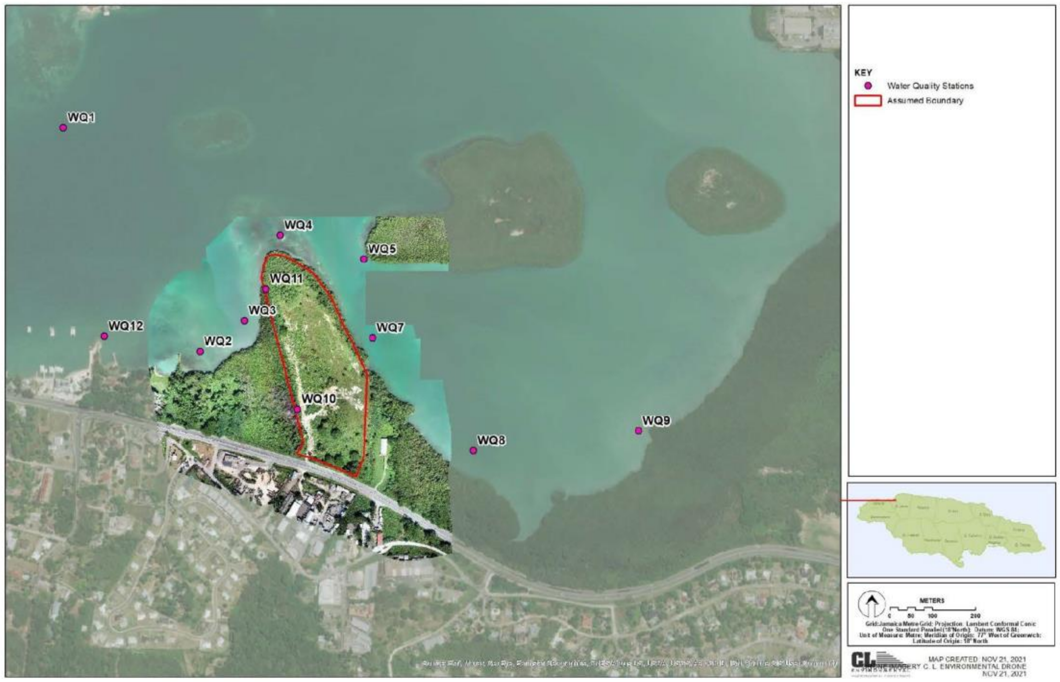

Figure 3 Proposed water quality sampling station

Terms of Reference for an Environmental Assessment
Proposed Mixed Use Development at Reading Pen, St. James

Figure 4 Proposed sediment trap and benthic sediment sampling locations

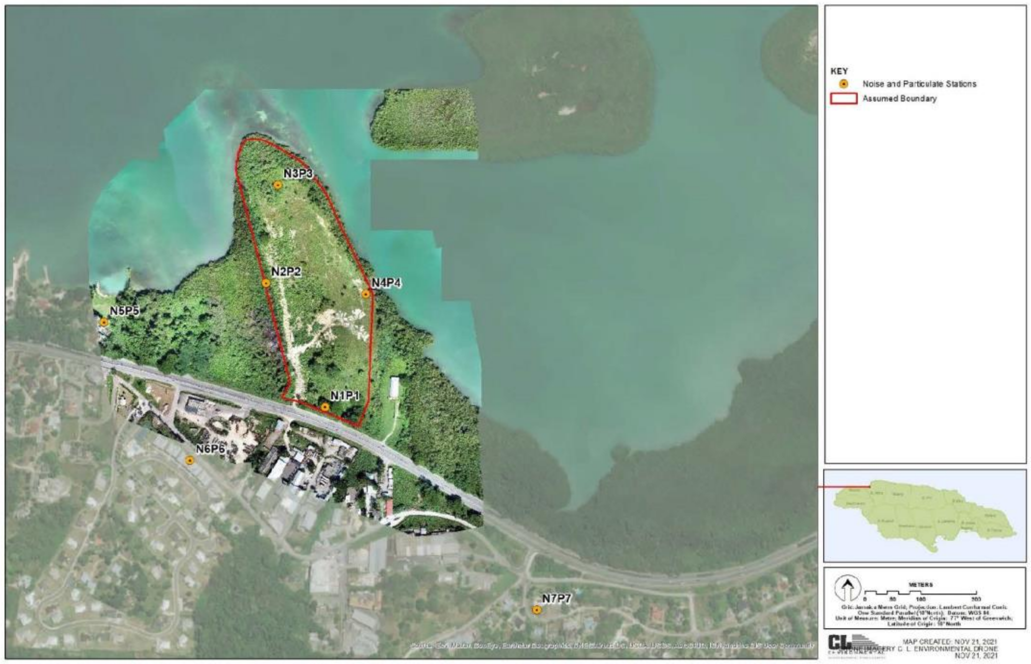

Figure 5 ***Proposed noise and particulate sampling stations***

5.2 Biological Environment:

Detailed description of terrestrial and marine habitats, existing vegetation type, detailed floral and faunal surveys inclusive of a species list; GPS Reference points, commentary on the biodiversity, ecological health and function in the project area, threats and conservation and significance. This should include:

- A qualitative and quantitative assessment of ecologically sensitive terrestrial and marine habitats in and around the proposed project sites and the areas of impact.
- Benthic surveys should be conducted with emphasis placed on the working footprint (seafloor) inclusive of temporary access points and buffer zones, which will be impacted by the proposed project structures/features such as coastal protection works, marina structures, beach nourishment and dredging/excavation (if required).
- Provision of options suitable to compensate for the unavoidable loss of seagrass and/or coral, including relocation/rehabilitation plans.
- A species list of terrestrial and marine flora and fauna (including but not limited to marine mammals, herpetofauna, avifauna, invertebrates and bats should be generated with special emphasis on those species considered rare, threatened, endangered, endemic, protected, invasive and economically or nationally important. Migratory species should also be considered.
- Identification and description of the different ecosystem types and structure including species dominance, possible biological loss or habitat fragmentation ought to be considered.
- The benthic survey should include the size and species name of all coral colonies within the footprint.
- Include abundance, height, and diameter at breast height (DBH) for a representational subset of all floral species.
- Assessment areas should be geo-referenced and displayed on a site overlay map in relation to the footprint of the development.
- The location of threatened and endemic flora and fauna species should be geo-referenced and displayed on a site overlay map in relation to the footprint of the development.
- Vegetation profile including, but not limited to the GPS location, height and DBH measurement of large trees
- Habitat Map of the area should be generated
- Any crocodile, sea turtle or bird nests observed in or around the project area should be recorded and mapped. This should be supported by information including but not limited to the following: existing sea turtle and bird nesting sites and seasons and habitat usage by migratory species

5.3 Mangrove Community

- A detailed assessment of the mangrove ecosystem should be conducted to include:
    - Mangrove Tree species and numbers within sample area
    - Mangrove Tree heights (m) for up to 5 of each species present
    - Diameter at breast height (DBH) in cm, for up to 5 of each species present
    - Density of mangrove seedlings within 1 m^2. This will be conducted in a randomly selected patches within the sample area.
    - Visible fauna
    - Standing water depth and salinity
    - Possible impact of wetland modification activities on surrounding areas
    - Determination of amount of mangrove to be impacted
    - Overall health and appearance and signs of human disturbance. The location of each transect will be recorded using a GPS.
    - Provision of options suitable to compensate for the unavoidable loss of mangrove trees, including a mangrove monitoring and rehabilitation plan.

Special emphasis must be placed on the hydrology within the mangrove swamp as well as investigating the existing mangrove mortality within the swamp and possible steps to rehabilitate.

5.4 Natural Hazard Vulnerability

Potential Natural Hazards and Disaster Risk Reduction Strategies (with consideration for Climate Change) will be assessed in relation to:

i. Hurricane Winds
ii. Flooding of the proposed development and associated access roads, which will guide the finished floor levels, will be investigated under the following scenarios:
    a. Storm surge
    b. Seal Level Rise (SLR)
    c. Pluvial flood events
    d. Flood risks associated with the drainage feature west of the development.
iii. Coastal Erosion
    a. Short term erosion
    b. Long term erosion
    c. Shoreline/beach stability under current and future scenarios
iv. Seismic Risk to be evaluated in relation to findings of the geotechnical study.

The natural hazard risk assessment should take in account, with considerations for future climate projections, for return periods of 25-, 50- and 100-year.

5.5 Climate Change Considerations

Carbon sequestration calculations will be conducted for any mangrove or seagrass community within the project area.

5.7 Traffic Impact Assessment

The objectives are to investigate the potential impact of the traffic during construction and during operations on the existing and future main road traffic. Two accesses will be required, with one being the main entrance that will be either signalized or not and the other unsignalized and used very infrequently.

It will involve:

- Meeting with the St. James Municipal Corporation and National Works Agency to discuss the project parameters and assumptions that will be made to refine the scope of works required for approval
- Background Data Collection:
    - Existing traffic count data on main road and associated intersection
    - Field/road conditions parameters will be collected for all the relevant roads and intersections
    - Other developments currently planned within the area

The data collected will be used to describe the existing conditions at all the selected locations. Comparisons will also be drawn to show what the existing conditions are as opposed to what the standards recommend. Analysis will be conducted to determine the existing Level of Service (LOS) at each intersection as well as on the roads.

The potential impact of hotel construction and operations on LOS will be determined and recommended mitigation measures provided.

5.8 Socioeconomic and Cultural/Heritage:

This section should provide details on: Demography, regional setting, current and potential land-use patterns; description of existing infrastructure such as transportation, electricity, water and telecommunications, and public health and safety; should be explored and other material assets of the area should also be examined. This will be done within 5 km of the proposed site.

A socio-economic survey within 2km of the proposed development to determine public perceptions of the project (both negative and positive) should also be completed and this should include but not be limited to potential impacts on social, physical, biological, and historical/cultural values. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires. The methodology for conducting the survey should be included as part of the EA report.

6.0 PUBLIC PARTICIPATION

Describe the public participation methods, timing, type of information provided and collected from public and stakeholder target groups meetings. The instrument used to collect the information must be included in the appendix. It may be useful and necessary to hold stakeholder meetings to inform the public of the proposed development and the possible impacts. This will also gauge the feeling/response of the public toward the development.

Stakeholders to be consulted will include but not be limited to: St. James Municipal Corporation, the National Fisheries Authority, and the Montego Bay Marine Park Trust.

The issues identified during the public participation process should be summarized and public input that has been incorporated or addressed in the EA should be outlined. Public Meetings should be held in accordance with the Virtual Guidelines for Conducting Public Presentation set forward by the National Environment and Planning Agency (NEPA). A virtual public meeting will be held to present the findings of the EA once the EA is completed and submitted for consideration. All relevant documents are required to be made available to the public. In addition, any material change to the design of the project will require a further public meeting to be undertaken by the developer and all changes made to the document. should be clearly outlined to the public.

7.0 IDENTIFICATION AND ASSESSMENT OF POTENTIAL IMPACTS AND RECOMMENDED MITIGATION MEASURES

A detailed analysis of the project components should be done in order to: identify the major potential environmental and public health impacts of the project; distinguish between levels of impact, significance of impact (a ranking from major to minor/significant to insignificant should be developed), positive and negative impacts, duration of impacts (long term or short term or immediate), direct and indirect and impacts, reversible or irreversible, long term and immediate impacts and identify avoidable impacts.

Cumulative impacts should also be evaluated considering previous developments and any proposed development immediately adjacent to the subject development within the area. The identified impacts should be profiled to assess the magnitude of the impacts. The major concerns surrounding environmental and public health issues should be noted and their relative importance to the design of the project and the intended activities indicated.

The extent and quality of the available data should be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should then be ranked as major, moderate, and minor and presented in separate matrices for all the phases of the project (i.e., preconstruction, construction, operational and decommissioning/closure). The potential impacts may be subdivided into Physical Impacts, Biological Impacts and Socio-economic/Cultural Impacts. All impacts should be listed, ranked, and assessed, preferably in a single table.

The impacts to be assessed should include but not be limited to the following:

7.1 Physical Impacts:

- Assessment of deviations in existing drainage patterns against potential flooding events.
- Potential impact on ecosystem (mangroves) from sediment loaded storm water runoff
- Assessment of the potential impacts of the project on the adjacent coastal areas.
- Water quality impacts from storm water runoff (during construction and operation phases) and potentially restrictive circulation, with and without the incorporation of best management practices.
- Temporary drainage for the site during construction to include mitigation for erosion and sediment control.

- Permanent drainage solution for the site/s during operation, to include mitigation for erosion and sediment control.
- A sediment control plan is to be included in the drainage report.
- Drainage control for crossing of rivers and/or gullies, to include impacts that drainage control features could have on aesthetics, water quality and sedimentation of river and/or gullies.
- Assessment of the impact of draining the sites on adjacent communities and on future developments including mitigation measures. This should be calculated and designed to facilitate the storm runoff without causing flooding of these development. Underpasses for the highway should be designed to accommodate the volume and velocity of storm water post-construction.
- Assessment of drainage channels for debris flow associated with up gradient land use as well as impacts related to climate change.
- Identify other effects of storm water such as the input of oil and grease into the aquatic environment.
- Geotechnical and engineering requirements
- Impacts of potential spills (such as oil and chemical spills)
- Drainage
- Solid Waste
- Noise impacts (to include impact from shooting range and the helipad on the proposed development)
- Vibration Impact from construction on closest receptors
- Operation and maintenance – provision of and demand requirements for potable water and electricity, waste disposal, sewage treatment and disposal, communication, and other utility requirements
- Impacts on aesthetics (to include “windows to the sea”,), landscape and seascape.
- Traffic Impact:
    - Access to, from and across the Bogue Main Road – including bicycle/pedestrian access requirements for corridor communities; a description of how emergency access requirements (fire, police, ambulance) will be addressed during construction.
    - Assessment of impacts the proposed development will have on the Level of Service (LOS) of the Bogue Main Road
    - Traffic management and road safety during construction and operation phases.

7.2 Biological Impacts:

This should include an assessment of the direct and indirect impacts of the project on the ecology of ecologically sensitive marine ecosystems with emphasis being placed on rare, endemic, threatened, protected, endangered, invasive, and economically important species. Other impacts should include

- Coastal modification and shoreline modification including but not limited sandy, muddy, and rocky shore ecosystem.
- Removal of seagrass and corals, relocation of seagrass and corals, shading
- Reef modification
- Assessment on impacts on other marine resources including but not limited to corals and seagrass.

