FINAL REPORT

ENVIRONMENTAL IMPACT ASSESSMENT
Mammee River Development Project

For

China Harbour Engineering Company Ltd (CHEC)

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PROPRIETARY RESTRICTION NOTICE

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Completion of this report would not have been possible without the contributions and inputs of the multidisciplinary ESL project team which included:

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Executive Summary

Environmental Solutions Limited (ESL) was contracted by China Harbour Engineering Company (CHEC) to conduct an Environmental Impact Assessment (EIA) for the Proposed Housing and Subdivision Development at Mammee Bay, St. Ann.

Description of the Project

The Mammee River Housing development project aims to construct a gated community that consists of thirty standard and thirty-nine deluxe three-bedroom bungalow units, and four 47-unit apartment complexes, ranging from one to two bedrooms that will house approximately 4,000 people. The development will feature a clubhouse with a pool, a gym, tennis courts, disability accessibility, parks, landscaping, sidewalks, birdwatching and walking trails, and an underground electrical distribution system.

The project will follow a sequence of activities that begins with site preparation, which includes surveying, bush clearing, stump removal, land preparation, temporary road construction, and earthworks. The next phase involves the construction of infrastructure such as: drainage, and river training to ensure efficient drainage and water management. Construction of an underground electrical grid, potable water mains, and sewage infrastructure with a sewage treatment plant being built in two phases. Solar power and eco-efficient water and energy management will be integral to the sustainable direction of the project.

Existing Environment

The project site is located in the Rio Bueno Watershed Management Unit (WMU), in the White River Sub Watershed Management Unit (6b). Due to the topography of the area, all the surface water flows north towards the coast.

The predominant geology across the project site, travertine, is characterized as soft, unconsolidated limestones. Within the project site there are other sections consisting of the Montpelier Formation (Mm) and undifferentiated coastal limestones. The Montpelier Formation in this area is described as white, well bedded chalk with common chert nodules along bedding planes and in some textures crystalline. The estimated thickness is a minimum of 243 m. The limestones of the Costal Group are considered soft marly limestone, reworked limestone and reef deposits.

Ecological Assessment

The property for proposed development is an undulating parcel of land with a mixture of modified secondary woodland found mainly along the perimeter of the property. Along the interior of the property is a relatively narrow strip of grassland where paths have been created to facilitate access to various sections of the property.

Fifty-one species of birds were identified during the study, 15 endemic, 29 resident, 5 migrant. Fourteen of Jamaica's Amphibians were recorded from the study site. Seventeen reptiles were recorded. The high number of endemic forest species suggests that the forest is in good health.

A total of 108 plant species were identified, 43 of which are trees, 16 shrubs, 28 herbs, 7 shrubby herbs, and 10 epiphytes and climbers, and 4 ferns. Five of the tree species were endemic along with 2 epiphytes.

Heritage Assessment

The land slated for construction is situated on parts of the early sugar estates of Mammee Bay and Roaring River, land previously inhabited by Jamaican indigenous peoples. Defining landmarks are the Mammee Bay Waterwheel in the northern part of the property, and the Roaring River Great House in the south. Both of which are owned by the government of Jamaica and outside of the boundaries of the property. Other structural features bordering the property include the ruins of the Mammee Bay great house, the Mammee Bay estate aqueduct, and ancillary buildings of the Roaring River Great House. Behind the Roaring River Great House, a Taíno site over which the great house and the great house ancillary building seem to have been constructed.

Socio-Economic Assessment

Steer Town is the nearest settlement to the project located just east of the project site. It comprises twelve districts including Mammee Bay South, Greenwich Park and Roaring River. These districts are however wide ranging in income levels. As evidenced in the windshield survey, sections of Mammee Bay, and most of Greenwich Park for example, would be classified as middle to high income residential communities with luxury townhomes, mansions and AirBnB rentals. The area surrounding the project has commercial developments with many hotels, small businesses, 'cook shops', restaurants and bars, car marts, gas stations etc. Within the study area, there are five health care institutions, four churches, eight recreational facilities, three schools, a community centre. The targeted communities also use the St. Ann's Bay Police Station, St Ann's Bay Fire Station and the St Ann's Bay Hospital. East of the site are attractions of significant national importance such as the Dunn's River Falls Park and the Mystic Mountain. The population within the sphere of influence is 11,639 persons within 3,603 households. It was determined during ESL's investigations community survey that 51% of the respondents surveyed highly approved of the proposed project.

Impact Identification and Analysis

The proposed development was analysed in the context of the existing environment and the associated potential environmental risks and opportunities. The impacts have been considered for pre-construction, construction, occupation, operation and decommissioning phases. The major impacts for the construction and operational phases and cumulative impacts are summarized below.

Construction Phase Impacts

- Clearing large areas during construction will expose topsoil which can be entrained during rainfall events. This is also possible where stockpiled material is exposed to rain. This can cause sediment loading in surface runoff and the impacts associated with this can be irreversible.
- Site clearing, and stock piling of material can also cause concerns for ambient air quality. The particulate matter in the air is expected to increase on windy days. This is particularly important as it can impact the environment and the health of persons downwind of the

construction activities.

- Noise pollution is common to all developments and many sources of noise pollution can be identified on a construction site. Prolonged exposure may have effects on persons and animals in and around the site and can have irreversible impacts on auditory functions.
- The use of a batching plant in construction raises the risk of fugitive dust and sediment laden run off from the site and these can have potential negative impacts on the environment.
- The transportation and storage of petroleum and other chemicals increases the risk of spillage. Other risks include combustion of flammable fuels and inhalation of toxic fumes. Any spills must be contained and cleaned as leaching into soils and shallow aquifers, and runoff into drains and streams can have negative impacts on the environment.
- Construction can produce large amounts of waste and the proper disposal is important to ensure the sustainability of the environment.
- Large tracts of existing flora are expected to be removed during construction. The overall biodiversity will decline, however there is the possibility of increased fruit trees which may attract more fruit eating organisms that can facilitate the dispersal of seeds and broaden the distribution of fruit trees across the property.
- Removal of vegetation during construction will affect the existing fauna. No rare or endangered species have been identified and the existing fauna will migrate to the surrounding habitat.
- Construction activities are expected to create various forms of direct and indirect employment in the community. However, construction phase employment can sometimes be short-lived and only exist for the duration of the project.
- It is expected that the construction activity will also increase business sales with the provision of goods and services during the construction phase.
- There is a risk to the destruction of previously undiscovered heritage sites.

Operational Phase Impacts

- Natural hazards associated with the site are similar to those that can be experienced across Jamaica. These include high winds, drought, tropical cyclones and earthquakes. The site is located near a fault line that has the capacity of generate moderate strength earth movements with magnitudes of up to 7 MMI, but the area has never experienced a localized earthquake in recorded history.
- Flooding is generally a concern as the development will increase runoff, however, this is not expected as internal drainage designs and training of the Mammee River is expected to decrease the impacts from flooding.
- Increased temperature and decreased rainfall due to climate change can impact the available water resources from NWC in the long-term.
- No negative impacts are foreseen with the wastewater treatment facility provided it is adequately maintained and frequently monitored.

Cumulative Impacts

- The expected population growth in Mammee Bay, with additional housing developments will continue to increase the demand for social services. Without additional resources, services such as police, fire brigade, health and solid waste collection and disposal will continue to be

strained.

- The increasing population will also increase the demand for potable water. This will be exacerbated with the expected increase in temperatures and decrease in rainfall.
- Increased employment and residential opportunities within the area may also encourage in-migration of people which may cause increased social interactions, both positive and negative.
- As the population increases as the development is inhabited traffic congestion within the area is expected to increase in the medium to long term
- The biodiversity of the plant and animal life in the area will decrease during construction, but may rebound to a degree after the development is operation given the amount of natural vegetation that is planned to remain in sight and careful species selection for landscaping.

Site Specific Mitigation

Mitigation measures have been discussed and are designed to reduce or eliminate the potential impacts identified. Mitigation measures are described for both the construction and operational phases of the project.

Construction Phase Mitigation Methods

- To limit the impact of sediment loading, material should be stored away from drainage paths, and they should be properly bermed. Stockpiles of material should be covered where possible and the areas should be paved or re-vegetated as soon as possible.
- Frequent wetting of the site can reduce fugitive dust and dust screens/vegetation barriers should be erected around the site to trap any fugitive dust.
- Temporary noise barriers and vegetation buffers could be used to decrease the impacts of noise from the construction site. Work activity should also be scheduled to reduce the impact of noise on the surrounding communities.
- Stationary noise sources should be located as far as possible from neighbouring communities and personnel operating equipment should wear the required personal protective equipment.
- Multiple Management Plans are recommended to continuously assess the effectiveness of the control measures.
- The developer is encouraged to retain and re-build a nursery with current plant species prior to construction and encourage residents to undertake landscaping with these species to replace vegetation loss, as well as maintain areas left forested for hiking trails.
- Where possible, trees which are considered mature and endemic should be retained. These trees have been clearly marked and should be protected to ensure they are not removed or bulldozed.
- The developer is encouraged to communicate closely with the surrounding communities to ensure that they are aware of the construction schedule and the potential impacts.