An assessment of the direct and indirect impacts of the project on the mangrove community should also be conducted. This should include but not be limited to:

- Provision of options suitable to compensate for the unavoidable loss of coral, seagrass, and mangrove trees, including a respective replanting/relocation/rehabilitation plan.
- Determination of amount of mangrove/coral/seagrass to be impacted.
- Criterion for rehabilitation/relocation site(s) selection for coral, seagrass or ecological sensitive flora species will be included.

Project impact (land clearance, noise, dust) on other floral and faunal species (birds, herpetofauna, bats etc.) should be explored.

The report will include proposals to compensate for unavoidable loss of natural resources.

7.3 Natural Hazards

The EA Report will include Risk Assessments and recommended Hazard Management and Mitigation Implementation for the following:

i. Hurricane Winds
ii. Flooding
  a. Storm surge
  b. Seal Level Rise (SLR)
  c. Pluvial flood events
d. Coastal Erosion

7.4 Socioeconomic/Cultural/Heritage Impacts

Effects on the socio-economic status such as changes to public access and recreational use; impacts on existing and potential economic activities; contribution of the development to the national economy and development of surrounding communities should be examined. Socio-economic and cultural impacts to include prescriptive rights, land use/resource effects, health, and safety of the potential workers as well as the residents of the surrounding environs should be described. Public perception as it relates to loss of property value, loss of aesthetic enjoyment among other things should be explored, as well as Loss of and damage to artefacts, archaeological and paleontological features.

7.5 Recommended Mitigation Measures

The mitigation measures should endeavour to avoid, reduce, and remedy the potential negative effects while at the same time enhancing the positive impacts projected. Mitigation and abatement measures should be developed for each potential negative impact identified. Full details of the methods proposed to be employed in the implementation of these measures should be provided, including details on the scheduling/timelines, source of materials, location, and responsible parties, where appropriate. Maps and diagrams should also be used to illustrate areas where mitigation measures are proposed to be implemented.

This should be represented in a table/matrix outlining the identified impacts and the proposed mitigation measures.

8.0 IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

Alternatives to the proposed development/project including the no-action alternative should be examined. These should be assessed according to the physical, biological, and socio-economic parameters of the site. This examination of alternatives should incorporate the use of the history of the overall area in which the site is located and previous uses of the site itself. Alternatives should also address specific aspects of the project such as methods proposed in the execution of the project (works) that have been identified as being causes of major impacts. A rationale for the selection of any project alternative should be provided.

This section should include at least three (3) alternatives including the No-Action alternative.

9.0 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

9.1 Environmental Management Plan

An Environmental Management Plan should be developed which will detail the requirements for the construction and operational phases of the project. This should include, but not be limited to methodology, training for construction and operation staff, recommendations to ensure that the implementation of mitigation measures and long-term minimization of negative impacts. Special emphasis should be placed on the preparation of an outline Coral Management Plan, Seagrass Management and Wetland Management Plan.

9.2 Environmental Monitoring Plan

An outline Environmental Monitoring Plan should be included in the EA. At the minimum the outline monitoring plan should include:

- Introduction outlining the need for a monitoring programme
- The locations selected for monitoring
- The mitigation measures to be implemented and the parameters and activities which will be monitored for each activity
- The proposed methodology to be employed for the monitoring of the various parameter.
- The frequency of the monitoring
- The proposed format that the monitoring reports should take
- The frequency of the submission of the monitoring reports
- The responsible parties for the monitoring

10.0 CONCLUSION AND RECOMMENDATIONS

11.0 LIST OF REFERENCES

12.0 APPENDICES

The appendices should include but not be limited to the following documents:

- Reference documents
- Photographs/ maps
- Data Tables
- Glossary of Technical Terms used
- Terms of Reference
- Composition of the consulting team, team that undertook the study/assessment, including name, qualification, and roles of team members
- Notes of Public Consultation sessions
- Instruments used in community surveys

All findings must be presented in the EA report and must reflect the headings in the body of the TORs, as well as references. GIS references should be provided where applicable. Two hard copies and an electronic copy must be submitted to NEPA for review after which the Agency will indicate the number of hard copies along with an electronic copy of the report to be submitted. One copy of the document should be perfect bound.

The report should include appendices with items such as maps, site plans, proposed streetscapes (that will demonstrate the preservation of the windows to the sea concept from the roadway), the study team and their individual qualifications, photographs, and other relevant information. All the foregoing should be properly sourced and credited.

Appendix 2 – NWC Letter

NATIONAL WATER COMMISSION
Water is life

28-48 Barbados Avenue
P.O. Box 65, Kingston 5
Tel: (876) 929-5430-5
Fax: (876) 926-1329

18 Oxford Road
Kingston 5
Tel: (876) 926-5825-7
Fax: (876) 929-1480

4 Marescaux Road
Kingston 5
Tel: (876) 929-3540-5
Fax: (876) 960-0582

231A Old Hope Road
Kingston 6
Tel: (876) 977-4998-9
977-5000
Fax: (876) 927-1870

231B Old Hope Road
Kingston 6
Tel: (876) 977-2496
(876) 977-9330
Fax: (876) 977-2708

2A Manhattan Road
Kingston 5
Tel: (876) 929-3540-5
Fax: (876) 968-8247

June 22, 2022

Letter by email: info@designhqltd.com

Mrs. Isiaa Madden-Brownie
Architect
Design H.Q. Limited

Dear Mrs. Madden-Brownie:

Re: Proposed Development: Reading Pen, Montego Bay, St. James
NWC Ref. #: 0409E/22

The National Water Commission (NWC) acknowledges your letter of enquiry dated June 13, 2022, pertaining to the availability of water and wastewater service to the above location.

The NWC advises that it is possible to provide both services requested, albeit at a Processing/Impact/Connection Fee once your application have been reviewed. The attached outlines what ought to be included in your submission.

Please note that wastewater connection is available at the Bogue WWTP, as such the associated off-site conveyance infrastructure must be constructed.

It must be understood that this letter does not constitute an approval from the NWC; such approval must be endorsed by the President and Chairman.

Easements for pipeline and facilities must be indicated in your formal application. NWC shall request titles in its name for lots with infrastructure to be taken over at the same time all titles are issued for all lots.

We trust this information will assist and look forward to hearing from you.

Yours truly,
NATIONAL WATER COMMISSION

IBennett

Ian Bennett
Manager, Engineering Design

Copy: Mr. Garth E. Jackson - VP, Engineering and Capital Projects, NWC
Mr. Kevin Kerr – VP, Operations, NWC

Appendix 3 – Jamaica Civil Aviation Authority No-Objection Letter

JAMAICA CIVIL AVIATION AUTHORITY

ANY REPLY OR SUBSEQUENT REFERENCE TO THIS COMMUNICATION SHOULD BE ADDRESSED TO THE DIRECTOR GENERAL OF CIVIL AVIATION AND NOT TO ANY OFFICER BY NAME AND THE FOLLOWING REFERENCE QUOTED—

4 WINCHESTER ROAD,
KINGSTON 10.
MAILING ADDRESS:
P.O. BOX 8998,
C.S.O., KINGSTON.

June 22, 2022

Mr. Shifu Huang
Director
LCH Development Limited
14 Bogue Industrial Estate
Montego Bay P.O.
St James

Attention: Mr. DuWayne O'Reggio, Design H.Q. Limited

Dear Mr. Huang,

Re: Obstacle Evaluation- 2 Reading Pen, Reading, St James

The Obstacle Evaluation and Procedures Development Unit of the Jamaica Civil Aviation Authority (JCAA) conducted an Obstacle Evaluation exercise on your proposed building construction. Evaluations of each coordinate were conducted to determine the impact on aircraft operations at the Sangster International Airport, taking in consideration the current and future layout of the airport.

Following assessment, the Jamaica Civil Aviation Authority has **no objection** to the construction of buildings in the specified location and heights submitted. Based on this study, the structure would not constitute a substantial adverse effect on aircraft operations or procedures, provided all of the conditions specified in this determination are adhered to.

This Determination is subject to strict compliance with the installation of medium-intensity obstacle lights, in accordance with local and international regulations. Instructions for obstacle lighting are as follows:

- The top corners of the buildings should be lit by medium-intensity, Type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2).
- These lights shall operate at 20 – 60 flashes per minute at all times, especially during periods of reduced ambient light and heavy rain or smoke.
- Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

.../2

Tele: 876.960.3965 Fax: 876.920.0194 WEB PAGE: www.jcaa.gov.jm EMAIL: jcivav@cwjamaica.com

- Obstacle lights should be regularly inspected to quickly detect and rectify any failure with minimum delay. ***Any failure or malfunction projected to last for a long duration should be reported immediately to the JCAA for promulgation of relevant element of the Integrated Aeronautical Information Package (IAIP); as well as resumption of normal operation.***

This determination is based on specific coordinates and heights submitted. Any changes or deviation to coordinates and/or heights, will void this determination. In addition, any future construction or alteration, including increase to heights, shall require a new application. Also, this determination does not include temporary construction equipment such as cranes, which may be used during construction of the structure, and shall require a separate application.

Please refer to the attached twenty (20) Obstacle Evaluation Reply forms for the project.

Regards,

C. Chambers
……………………………….
Christopher Chambers,
Director- Aeronautical Information Management

Attchs.

Copy: Mr. Nari Williams-Singh, Director General, JCAA
Mr. Howard Greaves, Deputy Director General, Air Navigation Services
Mr. Noel Ellis, Director Flight Safety

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220001	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 39.507"N 77° 56' 29.429"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 196.77°T (B) THR 07EXT-197.79°T	(A)THR 07 -6316.48m (B)THR 07EXT-6417.53m

Affected Annex 14 Surface				Base of Lowest Surface	Base Elevation
Outer Horizontal	■	Approach	☐	151.219m MSL	2.65m MSL
Conical	☐	Inner Approach	☐	**Height of Structure**	**Elevation of Apex**
Inner Horizontal	☐	Strip	☐	102.413m AGL	105.063m MSL
Transitional	☐	Take-off Climb	☐		
Inner Transitional	☐	En-route	☐		

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding	Recommendation	Specialist: Odaine Morgan
NOT APPLICABLE	NOT APPLICABLE	Signature: Morgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220002	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES
WGS-84 Coordinates of Site **18° 26' 39.959"N 77° 56' 29.984"W**		Nearest Govt. Aerodrome SANGSTER INTERNATIONAL AIRPORT	Nearest Private. Aerodrome N/A
WGS-84 Threshold Coordinates of Runway of nearest Aerodrome (A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W		Direction from nearest Runway (A) THR 07– 196.95°T (B) THR 07EXT-197.96°T	Distance from nearest Runway (A)THR 07 -6307.90m (B)THR 07EXT-6409.30m
Affected Annex 14 Surface Outer Horizontal ☒ Conical ☐ Inner Horizontal ☐ Transitional ☐ Inner Transitional ☐	Approach ☐ Inner Approach ☐ Strip ☐ Take-off Climb ☐ En-route ☐	Base of Lowest Surface 151.219m MSL	Base Elevation 2.65m MSL
		Height of Structure 102.413m AGL	Elevation of Apex 105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: ODMorgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220003	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES
WGS-84 Coordinates of Site **18° 26' 40.585"N 77° 56' 29.420"W**		Nearest Govt. Aerodrome SANGSTER INTERNATIONAL AIRPORT	Nearest Private. Aerodrome N/A
WGS-84 Threshold Coordinates of Runway of nearest Aerodrome (A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W		Direction from nearest Runway (A) THR 07– 196.86°T (B) THR 07EXT-197.88°T	Distance from nearest Runway (A)THR 07 -6284.68m (B)THR 07EXT-6385.90m
Affected Annex 14 Surface Outer Horizontal ■ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Take-off Climb ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface 151.219m MSL Height of Structure 102.413m AGL	Base Elevation 2.65m MSL Elevation of Apex 105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: OMorgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220004	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES
WGS-84 Coordinates of Site **18° 26' 40.127"N 77° 56' 28.865"W**		Nearest Govt. Aerodrome SANGSTER INTERNATIONAL AIRPORT	Nearest Private. Aerodrome N/A
WGS-84 Threshold Coordinates of Runway of nearest Aerodrome (A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W		Direction from nearest Runway (A) THR 07– 196.68°T (B) THR 07EXT-197.70°T	Distance from nearest Runway (A)THR 07 -6293.46m (B)THR 07EXT-6394.34m
Affected Annex 14 Surface Outer Horizontal ■ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Take-off Climb ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface 151.219m MSL Height of Structure 102.413m AGL	Base Elevation 2.65m MSL Elevation of Apex 105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: Morgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220005	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES
WGS-84 Coordinates of Site **18° 26' 39.782"N 77° 56' 29.669"W**		Nearest Govt. Aerodrome SANGSTER INTERNATIONAL AIRPORT	Nearest Private. Aerodrome N/A
WGS-84 Threshold Coordinates of Runway of nearest Aerodrome (A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W		Direction from nearest Runway (A) THR 07– 196.86°T (B) THR 07EXT-197.87°T	Distance from nearest Runway (A)THR 07 -6310.42m (B)THR 07EXT-6411.64m
Affected Annex 14 Surface Outer Horizontal ■ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Take-off Climb ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface 151.219m MSL Height of Structure 109.728m AGL	Base Elevation 2.65m MSL Elevation of Apex 112.378m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the building(s) should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: O Morgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220006	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 42.475"N 77° 56' 30.928"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 197.40°T (B) THR 07EXT-198.42°T	(A)THR 07 -6242.17m (B)THR 07EXT-6344.46m

Affected Annex 14 Surface

Outer Horizontal	■	Approach	☐
Conical	☐	Inner Approach	☐
Inner Horizontal	☐	Strip	☐
Transitional	☐	Take-off Climb	☐
Inner Transitional	☐	En-route	☐

Base of Lowest Surface	Base Elevation
151.219m MSL	2.65m MSL

Height of Structure	Elevation of Apex
102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: Morgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220007	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 42.929"N 77° 56' 31.483"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 197.58°T (B) THR 07EXT-198.60°T	(A)THR 07 -6233.75m (B)THR 07EXT-6336.39m

Affected Annex 14 Surface	Base of Lowest Surface	Base Elevation
Outer Horizontal ☒ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Take-off Climb ☐ Inner Transitional ☐ En-route ☐	151.219m MSL	2.65m MSL
	Height of Structure	**Elevation of Apex**
	102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding	**Recommendation**	Specialist: Odaine Morgan
NOT APPLICABLE	NOT APPLICABLE	Signature: Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220008	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 43.554"N 77° 56' 30.917"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 197.49°T (B) THR 07EXT-198.51°T	(A)THR 07 -6210.42m (B)THR 07EXT-6312.88m

Affected Annex 14 Surface

Outer Horizontal	■	Approach	☐
Conical	☐	Inner Approach	☐
Inner Horizontal	☐	Strip	☐
Transitional	☐	Take-off Climb	☐
Inner Transitional	☐	En-route	☐

Base of Lowest Surface	Base Elevation
151.219m MSL	2.65m MSL
Height of Structure	**Elevation of Apex**
102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding	**Recommendation**	Specialist: Odaine Morgan
NOT APPLICABLE	NOT APPLICABLE	Signature: OMorgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Reply Form

4 Winchester Road
Kingston 10
Mailing Address: P.O. Box 8998,
C.S.O. Kingston

Site Identification No	Operating Company	Site Location	Parish
LDL05220009	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 43.099"N 77° 56' 30.364"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 197.31°T (B) THR 07EXT-198.33°T	(A)THR 07 -6218.92m (B)THR 07EXT-6321.03m

Affected Annex 14 Surface		Base of Lowest Surface	Base Elevation
Outer Horizontal ■ Conical ☐ Inner Horizontal ☐ Transitional ☐ Inner Transitional ☐	Approach ☐ Inner Approach ☐ Strip ☐ Take-off Climb ☐ En-route ☐	151.219m MSL	2.65m MSL
		Height of Structure	**Elevation of Apex**
		102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding	**Recommendation**	Specialist: Odaine Morgan
NOT APPLICABLE	NOT APPLICABLE	Signature: ODMorgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
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Site Identification No	Operating Company	Site Location	Parish
LDL05220010	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 42.760"N 77° 56' 31.174"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 197.49°T (B) THR 07EXT-198.50°T	(A)THR 07 -6235.97m (B)THR 07EXT-6338.43m

Affected Annex 14 Surface				Base of Lowest Surface	Base Elevation
Outer Horizontal	☒	Approach	☐	151.219m MSL	2.65m MSL
Conical	☐	Inner Approach	☐	**Height of Structure**	**Elevation of Apex**
Inner Horizontal	☐	Strip	☐	109.728m AGL	112.378m MSL
Transitional	☐	Take-off Climb	☐		
Inner Transitional	☐	En-route	☐		

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: OMorgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220011	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 44.954"N 77° 56' 32.455"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 198.01°T (B) THR 07EXT-199.02°T	(A)THR 07 -6183.18m (B)THR 07EXT-6286.64m

Affected Annex 14 Surface				Base of Lowest Surface	Base Elevation
Outer Horizontal	■	Approach	☐	151.219m MSL	2.65m MSL
Conical	☐	Inner Approach	☐	**Height of Structure**	**Elevation of Apex**
Inner Horizontal	☐	Strip	☐	102.413m AGL	105.063m MSL
Transitional	☐	Take-off Climb	☐		
Inner Transitional	☐	En-route	☐		

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: Morgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220012	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 45.409"N 77° 56' 33.007"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 198.19°T (B) THR 07EXT-199.21°T	(A)THR 07 -6174.91m (B)THR 07EXT-6278.72m

Affected Annex 14 Surface				Base of Lowest Surface	Base Elevation
Outer Horizontal	■	Approach	☐	151.219m MSL	2.65m MSL
Conical	☐	Inner Approach	☐	Height of Structure	Elevation of Apex
Inner Horizontal	☐	Strip	☐	102.413m AGL	105.063m MSL
Transitional	☐	Take-off Climb	☐		
Inner Transitional	☐	En-route	☐		

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding	Recommendation	Specialist: Odaine Morgan
NOT APPLICABLE	NOT APPLICABLE	Signature: Morgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220013	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 46.036"N 77° 56' 32.442"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07–198.10°T (B) THR 07EXT-199.12°T	(A)THR 07 -6151.43m (B)THR 07EXT-6255.07m

Affected Annex 14 Surface		Base of Lowest Surface	Base Elevation
Outer Horizontal ■ Conical ☐ Inner Horizontal ☐ Transitional ☐ Inner Transitional ☐	Approach ☐ Inner Approach ☐ Strip ☐ Take-off Climb ☐ En-route ☐	151.219m MSL	2.65m MSL
		Height of Structure	**Elevation of Apex**
		102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding	**Recommendation**	Specialist: Odaine Morgan
NOT APPLICABLE	NOT APPLICABLE	Signature: Morgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220014	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 45.580"N 77° 56' 31.888"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 197.92°T (B) THR 07EXT-198.94°T	(A)THR 07 -6159.74m (B)THR 07EXT-6263.03m

Affected Annex 14 Surface

Outer Horizontal	☒	Approach	☐
Conical	☐	Inner Approach	☐
Inner Horizontal	☐	Strip	☐
Transitional	☐	Take-off Climb	☐
Inner Transitional	☐	En-route	☐

Base of Lowest Surface	Base Elevation
151.219m MSL	2.65m MSL

Height of Structure	Elevation of Apex
102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: OMorgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220015	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 45.233"N 77° 56' 32.693"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 198.09°T (B) THR 07EXT-199.11°T	(A)THR 07 -6177.19m (B)THR 07EXT-6280.81m

Affected Annex 14 Surface		Base of Lowest Surface	Base Elevation
Outer Horizontal ■ Conical ☐ Inner Horizontal ☐ Transitional ☐ Inner Transitional ☐	Approach ☐ Inner Approach ☐ Strip ☐ Take-off Climb ☐ En-route ☐	151.219m MSL	2.65m MSL
		Height of Structure 109.728m AGL	**Elevation of Apex** 112.378m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	**Recommendation** NOT APPLICABLE	Specialist: Odaine Morgan Signature: OMorgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220016	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 47.603"N 77° 56' 33.872"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 198.61°T (B) THR 07EXT-199.63°T	(A)THR 07 -6118.91m (B)THR 07EXT-6223.54m

Affected Annex 14 Surface		Base of Lowest Surface	Base Elevation
Outer Horizontal ☒ Conical ☐ Inner Horizontal ☐ Transitional ☐ Inner Transitional ☐	Approach ☐ Inner Approach ☐ Strip ☐ Take-off Climb ☐ En-route ☐	151.219m MSL	2.65m MSL
		Height of Structure	**Elevation of Apex**
		102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding	**Recommendation**	Specialist: Odaine Morgan
NOT APPLICABLE	NOT APPLICABLE	Signature: AMorgan Date: June 22, 2022

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Kingston 10

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Site Identification No	Operating Company	Site Location	Parish
LDL05220017	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 48.063"N 77° 56' 34.426"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 198.80°T (B) THR 07EXT-199.81°T	(A)THR 07 -6110.73m (B)THR 07EXT-6215.71m

Affected Annex 14 Surface		Base of Lowest Surface	Base Elevation
Outer Horizontal ■ Conical ☐ Inner Horizontal ☐ Transitional ☐ Inner Transitional ☐	Approach ☐ Inner Approach ☐ Strip ☐ Take-off Climb ☐ En-route ☐	151.219m MSL	2.65m MSL
		Height of Structure	**Elevation of Apex**
		102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: ODMorgan Date: June 22, 2022

Jamaica Civil Aviation Authority
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Site Identification No	Operating Company	Site Location	Parish
LDL05220018	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES
WGS-84 Coordinates of Site **18° 26' 48.686"N 77° 56' 33.864"W**		Nearest Govt. Aerodrome SANGSTER INTERNATIONAL AIRPORT	Nearest Private. Aerodrome N/A
WGS-84 Threshold Coordinates of Runway of nearest Aerodrome (A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W		Direction from nearest Runway (A) THR 07– 198.71°T (B) THR 07EXT-199.73°T	Distance from nearest Runway (A)THR 07 -6087.29m (B)THR 07EXT-6192.10m
Affected Annex 14 Surface Outer Horizontal ■ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Take-off Climb ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface 151.219m MSL Height of Structure 102.413m AGL	Base Elevation 2.65m MSL Elevation of Apex 105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: OMorgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220019	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 48.233"N 77° 56' 33.307"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 198.52°T (B) THR 07EXT-199.55°T	(A)THR 07 -6095.27m (B)THR 07EXT-6199.73m

Affected Annex 14 Surface

Outer Horizontal	■	Approach	☐
Conical	☐	Inner Approach	☐
Inner Horizontal	☐	Strip	☐
Transitional	☐	Take-off Climb	☐
Inner Transitional	☐	En-route	☐

Base of Lowest Surface	Base Elevation
151.219m MSL	2.65m MSL

Height of Structure	Elevation of Apex
102.413m AGL	105.063m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

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Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: ADMorgan Date: June 22, 2022

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Site Identification No	Operating Company	Site Location	Parish
LDL05220020	**LCH DEVELOPMENT LIMITED**	2 READING PEN, READING	ST JAMES

WGS-84 Coordinates of Site	Nearest Govt. Aerodrome	Nearest Private. Aerodrome
18° 26' 47.889"N 77° 56' 34.114"W	SANGSTER INTERNATIONAL AIRPORT	N/A

WGS-84 Threshold Coordinates of Runway of nearest Aerodrome	Direction from nearest Runway	Distance from nearest Runway
(A) THR 07 - 18° 29' 56.21"N 77° 55' 27.31"W (B) THR 07EXT- 18° 29' 58.26"N 77° 55' 22.62"W	(A) THR 07– 198.70°T (B) THR 07EXT-199.72°T	(A)THR 07 -6112.85m (B)THR 07EXT-6217.65m

Affected Annex 14 Surface		Base of Lowest Surface	Base Elevation
Outer Horizontal ■ Conical ☐ Inner Horizontal ☐ Transitional ☐ Inner Transitional ☐	Approach ☐ Inner Approach ☐ Strip ☐ Take-off Climb ☐ En-route ☐	151.219m MSL	2.65m MSL
		Height of Structure	**Elevation of Apex**
		109.728m AGL	112.378m MSL

Penetration: No

Effect of Penetration: N/A

Application Status: **NO OBJECTION**

Requirement and Recommendation- This site is located within the limits of ICAO Outer Horizontal Obstacle Limitation Surfaces (OLS) of the Sangster International Airport. The top corners of the buildings should be lit by medium-intensity, type B (flashing red) obstacle lights of 2000 candela per square metre (cd/m^2). These lights shall operate at 20 – 60 flashes per minute, and operate at all times, especially during periods of reduced ambient light and heavy rain or smoke. Additional lights shall be provided at intermediate levels. These additional intermediate lights shall be alternately low-intensity obstacle lights, Type B (fixed red), and medium-intensity obstacle lights, Type B (flashing red), and shall be spaced as equally as practicable between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 52m.

There should be no alterations to the height of the structure unless prior permission is given by the JCAA.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure
		Metallic ☐ Non metallic ☐
Finding NOT APPLICABLE	Recommendation NOT APPLICABLE	Specialist: Odaine Morgan Signature: OMorgan Date: June 22, 2022

Jamaica Civil Aviation Authority
4 Winchester Road
Kingston 10

Appendix 4 – Study Team

- **CL Environmental Co. Ltd.:**
    - Carlton Campbell, Ph.D., CIEC (Project Coordinator)
    - Matthew Lee, M.Sc. (Noise, Air Quality, Sediments)
    - Rachel D'Silva, B.Sc. (Marine and Benthic Studies)
    - Karen McIntyre, M.Sc. (GIS, Cartography, Socioeconomics)
    - Alec Silvera, B. Sc (Water Quality, Marine and Benthic Studies)
    - Glen Patrick (Field Technician)
    - Patrick Litchmore (Field Technician)

- **CEAC Solutions Company Limited**

  Areas of Study:
    - Hydrology, Flood Plain and Stormwater Discharge Modelling
    - Jetty Design
    - Traffic Impact Assessment
    - Hazard Assessment
    - Oceanography and Hydrodynamics
        - Currents and Tides
        - Wave Climate
        - Hurricane Wave Climate, Storm Surge and Hazards
        - Climate Change
        - Bathymetry

- **Associate Consultants:**
    - South China Construction and Engineering Ltd. (Stormwater Drainage Design)
    - Camilo Trench, PhD. (Mangrove and Coastal Vegetation)
    - Damion Whyte, M.Sc. (Terrestrial Faunal Studies)
    - Jannette Manning, M.Sc. (Public Perception Survey)
    - Le'Anne Green, M.Sc. (Seagrass Studies)

Appendix 5 – Hydrolab DS-5 Calibration Test Sheet

DATE: 4/1	DOCUMENT #: 19005-00-Tech_Series5_Instruc
PAGE: 1 OF 2	REVISION: 1

HydroMet

Section A: **Series 5, and 5x Sonde Functional Test Data Sheet**

Work Order # WO-01204206	Customer CL Environmental	Date Started 11/12/21
Housing Serial # 100100048757	Embedded Serial# 48757	Additional Driver Firmware:
Technician Phillip Druyor	Model: **Datasonde** ✓ 5 ✓ **Minisonde** 5x	Depth100 2.13 PAR 1.02 Turbidity 3.21 LDO 3.23

Customer Display Information

I/D N/A	DOM 011510	Baud Rate 19200	Security 2	SDI N/A	TTY
Parameter	Time	Temp	pH	SpCond	ORP
Units	HH:MM:SS	°C	Units	mS/cm	mV
Parameter	Dep100	PAR	TurbSC	LDO%	LDO
Units	meters	µE/s/m²	NTU	Sat	mg/l