Operational Phases Mitigation Methods

- The Mammee River retraining, drainage plans and detention ponds are projected to reduce flood risk.
- Houses should be well engineered to national building code standards to contend with potential high winds and seismic activity.
- The developer is encouraged to implement its existing plans for reuse of wastewater for irrigation and to employ green technologies such as solar power lighting and alternative energy solutions.
- The proximity to the highway places the development at risk of enduring noise nuisances due to heavy traffic flows, as a result multiple mitigation measures are recommended to minimize any impact on the residents.
- The developer is encouraged to implement its existing plans for physical and green sound barriers to reduce noise nuisance to the residents

Conclusions

After review of all the technical reports, analysis of data collected and stakeholder consultations, it is the considered opinion of the consultants that most of the environmental aspects related to the development are understood and the mitigation measures proposed will reduce or eliminate any potential impacts.

The project will also inject significant capital into the local economy through the purchase of construction materials, equipment and services and have wider indirect economic multiplier effects both during and post-construction.

It is the considered opinion of the consultants that based on the potential impacts identified and the mitigation measures proposed, the Mammee River Housing Development is a suitable use of the site. The *Town and Country Planning (St. Ann) Confirmed Development Order, 2000* deems the area 'not specifically zoned' which offers the community a chance to develop the area in way that benefits the wider community.

1. Introduction

1.1. Purpose

Environmental Solutions Limited (ESL) was contracted by China Harbour Engineering Company (CHEC) to conduct an Environmental Impact Assessment (EIA) for the Proposed Housing and Subdivision Development at Mammee Bay, St. Ann. CHEC is proposing to create homes for approximately 4,000 persons through the construction of an 834-unit gated housing community. The development will include amenities such as a club house, playing fields, greenspaces, and commercial centers.

This document represents the draft EIA report prepared for the proposed housing development and has been developed based on the specific Terms of Reference (TOR) received from the National Environment and Planning Agency (NEPA) (see Appendix A). The terms of reference have been prepared in accordance with the Natural Resources Conservation Authority (NRCA) Permit and License Regulations (Amended) 2015.

The EIA report entails a description of the proposed development; a review of the existing physical, biological, and social environment of the site and situation of the proposed development; a summary of key legislative and regulatory instruments, an assessment of the potential iterative impacts between the development and the existing and/or potential environmental conditions of the setting into which the project will be placed; suggested measures for mitigation of potential negative impacts; and summary of development guidelines with Environmental Quality Objectives (EQOs).

1.2. The Study Area

The project site is part of the extensive approximately 300-hectare Roaring River/Mammee Bay property owned by Jamaica North South Highway Company Limited. The project site is located on 64.8 hectares (160.12 acre) of this property. The project is divided into 2 lots registered as Vol-1514/Fol-137 and Vol-1514/Fol-141.

The project site is located on gently sloping land described as a secondary forested area located with the Highway 2000 boarding it to the West, and the main road to Ocho Rios Town boarding it to the North. The area is located 8 km from Ocho Rios.

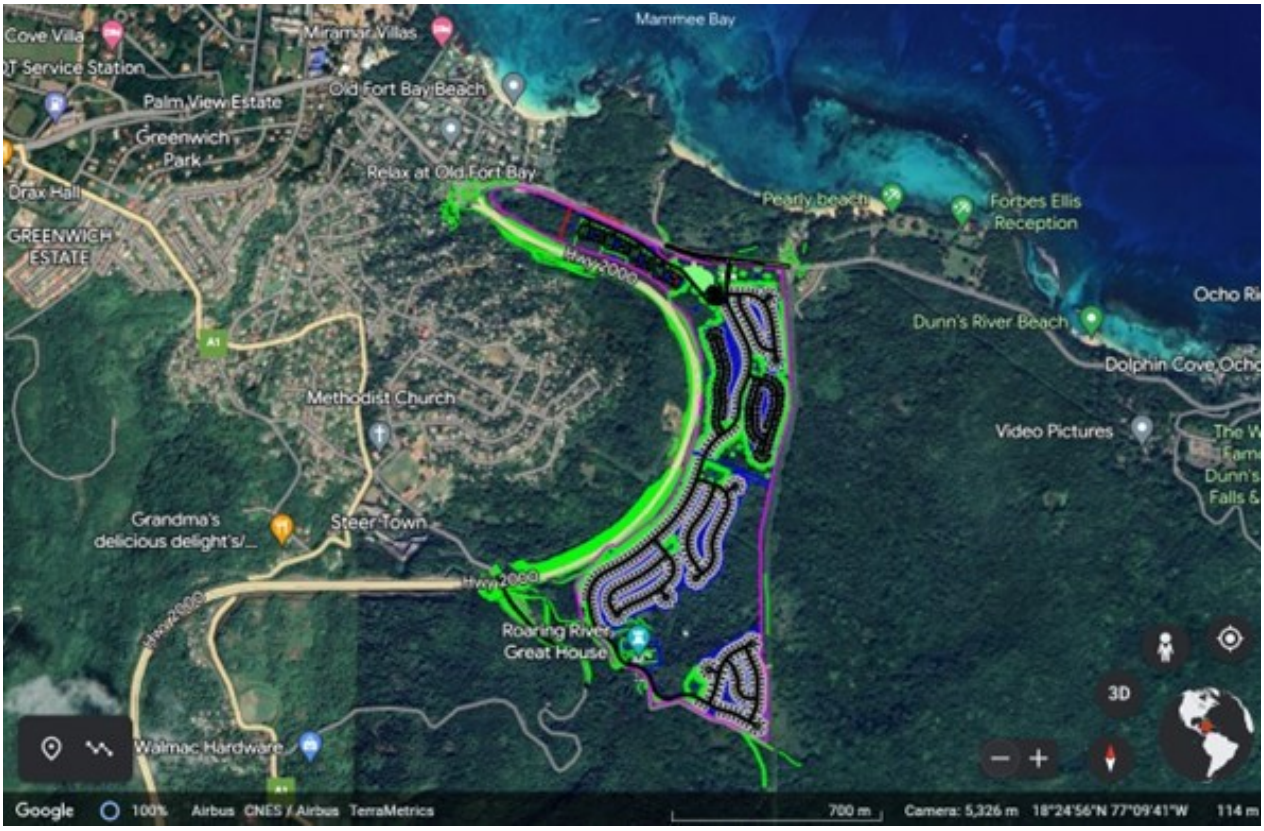


Figure 1-1: Location of Mammee Bay Development Project

1.3. General methodology

A team consisting of experienced environmental, hydrological, archeological, social, ecological and engineering professionals was assembled to conduct the required assessments, including the generation and analysis of baseline data, the determination of potential impacts, and recommendations for mitigation measures and guidelines.

The team used a collaborative method to data gathering, analysis, and presentation, whereby team members conducted reconnaissance investigations together to determine critical elements for analysis and the issues to be highlighted for review of the design and planning process. Baseline data for the study area was generated using a combination of the following research approaches:

- Analysis of maps, plans, aerial photos
- Field investigations
- Laboratory analyses
- Review of reports and background documents and datasets
- Structured interviews

The following sub-sections describe the approach taken for each category of natural and built environmental parameters.

1.3.1. Physical Assessment

1.3.1.1. Topography, Geology and Soils

The approach included field investigations, review of relevant literature, and analysis of topographic, geological and soil maps for the area. The assessment included the analysis of the following maps and findings from a geotechnical investigation conducted from January-March 2023:

1. The 1:50,000 Geological Map Series, Sheet 4
2. The 1:50,000 Topographic Map Series, Sheet 4 and 8
3. The 1:12,500 Topographic Map Series, Sheet 82a.

1.3.1.2. Hydrology and Drainage

Field investigations, collection and review of available reports, datasets and relevant literature were applied to determine the existing hydrologic features (surface and subsurface) in and surrounding the project site. This included the identification of natural drainage lines (streams, gullies); wells in the area and investigation of their yields; depth to groundwater from published data; and any preliminary potential impacts to groundwater from the proposed development.

CHEC conducted a drainage assessment of pre- and post-development runoff rates using the Rational Method. A review of this Drainage Report was done to determine the potential impacts and mitigation measures to reduce the identified impacts. Findings from the geotechnical investigation were also included in this section.

1.3.1.3. Natural Hazard Risk

The natural hazard vulnerability and risk of the study area was assessed via a review of relevant secondary data sources. These included topographic maps showing slopes and drainageways, reports produced by the Climate Studies Group at The UWI Mona, the UWI Mona's Seismic Unit, and historic damage assessment from the Office of Disaster Preparedness and Emergency Management (ODPEM), Mines and Geology Division (MGD) of the Government of Jamaica (GOJ) and any additional assessments conducted for the project.

1.3.1.4. Air, Water & Noise

Field investigations were conducted to capture information about the existing environmental conditions over the sampling period as it pertains to water, noise, and air. Investigations during the wet season were conducted between October 19 and 20, 2022 and investigations during the dry season were conducted between January 31, 2023, and February 1, 2023.