For Sonde with Depth – Coefficients

A: -4230.0	B: 14300.0	C: 16.8	D: -16000.0
E: -0.0101	F: -6.03	G: 6000.0	H: 3.44E-05
I: 0.008519	J: 3.37	SER: 0.0	

FLUOROMETER OFFSETS

1ST N/A	X10: N/A	X1: N/A
2ND N/A	X10: N/A	X1: N/A

For Sonde with TDG or PAR – Coefficients

A: -220.98	**B:** -220.98	**C:** N/A	**D:** N/A
Local: N/A	Ref: N/A		

Performance, Test and Evaluation

Current MPL Rev-- 5.44 Upgrade to MPL Rev--	pH Electrolyte & Teflon Junction Replaced- Yes ✓ No NA	DO membrane Replaced Yes No NA
Sensors cleaned –Yes ✓	RTC Battery Replaced Yes ✓ No	Desiccant Replaced –Yes ✓ No

Section B:

	Submission 1 Day 1	Submission Day
Customer Observations Verified / Customer Request	Y ✓ N N/A PT&E ✓ Upgrade	Y N N/A PT&E Upgrade
Set Time and Date	Yes ✓	Yes
Verified all hardware updates as current	Yes ✓	Yes
Total current draw. (Check all that apply) MPL PCB 40mA ✓ SC Turbidity 20mA ✓ LDO 80mA ✓ 4Beam Turbidity 10mA Flourometers: 1st 30mA 2nd 30mA 3rd 30mA PAR 10mA ✓ (Optimal Values not to exceed +20mA overall.)	140	
Current draw of circulator. (20 mA max. beyond previous values.)	N/A	
Operation of self-cleaning motor verified—	P ✓ F NA	P F NA
Audio functions correctly	P ✓ F	P F
RTC sleep/wake-up test.	P ✓ F	P F

Additional Notes:

1
19005-00-Tech_Series5_Instruc
Rev 1

DATE: 10-2-12	DOCUMENT #: 19005-00-Tech_Series5_Instruc
PAGE: 2 OF 2	REVISION: 1

Temp probe test at room temperature. 20.00 ° C (+/- 0.1)	Sonde Temp : 20.00 ° C	Sonde Temp : ° C
DO 100% sat integrity window verified at +50 mmHg over current bp. (Clark Cell only)	P F NA ✓	P F NA
DO 100% saturation calibration verified - local BP (+/- 0.2 mg/L Clark Cell) (+/- 0.1mg/L LDO)	Temp : 21.62 BP : 626.46 mg/L : 7.21 Drift +/- :	Temp : BP : mg/L : Drift +/- :
Scale Factor (0.7 -- 1.3) LDO Only	1.094391	
Conductivity zero (air) calibration verified - (+/-.005mS)	0.0000	
Conductivity calibration verified – ✓ 1.412 mS/cm (± .04 mS) 12.856 mS/cm (± .2 mS) 47.6 mS/cm (± .2 mS)	1.412	
Conductivity linearity verified – .100 mS/cm (± .005 mS) ✓ .500 mS/cm (± .025 mS)	.510	
pH 7 buffer calibration verified– (+/- .2 pH)	7.01	
pH slope calibration verified at 10.01 units.	10.01	
ORP calibration verified at 22.35 ° C (+/- 20 mV)	434	
Turbidity - Calibration accepted & verified with DI Water (0.0 +/- 0.7 NTU)	0.0	
Turbidity - Calibration accepted & verified at (100.0 +/- 1 NTU) with Hach StablCal	100.3	
Turbidity - Linearity verified with 40 NTU Hach StablCal – (+/- 4 NTU)	40.2	
Depth zero calibration verified – (.02 meters)	0.00	
Depth Check verified – (+/- 0.03 meters) Tank depth: 0.685	0.68	

Specific Ion N/A Low C N/A High C N/A mV N/A mV N/A	Specific Ion N/A Low C N/A High C N/A mV N/A mV N/A	Specific Ion N/A Low C N/A High C N/A mV N/A mV N/A

N03- calibration verified	P F NA ✓	P F NA
NH4+ calibration verified	P F NA ✓	P F NA
Cl- calibration verified	P F NA ✓	P F NA
Chlorophyll 'a' calibration verified	P F NA ✓	P F NA
Rhodamine 'wt' calibration verified	P F NA ✓	P F NA
Blue-green Algae calibration verified	P F NA ✓	P F NA
PAR calibration verified	P ✓ F NA	P F NA
TDG calibration verified (+/- 2 mmHg)	P F NA ✓	P F NA
Logging/Sensor Stability Test	P ✓ F	P F
pH linearity verified at 4 units. (+/- 0.20 units)	4.01	
Battery pack setup and checked	P ✓ F NA	P F NA

Display, Baud Rate, Communications mode settings returned as received.	Yes ✓ No

Calibrated Test Equipment Used – Description	X-number
Power Supply BK Precision 1617A	X- 8954
Fluke 1524 -- Reference Thermometer	X- 8244
DVM Digital Multimeter	X- 001765

Section C. Final Check-off Prior to Submitting for Estimate

Exterior is clean ✓	Hach Business System updated ✓
Clear pH 4 Buffer in storage cup ✓	Date Completed 11/17/21

Appendix 6 – Laboratory Water Quality Result Sheets

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(An Agency of the Ministry of Science, Energy & Technology)
P.O. Box 350, Hope Gardens, Kingston 6, Jamaica
Telephone: (876) 927-1771-4, 977-2190-1
www.src.gov.jm

ANALYTICAL SERVICES DEPARTMENT
REPORT SHEET

Reference #: A21447

Customer's Name: C L Environmental
Address: 20 Windsor Avenue, Kingston 5
Date of receipt: 2022/03/03 @ 1:16 pm
No. of samples submitted: 11
Sample Description: Sea Water

Date of sampling: 2022/03/03 @ 7:00 – 8:30 am
Samples collected by: Alec Silvera
Condition of sample: Cold
Location of sampling: Not Applicable
Location of test: SRC

RESULTS OF ANALYSIS

Method	Parameter	Date of Analysis	RP1	RP2	RP3	RP4
SMEW Method 9230	*Enterococcus* MPN/100mL	2022/03/04	<1.8	<1.8	<1.8	<1.8

Method	Parameter	Date of Analysis	RP5	RP6	RP7	RP8
SMEW Method 9230	*Enterococcus* MPN/100mL	2022/03/04	<1.8	7.8	<1.8	>1600

Method	Parameter	Date of Analysis	RP9	RP10	RP11
SMEW Method 9230	*Enterococcus* MPN/100mL	2022/03/04	140	6.8	<1.8

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ANALYTICAL RESULT – REF. #A21447

LABORATORY INFORMATION

NB: Highlighted tests are ISO/IEC 17025:2017 accredited by the Jamaica National Agency for Accreditation (JANAAC).
DISCLAIMER: *The tests which are not highlighted are outside of the scope of accreditation.*

METHOD(S): **SMEW:** Standard Methods for the Examination of Water & Wastewater, 23rd Edition, 2017.

AMBIENT CONDITIONS: *Not Applicable*

TEST UNCERTAINTY: *Provided upon request*

METHOD ADDITIONS, DEVIATIONS OR EXCLUSIONS: *Not Applicable*

GENERAL KEY:
CFU: Colony Forming Units,
TNTC: Too Numerous to Count,
D: Detected
ND: Not Detected.
N/A: Not Applicable
IC: Incomplete Analysis
LA: Lab Accident
MPN: Most Probable Number
MOG: Mould overgrowth
^: Result received from external laboratory

AMENDMENTS: *Not Applicable*

DISCLAIMERS:
- Results relate only to the sample received as identified and are a representative of sample tested.
- Where sampling was conducted by client, validity & applicability of the results will be dependent on whether suitable sampling procedures were adhered to.
- This report shall not be reproduced except in its entirety and only with the approval of SRC.
- SRC accepts no responsibility for any loss or damage that may occur as a result of the use of this report.
- Unless otherwise noted, samples were received in good condition.

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www.src.gov.jm

ANALYTICAL RESULT – REF. #A21447

Certified by	**Issued/Authorized by**
Signature: ________ (Laboratory Analyst)	Signature: ________ (Technical Manager)
Name: Vanessa Bailey-Higgins	Name: Mandesa Jackson
Date: 2022/03/16	Date: 2022/03/16

- END OF REPORT –

CLE 2202ET164_etc,shr

ENVIRONMENTAL, TECHNICAL AND ANALYTICAL SERVICES LIMITED
Hope Gardens, P.O. Box 28, Kingston 6
Telephone: 927-1944

Water and Wastewater Report Sheet, Page 1 of 2

REF. #:2202ET164-174 **ATTENTION:** Mr. Matthew Lee

COMPANY	C. L. Environmental Co. Ltd.	MEANS OF CONTRACT	Written
DATE RECEIVED	February 3, 2022	DATE REPORTED	February 3, 2022
NO. OF SAMPLES	Eleven (11)	SAMPLE VOLUME	Approx. 2L
STARTED	February 3, 2022	SAMPLE TYPE	Sea Water

REF. #	Sample Name	Parameter	Remarks
- - -	- - -	Faecal Coliform MPN/100mL	- - -
2202ET164	RP1	4.0	
2202ET165	RP2	23	
2202ET166	RP3	49	
2202ET167	RP4	79	
2202ET168	RP5	79	
2202ET169	RP6	49	
2202ET170	RP7	130	
2202ET171	RP8	920	
2202ET172	RP9	>1600	
2202ET173	RP10	>1600	
2202ET174	RP11	7.8	

CLE 2202ET164_etc,shr

ENVIRONMENTAL, TECHNICAL AND ANALYTICAL SERVICES LIMITED
Hope Gardens, P.O. Box 28, Kingston 6
Telephone: 927-1944

Water and Wastewater Report Sheet, Page 2 of 2

REF. #:2202ET164-174 **ATTENTION:** Mr. Matthew Lee

R11	DATE SAMPLED	February 3, 2022		TIME SAMPLED	6:00 – 8:00 AM
R11	DATE RECEIVED	February 3, 2022		TIME RECEIVED	3:30 PM
R11	DATE STARTED	February 3, 2022		TIME STARTED	3:30 PM

Parameter	Test Method	Detection Limit	Range
Coliform, Faecal MPN/100mL	Standard Methods for the Examination of Water and Wastewater, 31rd Edition, 2005 (SMEWW) Method 9221-E.1, 9221-E.2	1.1 MPN/100mL 1.8 MPN/100mL	

Certified By : .... Ryan Warburton, Quality Manager

Certified By : .... Analyst (Name)

.... (Signature)

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Hope Gardens, P.O. Box 28, Kingston 6
Telephone: 927-1944

Water and Wastewater Report Sheet, Page 1 of 2

REF. #:2203ET297-307 **ATTENTION:** Mr. Matthew Lee

COMPANY	C. L. Environmental Co. Ltd.		MEANS OF CONTRACT	Written
DATE RECEIVED	March 3, 2022		DATE REPORTED	March 9, 2022
NO. OF SAMPLES	Eleven (11)		SAMPLE VOLUME	Approx. 2L
STARTED	March 3, 2022		SAMPLE TYPE	Sea Water

REF. #	Sample Name	Parameter	Remarks
- - -	- - -	BOD_5, mg/L D. O.	- - -
2203ET297	RP1	1.8	
2203ET298	RP2	1.4	
2203ET299	RP3	1.7	
2203ET300	RP4	1.5	
2203ET301	RP5	1.8	
2203ET302	RP6	1.8	
2203ET303	RP7	1.6	
2203ET304	RP8	8.9	
2203ET305	RP9	1.6	
2203ET306	RP10	1.9	
2203ET307	RP11	1.5	

CLE 2203ET297_etc,shr

ENVIRONMENTAL, TECHNICAL AND ANALYTICAL SERVICES LIMITED
Hope Gardens, P.O. Box 28, Kingston 6
Telephone: 927-1944

Water and Wastewater Report Sheet, Page 2 of 2

REF. #:2203ET297-307 **ATTENTION:** Mr. Matthew Lee

R11	DATE SAMPLED	March 3, 2022		TIME SAMPLED	6:45 – 8:30 AM
R11	DATE RECEIVED	March 3, 2022		TIME RECEIVED	1:46 PM
R11	DATE STARTED	March 3, 2022		TIME STARTED	1:46 PM

Parameter	Test Method	Detection Limit	Range
BOD_5, mg/L D. O.	Dilution Method adapted from HACH Method 8043 **and** Standard Methods for the Examination of Water and Wastewater, 23rd Edition, 2017 (SMEWW) Method 5210.	(Method 1b) Sample unseeded & undiluted: Approx 0.1 mg/L	

Certified By : .... Ryan Warburton, Quality Manager

Certified By : .... Analyst (Name)

.... (Signature)

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Hope Gardens, P.O. Box 28, Kingston 6
Telephone: 927-1944

Water and Wastewater Report Sheet, Page 1 of 2

REF. #:2204ET528-538 **ATTENTION:** Mr. Matthew Lee

COMPANY	C. L. Environmental Co. Ltd.		MEANS OF CONTRACT	Written
DATE RECEIVED	April 7, 2022		DATE REPORTED	April 8, 2022
NO. OF SAMPLES	Eleven (11)		SAMPLE VOLUME	Approx. 2L
STARTED	April 7, 2022		SAMPLE TYPE	Sea Water and Drainwater (Brackish)

REF. #	Sample Name	Parameter	Remarks
- - -	- - -	BOD_5, mg/L D. O.	- - -
2204ET528	RP1	1.1	
2204ET529	RP2	1.2	
2204ET530	RP3	1.4	
2204ET531	RP4	1.4	
2204ET532	RP5	1.4	
2204ET533	RP6	1.5	
2204ET534	RP7	1.3	
2204ET535	RP8	1.0	
2204ET536	RP9	4.8	
2204ET537	RP10	1.1	
2204ET538	RP11	1.2	

CLE 2204ET528_etc,shr

ENVIRONMENTAL, TECHNICAL AND ANALYTICAL SERVICES LIMITED
Hope Gardens, P.O. Box 28, Kingston 6
Telephone: 927-1944

Water and Wastewater Report Sheet, Page 2 of 2

REF. #:2204ET528-538 **ATTENTION:** Mr. Matthew Lee

R11	DATE SAMPLED	April 7, 2022		TIME SAMPLED	7:30 AM
R11	DATE RECEIVED	April 7, 2022		TIME RECEIVED	3:40 PM
R11	DATE STARTED	April 47, 2022		TIME STARTED	3:40 PM

Parameter	Test Method	Detection Limit	Range
BOD_5, mg/L D. O.	Dilution Method adapted from HACH Method 8043 **and** Standard Methods for the Examination of Water and Wastewater, 23rd Edition, 2017 (SMEWW) Method 5210.	(Method 1b) Sample unseeded & undiluted: Approx 0.1 mg/L	

Certified By : .... Ryan Warburton, Quality Manager

Certified By : .... Analyst (Name)

.... (Signature)

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Glossary

%	Percentage
µg/L	microgram per litre
µS/cm	microsiemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BDLS	Analyte detected below method detection limit (MDL). MDL greater than standard value.
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BSA	Bismuth Sulfite Agar
c	parameter analysed in the field
C(B)	Samples collected by the client and picked up by an ESL bearer
C(C)	Samples collected by the client and delivered to ESL
C(H)	Analytical sample submitted in incorrect container. This may affect data quality.
C(L)	Samples collected by ESL
C(S)	Sample collected by the client then sub-sampled and delivered by ESL.
cfu	Colony Forming Units
CMMEF	Compendium of Methods for the Microbiological Examination of Foods
Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
D(C)	Sample diluted due to high concentration of target analyte
DR	Direct Reading
DS ADB	Double Strength azide dextrose broth
DS LTB	Double Strength Lauryl Tryptose Broth
DS PAB	Double Strength Pseudomonas Asparagine Broth
EB	Equipment Blank
E(E1)	Estimated Value. Data acquisition affected by equipment malfunction.
E(L1)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was outside of QC limits. Results for this may be affected by same bias.
E(L2)	Estimated Value due to the nature of the sample matrix.
E(M1)	Estimated Value. Result calculated using calibration curve.
E(M2)	Estimated Value. Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
E(M3)	Estimated Value. Sample performance indicate presence of interference
E(R)	Estimated Value. RPD value was outside control limits.
EC	*E. coli* Media
E(V)	Estimated Value. Count(s) obtained is/are outside of the method counting range.
EC-MUG	*E. coli* Media with 4-methylumbelliferyl-β-D-glucuronide
EHU	Environmental Health Unit
EPA	(US) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectroscopy
FAES	Flame Atomic Emission Spectroscopy
FB	Field Blank
FD	Field Duplicate
FL-PRO	Florida Petroleum Range Organic Method
GC-MS	Gas Chromatography Mass Spectrometry
H	Hach Water Analysis Workbook
H(A)	Off-scale high data obtained. Actual value may be greater than value given.

CLE 22020308-18 Page **5** of **6**

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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Certificate of Quality

Parameter: Faecal Enterococci (SM-9230 B)
QEHL Personnel: M. Mighty **Date of Analysis: 03/02/2022**

Media/Test Item (Batch #)	SS ADB (20/01/2022)	DS ADB (03/02/2022)	BEA (08/02/2022)	BHI Broth (10/02/2022)	BHI Broth + NaCl (10/02/2022)
Sterile (Yes/No)	Yes	Yes	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical	Typical	Typical

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Results of Sample Analysis

Sample ID (Matrix)	Test Method	Parameter(s)	Qualifier
		Faecal Enterococci (MPN/100mL)	
RP1 (Marine Water)	SM-9230 B	<1.8	-
RP2 (Marine Water)	SM-9230 B	6.8	-
RP3 (Marine Water)	SM-9230 B	11	-
RP4 (Marine Water)	SM-9230 B	79	-
RP5 (Marine Water)	SM-9230 B	46	-
RP6 (Marine Water)	SM-9230 B	110	-
RP7 (Marine Water)	SM-9230 B	23	-
RP8 (Marine Water)	SM-9230 B	140	-
RP9 (Marine Water)	SM-9230 B	>1600	-
RP10 (Marine Water)	SM-9230 B	<1.8	-
RP11 (Marine Water)	SM-9230 B	22	-

***Blue shaded parameters are ISO/IEC 17025:2005 accredited**

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Sample(s) Information

Job Number:	**22020308-18**
SPN:	-
Date of Report:	23/02/2022
Revision Date:	**Not Applicable**
Sample(s) Collected:	03/02/2022
Sample(s) Submitted:	03/02/2022
Temperature on Arrival:	2.7°C
Number of Samples:	11
Analysis Started:	03/02/2022
Analysis Completed:	16/02/2022
Prepared By:	**Tara-Lee Hylton, Technical Assistant**

Verified By ……E.Terrelonge………… Approved By…K.Simpson……
Eleanor Terrelonge, **Kearion Simpson,**
Team Lead, Microbiology **Senior Analyst**

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Where samples are collected by ESL, these are identified, and collection follows the lab's internal procedure for sampling, ESL-P 5.7.3 and the sampling plan created for the client and identified by the Sampling Plan Number (SPN) given in this report.

The ISO/IEC 17025 accreditation only applies to the tests identified in the Results of Sample Analysis.

The data presented in this report does not imply certification, approval, or endorsement of the client's services by ESL-QEHL or the accreditation body.

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ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

A division of

7 Hillview Avenue,
Kingston 10, Jamaica
Tel: (876) 978-9519, 978-6297, 978-5902
Fax: (876) 946-3745
E-mail: envirsol@cwjamaica.com

Certificate of Sample Analysis

CSA#: CLE 22020308-18

Attention:

Alec Silvera
CL Environmental Co Ltd.
22 Fort George Heights,
Kingston 8, Jamaica

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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ICP	Inductively Coupled Plasma
ISE	Ion Selective Electrode
LCA	Listeria Chromogenic Agar
LE	Data not available due to laboratory error
LIA	Lysine Iron Agar
MAC	MacConkey Agar
MB	Method Blank
mEndo	mEndo Agar/Broth
MFHPB	Microbiology Food Health Protection Branch, Government of Canada
mmhos/cm	Millimhos per centimetre
mg/kg	milligram per kilogram
mg/L	milligrams per litre
MPN	Most Probable Number
mS/cm	millisiemens per centimetre
N/A (1)	Data not yet Available. Analysis not complete.
N/A (2)	Data not Available. Sample matrix interferences prevented data acquisition.
N/A (3)	Data not Available. Insufficient sample submitted.
N/A (4)	Data not Available. Equipment malfunction prevented data acquisition.
N/A (5)	Data not Available. Analysis not complete due to force majeure.
NA	Nutrient Agar
NB	Nutrient Broth
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NTU	Nephelometric Turbidity Units
NWC	National Water Commission (Jamaica)
NST	No Time given for collection of samples
P(P)	Sample preserved prior to analysis
P(1)	Non-routine sample pre-treatment required
PAB	Pseudomonas Asparagine Broth
PCA	Plate Count Agar
PDA + C	Potato Dextrose Agar with Chloramphenicol
Pep Water	Peptone Water
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RED	Parameter Non-compliant
RPD	Relative Percentage Difference
SM	Standard Methods for the Examination of Water and Wastewater 23rd Edition
SRS	Standard Reference Solution
SS	Sample Submerged on receival at laboratory
SS ADB	Single Strength Azide dextrose broth
SS LTB	Single Strength Lauryl Tryptose Broth
SS PAB	Single Strength Pseudomonas Asparagine Broth
T(H)	Samples arrived at ESL-QEHL outside holding temperature (≤4.0°C).
TIT	Titrimetry
TPH	Total Petroleum Hydrocarbon
TSA	Tryptic Soy Agar
TSB	Tryptic Soy Broth
TSA+YE	Tryptic Soy Agar + Yeast Extract
TTC	Triphenyl Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

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Glossary

%	Percentage
µg/L	microgram per litre
µS/cm	Micro siemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BDLS	Analyte detected below method detection limit (MDL). MDL greater than standard value.
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BSA	Bismuth Sulfite Agar
c	parameter analysed in the field
C(B)	Samples collected by the client and picked up by an ESL bearer
C(C)	Samples collected by the client and delivered to ESL
C(H)	Analytical sample submitted in incorrect container. This may affect data quality.
C(L)	Samples collected by ESL
C(S)	Sample collected by the client then sub-sampled and delivered by ESL.
CFU	Colony Forming Units
CMMEF	Compendium of Methods for the Microbiological Examination of Foods
Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
D(C)	Sample diluted due to high concentration of target analyte
DR	Direct Reading
DS ADB	Double Strength Azide Dextrose Broth
DS LTB	Double Strength Lauryl Tryptose Broth
DS PAB	Double Strength Pseudomonas Asparagine Broth
EB	Equipment Blank
E(E1)	Estimated Value. Data acquisition affected by equipment malfunction.
E(L1)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was outside of QC limits. Results for this may be affected by same bias.
E(L2)	Estimated Value due to the nature of the sample matrix.
E(M1)	Estimated Value. Result calculated using calibration curve.
E(M2)	Estimated Value. Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
E(M3)	Estimated Value. Sample performance indicate presence of interference
E(R)	Estimated Value. RPD value was outside control limits.
EC	*E. coli* Media
E(V)	Estimated Value. Count(s) obtained is/are outside of the method counting range.
EC-MUG	*E. coli* Media with 4-methylumbelliferyl-β-D-glucuronide
EHU	Environmental Health Unit
EPA	(US) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectroscopy
FAES	Flame Atomic Emission Spectroscopy
FB	Field Blank
FD	Field Duplicate
FL-PRO	Florida Petroleum Range Organic Method
GC-MS	Gas Chromatography Mass Spectrometry
H	Hach Water Analysis Workbook
H(A)	Off-scale high data obtained. Actual value may be greater than value given.

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Certificate of Quality

Parameter: Faecal Enterococci (SM-9230 B)
QEHL Personnel: M. Mighty **Date of Analysis: 07/04/2022**

Media/Test Item (Batch #)	SS ADB (02/02/2022)	DS ADB (05/04/2022)	BEA (12/04/2022)	BHI Broth (20/04/2022)	BHI Broth + NaCl (20/04/2022)
Sterile (Yes/No)	Yes	Yes	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical	Typical	Typical

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Results of Sample Analysis

Sample ID (Matrix)	Test Method	Parameter(s)	Qualifier
		Faecal Enterococci (MPN/100mL)	
RP1 (Marine Water)	SM-9230 B	4.0	-
RP2 (Marine Water)	SM-9230 B	1600	-
RP3 (Marine Water)	SM-9230 B	1600	-
RP4 (Marine Water)	SM-9230 B	79	-
RP5 (Marine Water)	SM-9230 B	350	-
RP6 (Marine Water)	SM-9230 B	350	-
RP7 (Marine Water)	SM-9230 B	17	-
RP8 (Marine Water)	SM-9230 B	920	-
RP9 (Marine Water)	SM-9230 B	1600	-
RP10 (Marine Water)	SM-9230 B	280	-
RP11 (Marine Water)	SM-9230 B	220	-

***Blue shaded parameters are ISO/IEC 17025:2005 accredited**

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Sample(s) Information

Job Number:	**22040727-37**
SPN:	-
Date of Report:	17/05/2022
Revision Date:	**Not Applicable**
Sample(s) Collected:	07/04/2022
Sample(s) Submitted:	07/04/2022
Temperature on Arrival:	3.8°C
Number of Samples:	11
Analysis Started:	07/04/2022
Analysis Completed:	23/04/2022
Prepared By:	**Tara-Lee Hylton, Technical Assistant**

Verified By ……E. Terrelonge……
Eleanor Terrelonge,
Team Lead, Microbiology

Approved By……K Simpson……
Kearion Simpson,
Senior Analyst

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Where samples are collected by ESL, these are identified, and collection follows the lab's internal procedure for sampling, ESL-P 5.7.3 and the sampling plan created for the client and identified by the Sampling Plan Number (SPN) given in this report.

The ISO/IEC 17025 accreditation only applies to the tests identified in the Results of Sample Analysis.

The data presented in this report does not imply certification, approval, or endorsement of the client's services by ESL-QEHL or the accreditation body.

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ISO 17025 ACCREDITED LABORATORY

7 Hillview Avenue,
Kingston 10, Jamaica
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Fax: (876) 946-3745
E-mail: envirsol@cwjamaica.com

Certificate of Sample Analysis

CSA#: CLE 22040727-37

Attention:

Alec Silvera
C.L. Environmental Ltd.
P.O. Box 2919 Constant Spring P.O. Kingston 8

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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ICP	Inductively Coupled Plasma
ISE	Ion Selective Electrode
LCA	Listeria Chromogenic Agar
LE	Data not available due to laboratory error
LIA	Lysine Iron Agar
MAC	MacConkey Agar
MB	Method Blank
mEndo	mEndo Agar/Broth
MFHPB	Microbiology Food Health Protection Branch, Government of Canada
mmhos/cm	Millimhos per centimetre
mg/kg	milligram per kilogram
mg/L	milligrams per litre
MPN	Most Probable Number
mS/cm	millisiemens per centimetre
N/A (1)	Data not yet Available. Analysis not complete.
N/A (2)	Data not Available. Sample matrix interferences prevented data acquisition.
N/A (3)	Data not Available. Insufficient sample submitted.
N/A (4)	Data not Available. Equipment malfunction prevented data acquisition.
N/A (5)	Data not Available. Analysis not complete due to force majeure.
N/A (6)	Data not available due to issues with the shipment of the sample(s).
NA	Nutrient Agar
NB	Nutrient Broth
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NTU	Nephelometric Turbidity Units
NWC	National Water Commission (Jamaica)
NST	No Time given for collection of samples
P(P)	Sample preserved prior to analysis
P(1)	Non-routine sample pre-treatment required
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PDA + C	Potato Dextrose Agar with Chloramphenicol
Pep Water	Peptone Water
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RED	Parameter Non-compliant
RPD	Relative Percentage Difference
RSD	Relative Standard Deviation
SM	Standard Methods for the Examination of Water and Wastewater 23rd Edition
SRS	Standard Reference Solution
SS	Sample Submerged upon receival at the laboratory
SS ADB	Single Strength Azide Dextrose Broth
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T(H)	Samples arrived at ESL-QEHL outside holding temperature (≤4.0°C).
TIT	Titrimetry
TPH	Total Petroleum Hydrocarbon
TSA	Tryptic Soy Agar
TSB	Tryptic Soy Broth
TSA + YE	Tryptic Soy Agar + Yeast Extract
TTC	2,3,5 Triphenyl-2H-Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

CLE 22040727-37 Page **6** of **6**

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TESTING & MONITORING SERVICES LTD.