Sampling exercises and assessments were done within the proposed development site for the Mammee River development and at any potential possible receptors to site activities. Water quality samples were taken along Little River 2, the Roaring River (or tributaries of these main rivers) and in the marine area where these surface waters drain. Groundwater samples were not collected due to their proximity to and direction from the proposed development site. The two closest wells to the project area, according to

information obtained from Jamaica's Online Hydrologic Web Map (WRA), included the Thickets Well (located approximately 5 km south or upstream of the proposed project area) and the Pimento Walk – Ocho Rios 4 (Murphy Hill) Well (located approximately 3km south-east of the proposed project area). The general groundwater flow in the area is towards the northern coast. 24(±4)-hour air quality assessments were conducted at nine (9) locations to determine the existing air quality at the proposed project location during the sampling exercise, as well as at possible sensitive receptors. The objective of the air quality assessment was to determine, as best as possible, the existing concentration of respirable particulates (PM_{10}) in these areas. Air quality measurements were taken at nine (9) locations along the boundary of the proposed project site, and in the surrounding areas. Sites likely to be most affected by changes in air quality, for example, those areas with high human populations (e.g., residential communities, tourist 'hotspots') were considered for this exercise as these sites were determined to be some of the most sensitive receptors.

Noise surveys and air quality assessments included sites along or close to the boundaries of the proposed site location, within and close to the Old Fort Bay community and along the St. Ann's Bay to Ocho Rios A1 Road.

A summary of the assessments is outlined in Table 1-1 below.

Table 1-1: Summary of Investigations for the Proposed Project Site in Mammee Bay, St. Ann

Attributes	Parameters	Data Points	Wet Season Sampling Period	Dry Season Sampling Period
Water Quality (Freshwater)	Physical, Chemical and Microbiological	6) Sampling Stations	One sampling period on October 19, 2022	One sampling period on January 31, 2023
Water Quality (Marine Water)		Five (5) Sampling Stations (Wet) & Four (4) Sampling Stations (Dry)	One sampling period on October 20, 2022	One sampling period on February 1, 2023
Air Quality	Respirable Particulates (PM_{10})	(9) Sampling Stations	PM_{10} measurements collected during one 24±4-hour sampling period in October 2022 between 9:55 a.m. on October 19, 2022, and 2:09 p.m. on October 20, 2022.	PM_{10} measurements collected during one 24±4-hour sampling period between January 31, 2023, at 9: 50 m. and February 1, 2023 at 2:09 p.m.

Attributes	Parameters	Data Points	Wet Season Sampling Period	Dry Season Sampling Period
Noise Levels	Noise Levels (dBA)	(9) Sampling Stations	Two (2) 3-minute assessments at each site over a 2- day period (i.e., once on October 19, 2022 & once on October 20, 2022).	Two (2) 3-minute assessments at each site over a 2- day period (i.e., once on January 31, 2023 & once on February 1, 2023).

Air quality results at the end of the sampling period were compared to the National Environment and Planning Agency's (NEPA) and the US EPA's Ambient Air Quality Standards. The results from the daytime noise survey at the end of the sampling period were compared to the NEPA Standard of 55dBA for residential areas, while water quality results were compared to the Jamaica's National Resource and Conservation Authority's (NRCA) Ambient Water Quality Guidelines.

Air quality sampling and noise sampling locations were taken at the same locations and are shown in Figure 1-2 below while water quality sampling locations are shown in Figure 1-3.