RP 2022-04-07

April 21, 2022

Name of Company: CL Environmental

Contact Person(s): Matthew Lee

Address: 20 Windsor Ave, Kingston 5, Jamaica

Telephone: 876-439-9584

Email: mlee@clenvironmental.com

Sample Date: **April, 04, 2022**

Date Received: April, 04, 2022

Number of Samples: 11

Type of Material: Marine

Date Tested: April 07-20, 2022

RESULTS FOR SAMPLES SUBMITTED

Parameters	Unit	Method	Detection Limit	RP 1	RP 2	RP 3	RP 4	RP 5	RP 6	RP 7	NRCA Standard
Nitrates	Mg/L	HACH 8039	0.03	2.6	4.7	2.0	2.4	2.0	1.8	1.2	0.007-0.014
Phosphates	Mg/L PO_4^{3-}	H ACH 8048	0.02	4.80	0.34	0.11	0.06	0.06	0.08	0.09	0.001-0.003
TSS	mg/L	HACH 8006	5.0	<5	<5	<5	<5	<5	<5	<5	NA
Faecal Coliform	MPN/100ml	SMEWW 9221 E	1.1	11	230	36	2400	11	3500	22	<2-13

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RP 2022-03-03

Parameters	Unit	Method	Detection Limit	RP 8	RP 9	RP 10	RP 11	NRCA Standard
Nitrates	Mg/L	HACH 8039	0.03	0.5	0.9	1.3	1.2	0.007-0.014
Phosphates	Mg/L PO_4^{3-}	HACH 8048	0.02	0.50	0.02	0.07	0.03	0.001-0.003
TSS	mg/L	HACH 8006	5.0	132	<5	5	<5	NA
Total Coliform	MPN/100ml	SMEWW 9221 E	1.1	3500	<1.1	<1.1	<1.1	<2-13

Methods: HACH Water Analysis Handbook 7th Edition
SMEWW Standard Methods for the Examination of Water and Wastewater, 21st Ed 2005

Reported by: Odian Barrett, Analyst

Approved by: Prof. Nilza Aples
Director of Analytical Testing and Monitoring

CETMS Ltd. does not accept responsibility for any deviations in results if:
i. Samples are not collected and handled in accordance with the Ministry of Health, Environmental Health Unit, Sampling and Field Measurements Protocol (January 2015)
ii. Samples are not delivered to the lab within the maximum holding time for each respective analysis requested
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RP 2022-03-03

March 21, 2022

Name of Company: CL Environmental

Contact Person(s): Matthew Lee

Address: 20 Windsor Ave, Kingston 5, Jamaica

Telephone: 876-439-9584

Email: mlee@clenvironmental.com

Sample Date: **March,03, 2022**

Date Received: March, 03, 2022

Number of Samples: 11

Type of Material: Marine

Date Tested: March 03-15, 2022

RESULTS FOR SAMPLES SUBMITTED

Parameters	Unit	Method	Detection Limit	RP 1	RP 2	RP 3	RP 4	RP 5	RP 6	RP 7	NRCA Standard
Nitrates	Mg/L	HACH 8039	0.03	2.0	1.8	1.5	1.2	1.7	1.5	1.7	0.007-0.014
Phosphates	Mg/L PO_4^{3-}	H ACH 8048	0.02	0.82	0.12	0.08	0.11	0.16	0.06	0.09	0.001-0.003
TSS	mg/L	HACH 8006	5.0	<5	<5	<5	<5	<5	<5	<5	NA
Faecal Coliform	MPN/100ml	SMEWW 9221 E	1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<1.1	<2-13

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RP 2022-02-03

Parameters	Unit	Method	Detection Limit	RP 8	RP 9	RP 10	RP 11	NRCA Standard
BOD	Mg/L	HACH 8043	0.01	1.82	1.43	1.16	1.46	0.0-1.16
Nitrates	Mg/L	HACH 8039	0.03	2.1	0.2	1.9	1.5	0.007-0.014
Phosphates	Mg/L PO_4^{3-}	HACH 8048	0.02	0.05	0.63	0.08	0.05	0.001-0.003
TSS	mg/L	HACH 8006	5.0	5	16	<5	6	NA
Total Coliform	MPN/100ml	SMEWW 9221 E	1.1					<2-13

Methods: HACH Water Analysis Handbook 7th Edition
SMEWW Standard Methods for the Examination of Water and Wastewater, 21st Ed 2005

Reported by: Odian Barrett, Analyst

Approved by: Prof. Nilza Aples
Director of Analytical Testing and Monitoring

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RP 2022-02-03

February 18, 2022

Name of Company: CL Environmental

Contact Person(s): Matthew Lee

Address: 20 Windsor Ave, Kingston 5, Jamaica

Telephone: 876-439-9584

Email: mlee@clenvironmental.com

Sample Date: February,03, 2022

Date Received: February, 03, 2022

Number of Samples: 12

Type of Material: Marine

Date Tested: February 03-15, 2022

RESULTS FOR SAMPLES SUBMITTED

Parameters	Unit	Method	Detection Limit	RP 1	RP 2	RP 3	RP 4	RP 5	RP 6	RP 7	NRCA Standard
BOD	Mg/L	HACH 8043	0.01	1.62	1.54	1.47	1.15	1.34	1.68	1.52	0.0-1.16
Nitrates	Mg/L	HACH 8039	0.03	1.4	1.6	1.5	1.3	1.2	1.9	1.7	0.007-0.014
Phosphates	Mg/L PO_4^{3-}	H ACH 8048	0.02	0.36	0.75	0.12	0.09	0.09	0.09	0.10	0.001-0.003
TSS	mg/L	HACH 8006	5.0	2	8	5	5	13	<5	<5	NA
Faecal Coliform	MPN/100ml	SMEWW 9221 E	1.1								<2-13

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TESTING & MONITORING SERVICES LTD.

RP 2022-04-07

Parameters	Unit	Method	Detection Limit	RP 8	RP 9	RP 10	RP 11	NRCA Standard
Nitrates	Mg/L	HACH 8039	0.03	1.4	1.6	1.9	2.4	0.007-0.014
Phosphates	Mg/L PO_4^{3-}	HACH 8048	0.02	0.06	0.27	0.24	0.08	0.001-0.003
TSS	mg/L	HACH 8006	5.0	5	52	5	<5	NA
Total Coliform	MPN/100ml	SMEWW 9221 E	1.1	120	230	51	<1.1	<2-13

Methods: HACH Water Analysis Handbook 7th Edition
SMEWW Standard Methods for the Examination of Water and Wastewater, 21st Ed 2005

Reported by: Odian Barrett, Analyst

Approved by: Prof. Nilza Aples
Director of Analytical Testing and Monitoring

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ii. Samples are not delivered to the lab within the maximum holding time for each respective analysis requested
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Appendix 7 – Raw Laboratory and Hydrolab Data

Table 11-1 *in-situ* Water Quality Hydrolab Data

Run 1	Stn	TEMP. °C	COND (mS/cm)	SAL (ppt)	pH	D.O. (mg/l)	Turb (NTU)	TDS (g/l)	PAR (uE/cm/s)
	1	26.60	53.91	35.75	7.97	6.05	0.08	34.53	98.60
	2	26.51	53.64	35.50	7.89	5.13	4.95	34.35	115.00
	3	26.43	53.73	35.58	7.97	6.00	0.67	34.39	156.00
	4	26.36	53.60	35.37	7.85	4.26	0.00	34.31	77.50
	5	26.53	53.62	35.50	7.95	5.66	0.83	34.84	48.25
	6	26.62	53.77	35.61	7.95	5.46	1.36	34.40	226.80
	7	26.71	53.67	35.54	7.91	5.87	0.10	34.28	22.33
	8	26.75	53.78	35.57	7.92	5.46	1.07	34.42	40.33
	9	23.45	2.59	1.39	7.70	1.90	30.50	1.65	-
	10	26.46	53.59	35.47	7.94	5.53	2.10	34.33	87.50
	11	26.51	53.73	35.58	7.94	5.31	1.05	34.41	262.00
Run 2	Stn	TEMP. °C	COND (mS/cm)	SAL (ppt)	pH	D.O. (mg/l)	Turb (NTU)	TDS (g/l)	PAR (uE/cm/s)
	1	27.49	54.29	35.98	8.10	-	0.00	34.74	515.00
	2	27.68	54.24	35.94	8.10	-	1.75	34.72	771.50
	3	27.44	54.20	35.93	8.08	-	2.80	34.69	612.33
	4	27.71	54.11	35.83	8.08	-	0.00	34.57	693.50
	5	27.79	54.08	35.88	8.10	-	0.00	34.62	242.67
	6	27.59	53.91	35.72	8.10	-	0.00	34.54	343.75
	7	27.87	54.36	36.06	8.10	-	1.33	34.82	333.75
	8	27.87	54.27	35.96	8.08	-	15.20	34.73	166.00
	9	22.65	4.38	2.34	7.36	-	14.40	2.80	-
	10	27.38	54.24	36.43	8.07	-	4.80	34.66	212.50
	11	27.71	54.36	36.02	8.11	-	3.20	34.77	806.00
Run 3	Stn	TEMP. °C	COND (mS/cm)	SAL (ppt)	pH	D.O. (mg/l)	Turb (NTU)	TDS (g/l)	PAR (uE/cm/s)
	1	28.58	54.46	36.13	8.13	6.03	0.50	34.87	209.00
	2	28.73	54.22	35.94	8.20	5.52	0.50	34.72	777.00
	3	28.47	54.17	35.92	8.20	6.15	0.00	34.45	602.50
	4	28.71	53.99	35.81	8.20	6.05	0.70	34.49	638.50
	5	28.84	54.34	36.04	8.18	5.80	0.80	34.76	467.25
	6	28.70	54.29	35.96	8.18	5.63	0.04	34.74	345.20
	7	28.72	54.24	35.88	8.18	6.31	0.90	34.61	394.50
	8	28.52	53.77	35.47	8.18	5.93	0.00	33.95	193.00
	9	25.85	4.24	2.31	7.78	3.96	19.40	2.71	-
	10	28.61	53.99	35.75	8.15	4.43	2.10	34.55	163.50

	11	28.58	54.24	35.94	8.21	6.27	1.45	34.69	757.00
Average	Stn	TEMP. °C	COND (mS/cm)	SAL (ppt)	pH	D.O. (mg/l)	Turb (NTU)	TDS (g/l)	PAR (uE/cm/s)
	1	27.56	54.22	35.95	8.07	6.04	0.19	34.71	274.20
	2	27.64	54.03	35.79	8.06	5.32	2.40	34.59	554.50
	3	27.45	54.03	35.81	8.08	6.07	1.16	34.51	456.94
	4	27.59	53.90	35.67	8.04	5.15	0.23	34.46	469.83
	5	27.72	54.01	35.81	8.07	5.73	0.54	34.74	252.72
	6	27.64	53.99	35.76	8.07	5.55	0.47	34.56	305.25
	7	27.76	54.09	35.83	8.06	6.09	0.78	34.57	250.19
	8	27.71	53.94	35.67	8.06	5.70	5.42	34.37	133.11
	9	23.98	3.74	2.01	7.61	2.93	21.43	2.39	-
	10	27.48	53.94	35.88	8.05	4.98	3.00	34.51	154.50
	11	27.60	54.11	35.84	8.09	5.79	1.90	34.62	608.33

Table 11-2 Laboratory Water Quality data

	STN.	BOD (mg/l)	TSS (mg/l)	NIT (mg/l)	PHOS (mg/l)	F.COLI (mpn/100ml)	Faecal Enterococci (MPN/100mL)
run 1	WQ1	1.62	2	1.4	0.36	4	1.8
	WQ2	1.54	8	1.6	0.75	23	6.8
	WQ3	1.47	5	1.5	0.12	49	11
	WQ4	1.15	5	1.3	0.09	79	79
	WQ5	1.34	13	1.2	0.09	79	46
	WQ6	1.68	5	1.9	0.09	49	110
	WQ7	1.52	5	1.7	0.1	130	23
	WQ8	1.82	5	2.1	0.05	920	140
	WQ9	1.43	16	0.2	0.63	1600	1600
	WQ10	1.16	5	1.9	0.08	1600	1.8
	WQ11	1.46	6	1.5	0.05	7.8	22
	STN.	BOD (mg/l)	TSS (mg/l)	NIT (mg/l)	PHOS (mg/l)	F.COLI (mpn/100ml)	Faecal Enterococci (MPN/100mL)
run 2	WQ1	1.8	5	2	0.82	1.1	1.8
	WQ2	1.4	5	1.8	0.12	1.1	1.8
	WQ3	1.7	5	1.5	0.08	1.1	1.8
	WQ4	1.5	5	1.2	0.11	1.1	1.8
	WQ5	1.8	5	1.7	0.16	1.1	1.8
	WQ6	1.8	5	1.5	0.06	1.1	7.8
	WQ7	1.6	5	1.7	0.09	1.1	1.8

	WQ8	1.6	5	0.9	0.02	1.1	140
	WQ9	8.9	132	0.5	0.5	3500	1600
	WQ10	1.9	5	1.3	0.07	1.1	6.8
	WQ11	1.5	5	1.2	0.03	1.1	1.8
	STN.	**BOD (mg/l)**	**TSS (mg/l)**	**NIT (mg/l)**	**PHOS (mg/l)**	**F.COLI (mpn/100ml)**	**Faecal Enterococci (MPN/100mL)**
run 3	WQ1	1.1	5	2.6	4.8	11	4
	WQ2	1.2	5	4.7	0.34	230	1600
	WQ3	1.4	5	2	0.11	36	1600
	WQ4	1.4	5	2	0.06	2400	79
	WQ5	1.4	5	2	0.06	11	350
	WQ6	1.5	5	1.8	0.08	3500	350
	WQ7	1.3	5	1.2	0.09	22	17
	WQ8	1	5	1.4	0.06	120	920
	WQ9	4.8	52	1.6	0.27	230	1600
	WQ10	1.1	5	1.9	0.24	51	280
	WQ11	1.2	5	2.4	0.08	1.1	220
avg.	**STN.**	**BOD (mg/l)**	**TSS (mg/l)**	**NIT (mg/l)**	**PHOS (mg/l)**	**F.COLI (mpn/100ml)**	**Faecal Enterococci (MPN/100mL)**
	WQ1	1.51	4.00	2.00	1.99	5.37	2.53
	WQ2	1.38	6.00	2.70	0.40	84.70	536.20
	WQ3	1.52	5.00	1.67	0.10	28.70	537.60
	WQ4	1.35	5.00	1.50	0.09	826.70	53.27
	WQ5	1.51	7.67	1.63	0.10	30.37	132.60
	WQ6	1.66	5.00	1.73	0.08	1183.37	155.93
	WQ7	1.47	5.00	1.53	0.09	51.03	13.93
	WQ8	1.47	5.00	1.47	0.04	347.03	400.00
	WQ9	5.04	66.67	0.77	0.47	1776.67	1600.00
	WQ10	1.39	5.00	1.70	0.13	550.70	96.20
	WQ11	1.39	5.33	1.70	0.05	3.33	81.27