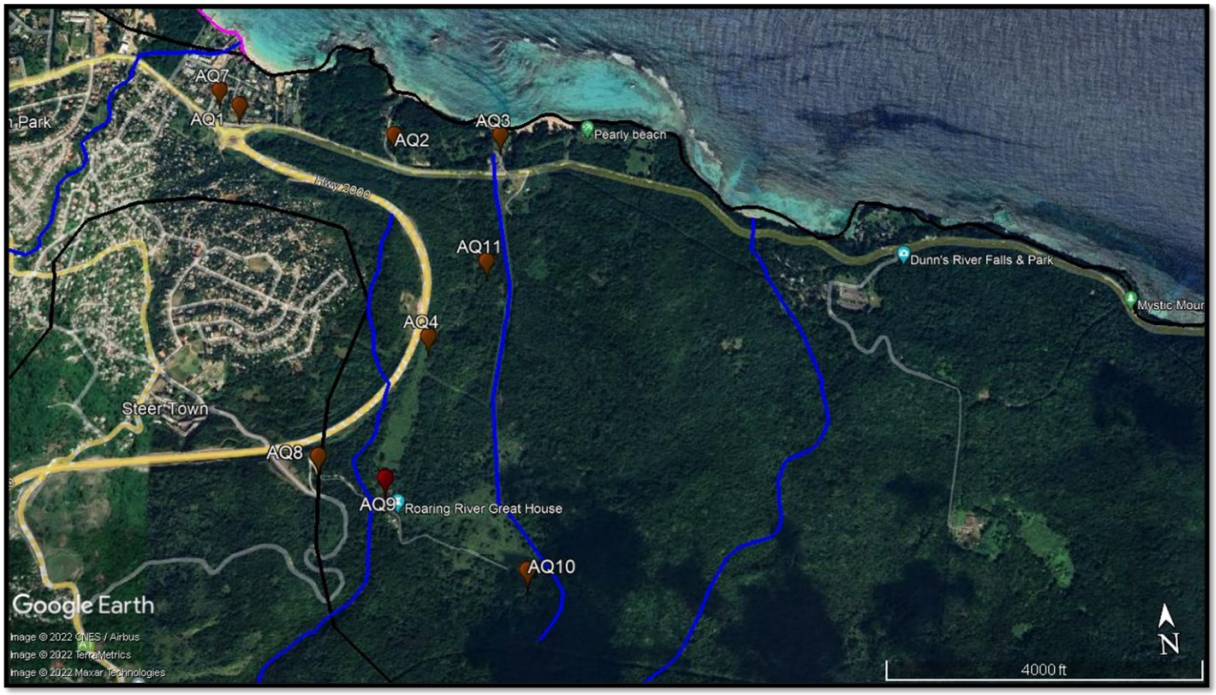


Figure 1-2: Air Quality and Noise Sampling Locations

Figure 1-3: Water Quality Sampling Locations

1.3.2. Biological Assessment

Surveys were conducted across the property to account for the varying types of ecological communities that were present (See Figure 1-4). During the survey, notes were taken of the plant species encountered and the land-use types observed. Stops were made at regular intervals to conduct walk-throughs for more thorough investigations. Plant species encountered during the field surveys were identified in-situ, or samples were collected and taken to the University of the West Indies (UWI) Herbarium for later identification.

Figure 1-4: Location of transects surveyed (star indicates start of transect)

Literature by Asprey & Robbins (1953), Adams (1972) and Parker (2003) were also used to assist in plant identification and vegetation classification. The entire sampling process was aided by ArcGIS Field Maps application to capture coordinates of important changes to the landscape within the site boundary.

The sample points for the nocturnal fauna assessments were placed within the 2 main forest categories. The study was carried out primarily along the trails distributed throughout the study area (See Figure 1-5). The study was conducted over 2 weeks: fieldwork (September 22 and October 6, 2023) and nocturnal studies using acoustic detectors (September – October 6, 2023). See Appendix K for full nocturnal ecology report.

Figure 1-5: Location of Audiomoths

1.3.3. Archaeological/Heritage Assessment

A combination of desk and field research was used to assess the archaeological/heritage attributes of the site.

1.3.3.1. Desk Research

Primary research material from the archives included cadastral maps and some estate maps which were not used as the lines were very faded. Secondary source material was drawn from internet sites, publications, and forthcoming publications.

1.3.3.2. Field Research

Field research entailed a walking survey, where the property was divided into three sections – southern, central and northern. (See Figure 1-6). The property was traversed using the existing dirt roadways and footpaths. Clearing undergrowth, thereby creating a new path, was also necessary to penetrate some of the more wooded areas in the northern part of the property. This type of survey readily identified structural features and surface scatter of artefacts. However, due to the thick undergrowth, the features that were expected to be present were not located.

*Figure 1-6: Walking Survey Paths * Red lines are walking path transects*

A salvage archeology study was conducted August 26-27, 2003. The areas to be excavated were determined by the JNHT and were located in two parts of the property. One was located east of the Roaring River Great House and the other to the west of it. As recommended by the JNHT, Bucket Test Pits (BTP) were utilized to expedite the archaeological investigations. The intention was for the bucket on the tractor/backhoe to scoop up material from the designated test points. The bucket utilized has a width of 1.47 metres and a fork depth of 31 cm. The tractor was equipped with a backhoe only. Tape and compass were used to measure the points. The archaeologist inspected both the material excavated and material in the unit itself that was loosened by the backhoe but remained in the unit.

The first backhoe pass over the designated spot was recorded as Context 1 and the second as Context 2, and so forth (See Figures 1-7 and 1-8). Screening of material was used as necessary. Four units were placed in each area at intervals between 10 metres to 20 metres apart. For full salvage archeology report, please see Appendix J.