Appendix 8 – Bruel & Kjaer Type 4321 Noise Calibration Certificate

HBK HOTTINGER BRÜEL & KJÆR

The Hottinger Brüel & Kjær Inc. Calibration Laboratory
3079 Premiere Parkway Suite 120
Duluth, GA 30097
Telephone: 770-209-6907
Fax: 770-447-4033
Web site address: http://www.hbkworld.com

A2LA ACCREDITED

Calibration Certificate # 1568.01

CERTIFICATE OF CALIBRATION No.: CAS-533887-W0Z6N6-401 Page 1 of 2

CALIBRATION OF:

Calibrator: Brüel & Kjær Type 4231 Serial No.: 3008614
IEC Class: 1

CUSTOMER:

C.L. Environmental Company Ltd.
20 Windsor Avenue, Kingston 5
Kingston, Jamaica

CALIBRATION CONDITIONS:

Environment conditions:	Air temperature:	23.7	°C
	Air pressure:	98.131	kPa
	Relative Humidity:	49.9	%RH

SPECIFICATIONS:

This document certifies that the acoustic calibrator as listed under "Type" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurements. The calibration of the listed transducer was accomplished using a test system which conforms to the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and guidelines of ISO 10012-1. For "as received" and "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation. This Certificate and attached data pages shall not be reproduced, except in full, without written approval of the Hottinger Brüel & Kjær Inc. Calibration Laboratory-Duluth, GA. Results relate only to the items tested. The transducer has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants. The acoustic calibrator has been calibrated in accordance with the requirements as specified in IEC60942.

PROCEDURE:

The measurements have been performed with the assistance of Hottinger Brüel & Kjær Inc. acoustic calibrator calibration application
Software version 2.3.4 Type 7794 using calibration procedure 4231 Complete

RESULTS:

- [X] "As Received" Data: Within Acceptance Criteria
- [ ] "As Received" Data: Outside Acceptance Criteria
- [X] "Final" Data : Within Acceptance Criteria
- [ ] "Final" Data : Outside Acceptance Criteria

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the calibrator under calibration.

Date of Calibration: September 14, 2021

Meshaun Hobbs
Calibration Technician

Certificate issued: September 14, 2021

Harold Williams

Harold Williams
Quality Representative

CERTIFICATE OF CALIBRATION

No.: CAS-533887-W0Z6N6-401

Type: 4231 Serial No.: 3008614 Page 2 of 2

Sound Pressure Levels

All stated values are valid at environmental reference conditions

Nominal Level [dB]	Accept Limit Lower [dB]	Accept Limit Upper [dB]	Measured Level [dB]	Measurement Uncertainty [dB]
94	93.80	94.20	93.96	0.12
114	113.80	114.20	113.93	0.12

Frequency

Nominal Frequency [Hz]	Accept Limit Lower [Hz]	Accept Limit Upper [Hz]	Measured Frequency [Hz]	Measurement Uncertainty [Hz]
1000	999.00	1001.00	999.98	0.10

Total Distortion*

Distortion mode: [X] **TD*** [ ] **THD***

Calibration Level [dB]*	Accept Limit [%]*	Measured Distortion [%]*	Measurement Uncertainty [%]*
94	1.00	0.34	0.13
114	1.00	0.10	0.13

Environmental Reference Conditions:

Pressure: 101.3 kPa, Temperature: 23 °C, Relative Humidity: 50%

Instrument List

Type	Description	Serial no	Cal. date	Due date	Calibrated by	Trace number
3560	PULSE Analyzer	2723320	2020-10-20	2021-10-20	JCA	CAS-475391-Q6N6H0-103
9545	Transfer Microphone	3	2020-10-21	2021-10-21	MH	CAS-475391-Q6N6H0-404
4228	Reference Sound Source	1618502	2021-04-30	2023-04-30	M. Hobbs	CAS-512601-T0X4B1-402

During the calibration the calibrator has been loaded by the load volume of the Transfer Microphone. The load volumes for a number of different types of Transfer Microphones are listed in the table below.
For Brüel & Kjær Pistonphones types 4220 and 4228 the result of the SPL calibration has been corrected to be valid for a load volume of 1333 mm^3 . For all other types the result is valid with the actual load volume.

Transfer Microphone Type	Fulfils standard IEC 61094-1 LS	Fulfils standard IEC 61094-4 WS	Load Volume 1" (1/2" mic including DP-0776)	Load Volume 1/2"
4180	yes	yes	1126 mm^3	43 mm^3
4192	-	yes	1273 mm^3	190 mm^3
9545	-	-	1333 mm^3	-

Condition "As Received":

Good

Comments

Appendix 9 – AirMetrics Tactical Air Sampler Flow Meter Calibration Certificate

NIST Traceable Transfer Standard Calibration

Calibration Date:	07/21/2021	Orifice #	MNF1829-	By:	
Ambient Temp, °K:	297.9	Pri Std #	LFE774300		
Amb Press, mmHg:	758.0	Manometer #	DIG1829	Chk:	

Std ΔH (inH_2O)	Manometer ΔH (inH_2O)	Actual Flow (alpm)	Calc Flow (alpm)	Difference* (%diff)
4.82	4.75	7.867	7.852	0.20
4.00	3.92	7.108	7.123	-0.21
3.20	3.13	6.343	6.354	-0.17
2.47	2.41	5.571	5.563	0.15
1.84	1.79	4.792	4.780	0.26
1.49	1.44	4.269	4.276	-0.17
1.16	1.12	3.743	3.759	-0.43
0.86	0.82	3.215	3.201	0.42

Manometer ΔH vs Act Flow Linear Regression Results:

m_{flo} =	**5.8231**
b_{flo} =	**-0.1039**
r^2 =	**0.9999**

* all points must be within ± 2%

The MiniFlo calibration is performed with an NIST-traceable standard. Each unit has a unique pair of calibration constants derived from the calibration which are used to calculate the actual air flow rate at all ambient conditions. The unit's calibration should be recertified annually.

The actual flow rate is a function of the pressure drop across the device, the ambient temperature, and the ambient pressure. The relationship of these variables and the unique calibration constants ("m" and "b") for each device is presented in the following equation (Eq.A):

$$Q_{act} = m_{flo} \times \sqrt{\frac{\Delta H \times T_{act}}{P_{act}}} + b_{flo}$$

Q_{act} = actual flowrate, liters per min
ΔH = manometer reading, inches of water
T_{act} = ambient temperature, °K
P_{act} = ambient pressure, millimeters of mercury

CAUTION: The weather service, most airports, etc, reduce the atmospheric pressure to a common reference (sea level). The equation above requires the atmospheric pressure at the location where the MiniFlo is being used.

The equation below may be used to estimate the ambient atmospheric pressure at any elevation if the sea level pressure is known.

$$P_{act} = P_{sea} \times \left(1 - \frac{E}{145300}\right)^{5.25}$$

P_{act} = Ambient Atmospheric Pressure
P_{sea} = Sea Level Atmospheric Pressure
E = Site elevation, feet

Airmetrics
1940 Don St., Suite 300
Springfield, OR 97477
(541) 683-5420

Appendix 10 – Perception Survey Community Questionnaire

READING PEN, ST JAMES
COMMUNITY QUESTIONNAIRE

DATE:___________________ **INTERVIEWER:_______________**

LCH Development Limited is proposing to develop approximately 17.5 acres of waterfront property located at 2 Reading Pen, St. James, to be known as "The Peninsula". A "Mixed-Use" residential development is proposed and will be done in five Zones. The overall objective of this development is to offer luxury living and associated amenities to promote a lifestyle of wellbeing.

It is proposed that Zone 1 (The Villas at the Peninsula) will comprise fifteen (15) villas along the waterfront. Each villa will be two storeys/levels and 3,000 square feet in size with 3-bedrooms. This zone will also have garage space, staff quarters, a pool and deck with pergola.

Zone 2 (The Peninsula Bay) will be five storeys/levels and will comprise a fine dining restaurant, a clubhouse and lounge, six (6) guest apartments and a mini marina with at least eight berths.

Zone 3 (The Towers at the Peninsula) will comprise four (4) high-rise towers approximately 336 feet/102 metres tall, with each tower being designed to cater to needs of a unique target audience. It is proposed that **Towers 1, 2 ad 3 will each have 142 housing units**, comprising 19 one-bedroom, 89 two-bedroom, 28 three-bedroom, 4 four-bedroom and 2 five-bedroom units and will be 28 storeys/levels in height. **Towers 1 and 2** will be geared to the working persons and their families who seek to work remotely and will feature a fitness centre, pool deck, kids lounge and adult entertainment lounges. In addition, office lounges and meeting rooms will also be available to meet the requirements of this group. **Tower 3** will cater to retirees seeking to relax and enjoy the sun sand and sea at leisure. This tower will also have outdoor/indoor lounges, a pool deck and amenities and fitness activities suited for a mature audience. **Tower 4, also 28 storeys/levels in height, will comprise 114 "ultra-luxe" high rise residences**, a sky villa and helipad. This tower will comprise 14 one-bedroom, 23 two-bedroom, 24 two-bedroom-deluxe, 22 three-bedroom, 24 four-bedroom and 7 five-bedroom units. In addition to these residences this tower will also have a mini-theatre, games room, bar and lounges with catering services and a full service spa. These Towers will have multi-storey parking garages and storage spaces to support each residential unit.

Zone 4 (The Commercial Spaces) is proposed for commercial development and will have a supermarket/deli with a mini food court. The supermarket will be a single storey double height structure with a mezzanine (loft) area housing the mini food court. A three-storey building will also house shops and offices to support the residences of the complex.

Zone 5 (General Ground Amenities & Project Management and Back of House Buildings) will have as part of the amenities, two tennis courts, one basketball court, recreational parks with jogging/walking trails and gazebos. There will also be a water feature with outdoor landscaped lounges and gazebos. Ponds (lined with heavy duty liners) will also be incorporated in the design. The development will also have backup power generator systems.

For this project, water supply and sewage treatment will be via connection into the National Water Commission facilities. At this time, no timeline projection is available.

COHORT DESCRIPTION

1. What is the name of this/your community? __________________________
2. (i) Male (ii) Female
3. Age group (i) 18- 25 yrs (ii) 26-33 yrs (iii) 34-41 yrs (iv) 42 – 50 yrs (v) 51 – 60 yrs (vi) older than 60 yrs
4. Are you the head of your household (i) yes (ii) no
5. What is your current employment status? (i) self-employed (ii) have an employer (iii) unemployed (iv) retired
6. Including yourself, how many people live in your household? ____ (i) # of adults ____ (ii) # of children under 18 yrs ____
7. How long have you lived in your community? (i) <2 yrs (ii) 3-5 yrs (iii) 5- 10 yrs (iv)10-15 yrs (v) >15 yrs (vi) all your life
8. In the event of illness, where do you mainly obtain health care (write in name & location)?(i) Public Clinic______________ (ii) Public Hospital _________________(iii) Private Doctor __________________ (iv) Private Hospital________________
9. Do you suffer from any of the following conditions? (i). Asthma (ii). Sinusitis (iii) coughing (iv) congestion/bronchial problems (v) chest pains (vi) bouts of diarrhoea (vii) none
10. What is your average weekly income? (i) no income (ii) under $9,000 per week (iii) $9,000 per week (iv) $9,001 - $12,000 per week (v) $12,001 - $20,000 per week (vi) over $20,000 per week (vii) refuse to answer
11. What is the highest level of education you completed? (Which was the last school you attended) (i) None (ii) Primary/All Age (iii) Some High School (iv) High School (v) College (vi) University (vii) HEART/Vocational training institute
12. Is there anyone in your household attending school at this time? (i) yes (ii) no
    a. What school(s) do they attend (i) infant/basic (ii) primary/all age (iii) high school (iv) college (v) University (vi) HEART/ Vocational Training Institute
13. Are there any recreational centres/spaces in your community? (i). Yes (ii) No
    a. **If yes** please give name and type _______________________________

May 2022

PERCEPTION

14. Have you ever heard of a company called LCH Development limited? (i) yes; (ii) no
15. Have you ever heard of a project called The Peninsula? (i) yes; (ii) no
16. Do you know what the term Mixed-Use Residential Development means? (i) yes; (ii) no
17. Did you know that LCH Development Limited is proposing to construct a Mixed-Use Residential Development in the Reading area of Montego Bay? (i) yes (ii) no
    a. **If yes** Were you aware that this development would include residential villas? (i) yes; (ii) no
    b. **If yes** Were you aware that this development would include four residential towers/high rise buildings? (i) yes; (ii) no
    c. **If yes** Were you aware that this development would include buildings being up to 336ft/102m/28levels tall? (i) yes; (ii) no
    d. **If yes** Were you aware that this development would include commercial spaces (supermarket/office space)? (i) yes; (ii) no
    e. **If yes**, how were you made aware? (i) Newspaper (ii) Television (iii) Radio (iv) Community meeting (v) Word of mouth (vi) social media (vii) Other -----------------------------
18. Have there been any problems/issues on the proposed project site in Reading? (i) yes (ii) no (iii) don't know
    a. **If yes** what were/are the issues ______________________________
19. Do you have any general concerns about the project as proposed? (i) yes; (ii) no (iii) not sure/don't know
    a. **If yes**, what are they? ______________________________