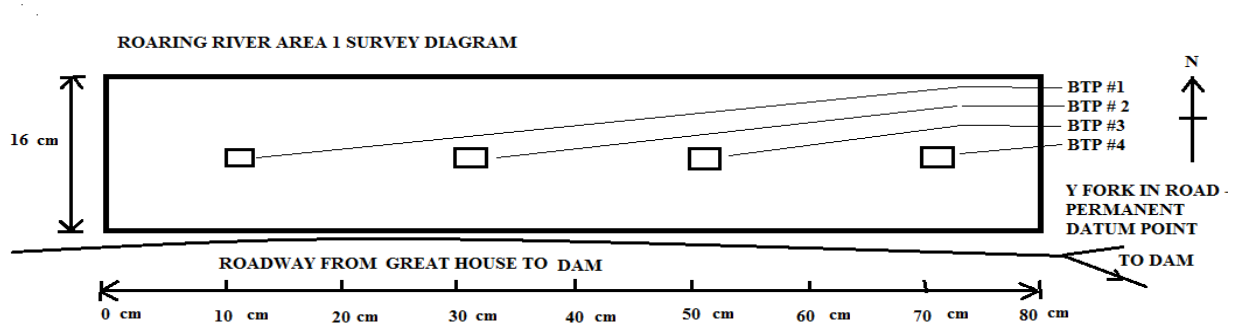


Figure 1-7: Survey map of Roaring River Salvage Archaeology Area 1

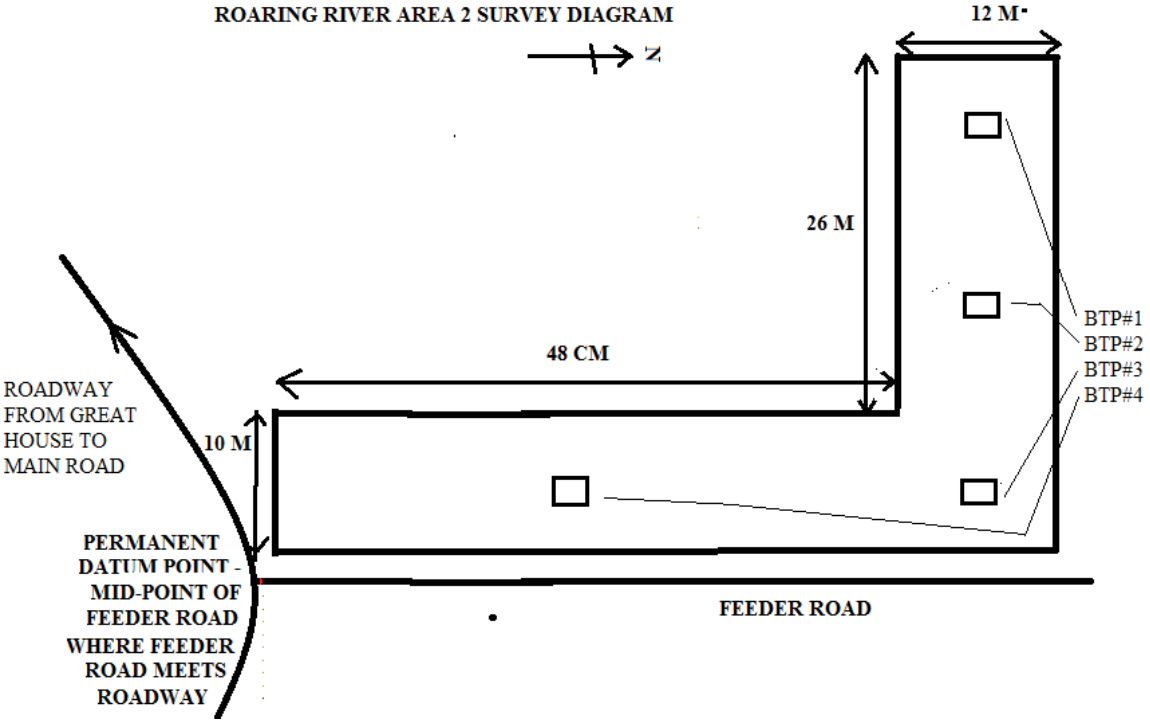


Figure 1-8: Survey map of Roaring River Salvage Archaeology Area 2

1.3.4. Socio-Economic Assessment

A mixed methods approach to data gathering (combination of quantitative and qualitative data collection methods) was employed. Key informant interviews with organisations and businesses, and field surveys with community residents within the area formed part of the exercise. The assessment extended beyond the project site to include areas of influence within a 1-2 km radius of the development site. (See Figure 1-9). Secondary reports were also consulted to glean data on population, livelihoods, and other socio-economic parameters.