    ____
    b. **If yes**, what would you suggest to address/resolve your concern(s)? ______________________________

    ____
20. Do you have any concerns with the residential towers being a maximum of 28 storeys/levels in height? (i) yes; (ii) no (iii) not sure/don't know
    a. **If yes**, what are they? ______________________________

    ____
    b. **If yes**, what would you suggest to address/resolve your concern(s)? ______________________________

    ____
21. Do you depend/use the proposed site (the lands/ beach area) for any type of activity? (i) yes; (ii) no
    a. **If yes** for what purpose ______________________________
22. Do you depend/use the proposed area for the marina for any type of activity? (i) yes; (ii) no
    a. **If yes** for what purpose ______________________________
23. Do you know of anyone who depends/uses the proposed site (lands/ beach area) for any type of activity? (i) yes; (ii) no
    a. **If yes** for what purpose ______________________________
24. Do you think this project will affect your life/livelihood (i) positively or (ii) negatively? (iii) not at all (iv) not sure/don't know
    a. **If positive** how so? ______________________________
    b. **If negative** how so? ______________________________
    c. **If negative** how do you think your issue could be resolved**?** ______________________________

    ____
25. Do you think this project will affect your community (i) positively or (ii) negatively? (iii) not at all (iv) not sure/don't know
    a. **If positive** how so? ______________________________
    b. **If negative** how so? ______________________________
    c. **If negative** how do you think this issue could be resolved**?** ______________________________

    ____
26. Do you think this project will affect the environment (i) positively or (ii) negatively? (iii) not at all (iv) not sure
    a. **If positive** how so? ______________________________
    b. **If negative** how so? ______________________________
    c. **If negative** how do you think this issue could be resolved**?** ______________________________

    ____

May 2022

HOUSING, HEALTH AND SOCIAL SERVICES

27. Do you _______ the house you live in? (i) Own (ii) Lease (iii) Rent (iv) Government Own (v) Squat (vi) Family own (vii) Other, specify ____________

28. Do you ________ the land on which your house is located?
    (i) Own (ii) Lease (iii) Squat on (iv) Family Owned (v) Government Owned (vi) Other, specify ______________

29. What type of construction material is your residence made from?
    a. **Walls:** (i) Concrete and blocks (ii) Wood/Board (iii) Zinc (iv) Other specify________
    b. **Roof:** (i) Metal sheeting (zinc) (ii)Concrete (iii)Wood (iv) Other specify________

30. How many of the following rooms does your residence have? (i) Bedrooms _______ (ii) Bathrooms ________

31. What type of toilet facility do you have? (i) Water Closet (ii) Pit Latrine (iii) None (iv)Other, specify ____________

32. What does your household use for lighting? (i) Electricity (ii) Kerosene oil (iii) Gas (iv) Solar (v) Other, specify ___________

33. What (type of fuel does the household) do you **use most** for cooking? (i) Gas (ii) Electricity (iii)Wood (iv)Coal (v)Other, specify _____________

34. What is the main source of domestic water supply for the household? (i) Public piped water into dwelling (ii) Private Tank (iii) Community Tank (iv) Government Water Trucks (free) (v)Public Standpipe (vi). Private Water Trucks (paid) (vii) Spring or River (viii) Other, specify________

35. Do you have any problems with domestic/household water supply (i) yes (ii) no
    a. **If yes**, what is the problem? (i) no water at all (ii) no pipes run to the area (iii) irregular water supply (iv) low water pressure (v) other _____________________________
    b. **If yes** how do you cope with the problem (i) collect rain water (ii) buy water (iii) collect water from a spring/river (iv) water truck supplies water (v) community standpipe (vi) other _______________________
    c. **If yes** how do you store water (i) small containers (bottles) (ii) drums (iii) underground tank (iii) aboveground tank/black tank (iv) other ________________

36. Do you have access to a residential telephone (land line)?(i) yes (ii) no
    a. **If no**, do you have a mobile/cell phone? (i) yes (ii) no

37. Does your community have fixed line (residential) telephone (land line) service? (i) yes (ii) no (iii) don't know

38. What is the main method of garbage disposal for your household? (i) Public Garbage Truck (ii) Private Collection (iii) Burn (iv)Other specify ________
    a. **If public garbage truck**, how often do trucks pick up garbage? (i) once per week (ii) twice per week (iii) every 2 weeks (iv) 1 time per month (v) less than once per month

NATURAL HAZARDS & SOCIAL AMENITIES

39. Are there problems with frequent flooding in your community? (i) Yes (ii) No
    a. **If yes** when does flooding occur (i) each time it rains (ii) only times of heavy rains (iii) during hurricanes
    b. **If yes** how often does it rain to cause flooding? (i) once weekly (ii) once monthly (iii) once in three months (iv) once in six months (v) once in a year (vi) less than once in a year
    c. **If yes** where are the affected areas? ____
    d. **If yes** how high does the water level rise? (i) less than 1 foot (ii) 1-5 ft (iii) more than 5 ft

40. Are there problems with frequent flooding at or near the proposed area? (i) Yes (ii) No (iii) don't know
    a. **If yes** when does flooding occur (i) each time it rains (ii) only times of heavy rains (iii) during hurricanes
    b. **If yes** how often does it rain to cause flooding? (i) once weekly (ii) once monthly (iii) once in three months (iv) once in six months (v) once in a year (vi) less than once in a year
    c. **If yes** where are the affected areas? ____
    d. **If yes** how high does the water level rise? (i) less than 1 foot (ii) 1-5 ft (iii) more than 5 ft

41. Is the proposed area affected by tidal changes such as storm surge/sea level rise? (i) yes (ii) no (iii)not sure/don't know

42. Do you know of any site or area nearby considered to be (i) a protected area/ area of environmental importance (ii) historic area (iii) or other area of national importance? (i) Yes (ii) No (iii) don't know
    a. **If yes** please give us as much detail as you can on this area ____

43. Is there anything in particular about your area that you would like to tell us?

    ____

Signature of Interviewer: .... Thank You for your time.

Would you mind submitting your name and contact information (telephone/email) for verification/follow-up purposes if the National Environment & Planning Agency (NEPA) wishes to make contact?

____

May 2022

Appendix 11 - Perception Survey Stakeholder Questionnaire

READING PEN, ST JAMES

STAKEHOLDER QUESTIONNAIRE

DATE:__________________ **INTERVIEWER:**______________

LCH Development Limited is proposing to develop approximately 17.5 acres of waterfront property located at 2 Reading Pen, St. James, to be known as "The Peninsula". A "Mixed-Use" residential development is proposed and will be done in five Zones. The overall objective of this development is to offer luxury living and associated amenities to promote a lifestyle of wellbeing.

It is proposed that Zone 1 (The Villas at the Peninsula) will comprise fifteen (15) villas along the waterfront. Each villa will be two storeys/levels and 3,000 square feet in size with 3-bedrooms. This zone will also have garage space, staff quarters, a pool and deck with pergola.

Zone 2 (The Peninsula Bay) will be five storeys/levels and will comprise a fine dining restaurant, a clubhouse and lounge, six (6) guest apartments and a mini marina with at least eight berths.

Zone 3 (The Towers at the Peninsula) will comprise four (4) high-rise towers approximately 336 feet/102 metres tall, with each tower being designed to cater to needs of a unique target audience. It is proposed that **Towers 1, 2 ad 3 will each have 142 housing units**, comprising 19 one-bedroom, 89 two-bedroom, 28 three-bedroom, 4 four-bedroom and 2 five-bedroom units and will be 28 storeys/levels in height. **Towers 1 and 2** will be geared to the working persons and their families who seek to work remotely and will feature a fitness centre, pool deck, kids lounge and adult entertainment lounges. In addition, office lounges and meeting rooms will also be available to meet the requirements of this group. **Tower 3** will cater to retirees seeking to relax and enjoy the sun sand and sea at leisure. This tower will also have outdoor/indoor lounges, a pool deck and amenities and fitness activities suited for a mature audience. **Tower 4, also 28 storeys/levels in height, will comprise 114 "ultra-luxe" high rise residences**, a sky villa and helipad. This tower will comprise 14 one-bedroom, 23 two-bedroom, 24 two-bedroom-deluxe, 22 three-bedroom, 24 four-bedroom and 7 five-bedroom units. In addition to these residences this tower will also have a mini-theatre, games room, bar and lounges with catering services and a full service spa. These Towers will have multi-storey parking garages and storage spaces to support each residential unit.

Zone 4 (The Commercial Spaces) is proposed for commercial development and will have a supermarket/deli with a mini food court. The supermarket will be a single storey double height structure with a mezzanine (loft) area housing the mini food court. A three-storey building will also house shops and offices to support the residences of the complex.

Zone 5 (General Ground Amenities & Project Management and Back of House Buildings) will have as part of the amenities, two tennis courts, one basketball court, recreational parks with jogging/walking trails and gazebos. There will also be a water feature with outdoor landscaped lounges and gazebos. Ponds (lines with heavy duty liners) will also be incorporated in the design. The development will also have backup power generator systems.

For this project, water supply and sewage treatment will be via connection into the National Water Commission facilities. At this time, no timeline projection is available.

What is the name of your organisation? _________________________________

PERCEPTION

1. Have you ever heard of a company called LCH Development limited? (i) yes; (ii) no
2. Have you ever heard of a project called The Peninsula? (i) yes; (ii) no
3. Do you know what the term Mixed-Use Residential Development means? (i) yes; (ii) no
4. Did you know that LCH Development Limited is proposing to construct a Mixed-Use Residential Development in the Reading area of Montego Bay? (i) yes (ii) no
   a. **If yes** Were you aware that this development would include residential villas? (i) yes; (ii) no
   b. **If yes** Were you aware that this development would include four residential towers/high rise buildings? (i) yes; (ii) no
   c. **If yes** Were you aware that this development would include buildings being up to 336ft/102m/28levels tall? (i) yes; (ii) no
   d. **If yes** Were you aware that this development would include commercial spaces (supermarket/office space)? (i) yes; (ii) no
   e. **If yes**, how were you made aware? (i) Newspaper (ii) Television (iii) Radio (iv) Community meeting (v) Word of mouth (vi) social media (vii) Other ------------------------------
5. Have there been any problems/issues on the proposed project site in Reading? (i) yes (ii) no (iii) don't know
   a. **If yes** what were/are the issues ____
6. Does your organization have any general concerns about the project as proposed? (i) yes; (ii) no (iii) not sure/don't know
   a. **If yes**, what are they? ____
   ____
   b. **If yes**, what would you suggest to address/resolve your concern(s)? ______________________
   ____
7. Does your organization have any concerns with the residential towers being a maximum of 28 storeys/levels in height? (i) yes; (ii) no (iii) not sure/don't know
   a. **If yes**, what are they? ____

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____

b. **If yes**, what would you suggest to address/resolve your concern(s)? ____

8. Does your organization depend/use the proposed site (the lands/ beach area) for any type of activity? (i) yes; (ii) no
   a. **If yes** for what purpose ____

9. Does your organization depend/use the proposed area for the marina for any type of activity? (i) yes; (ii) no
   a. **If yes** for what purpose ____

10. Is your organization aware of any entity that depends/uses the proposed site (lands/ beach area) for any type of activity? (i) yes; (ii) no
    a. **If yes** for what purpose ____

11. Do you think this project will in general affect your organization (i) positively or (ii) negatively? (iii) not at all (iv) not sure/don't know
    a. **If positive** how so? ____
    b. **If negative** how so?____
    c. **If negative** how do you think your issue could be resolved**?** ____

12. Do you think this project will affect your organization's core functions (i) positively or (ii) negatively? (iii) not at all (iv) not sure/don't know
    a. **If positive** how so? ____
    b. **If negative** how so?____
    c. **If negative** how do you think this issue could be resolved**?** ____

13. Does your organization think this project will affect the environment (i) positively or (ii) negatively? (iii) not at all (iv) not sure
    a. **If positive** how so? ____
    b. **If negative** how so?____
    c. **If negative** how do you think this issue could be resolved**?** ____

14. Does your organization think this project will affect the Montego Bay Marine Park (i) positively or (ii) negatively? (iii) not at all (iv) not sure
    a. **If positive** how so? ____
    b. **If negative** how so?____
    c. **If negative** how do you think this issue could be resolved**?** ____

15. Does your organization think this project will affect the Airport Point (Montego Bay Marine Park Special Fishery Conservation Area) (i) positively or (ii) negatively? (iii) not at all (iv) not sure
    a. **If positive** how so? ____
    b. **If negative** how so?____
    c. **If negative** how do you think this issue could be resolved**?** ____

16. Does your organization think this project will affect the Bogue Lagoons (Bogue Island Lagoon Special Fishery Conservation Area) (i) positively or (ii) negatively? (iii) not at all (iv) not sure
    a. **If positive** how so? ____
    b. **If negative** how so?____
    c. **If negative** how do you think this issue could be resolved**?** ____

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17. Does your organization think this project will affect the fish and wildlife and associated ecosystems (i) positively or (ii) negatively? (iii) not at all (iv) not sure
    a. **If positive** how so? ____________________
    b. **If negative** how so? ____________________
    c. **If negative** how do you think this issue could be resolved**?** ____________________

NATURAL HAZARDS & SOCIAL AMENITIES

18. Are there problems with frequent flooding at or near the proposed area? (i) Yes (ii) No (iii) don't know
    a. **If yes** when does flooding occur (i) each time it rains (ii) only times of heavy rains (iii) during hurricanes
    b. **If yes** how often does it rain to cause flooding? (i) once weekly (ii) once monthly (iii) once in three months (iv) once in six months (v) once in a year (vi) less than once in a year
    c. **If yes** where are the affected areas? ____________________
    d. **If yes** how high does the water level rise? (i) less than 1 foot (ii) 1-5 ft (iii) more than 5 ft
19. Is the proposed area affected by tidal changes such as storm surge/sea level rise? (i) yes (ii) no (iii)not sure/don't know
20. Do you know of any site or area nearby considered to be (i) a protected area/ area of environmental importance (ii) historic area (iii) or other area of national importance? (i) Yes (ii) No (iii) don't know
    a. **If yes** please give us as much detail as you can on this area ____________________
21. Is there anything in particular that you would like to tell us?

____

Signature of Interviewer: .... Thank You for your time.

Would you mind submitting your name and contact information (telephone/email) for verification/follow-up purposes if the National Environment & Planning Agency (NEPA) wishes to make contact?

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