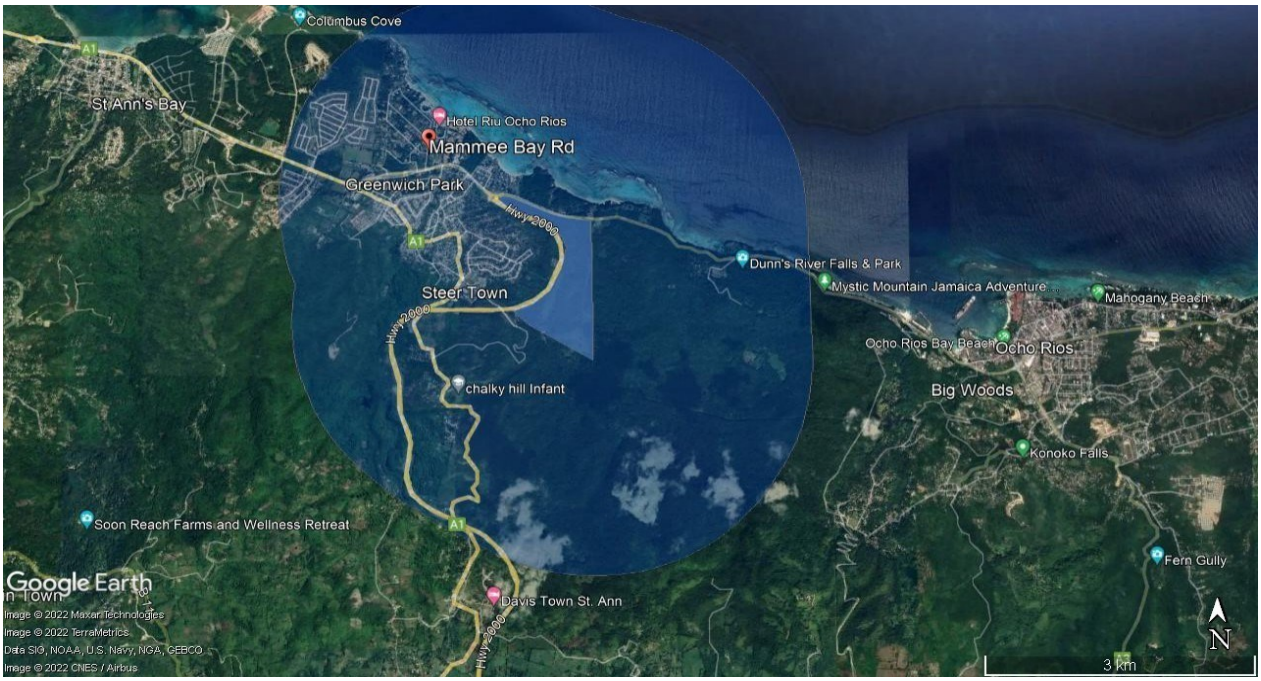


Figure 1-9: Mammee River Development Sphere of Influence

1.3.4.1. Assumptions and Limitations

This report provides a summary of the assessment of potential environmental and social impacts of the transformative Mammee river housing development project in St Ann, and in that regard the findings and recommendations reflect the characteristics of selected parameters gleaned from field investigations, as well as from relevant data available at the time of the investigation and production of this report. ESL assumes that the records and reports reviewed in the preparation of this report were complete and accurate.

Some limitations to the report should be noted particularly with respect to geotechnical investigations, hydrological assessments, and carrying capacity studies. Geotechnical and hydrological investigations were designed and executed between January and March 2023, according to the site plan provided by CHEC in early January 2023. However, following completion of the Geotech and hydrological studies the site plan was significantly modified with respect to placement of some structures and infrastructure design (retention ponds, sewage treatment plant, housing, and commercial units). It is the considered opinion of the consultants that further investigations may be required prior to construction to confirm that the subsurface and drainage conditions are fit for purpose as subsequently presented. Review of potential impacts of the changes is currently underway.

Regarding the carrying capacity studies, these were not included in the initial scope of work and were only presented for consideration when NEPA submitted an approved Terms of Reference in May 2023. Full ecological studies had been completed months before and could serve as reference for later carrying capacity analysis if this remains a condition from NEPA. Two studies were consequently conducted, a tree survey and a nocturnal ecological survey which helped to address the knowledge gaps, but are also limited by time and weather conditions for perfect accuracy. Similarly, physical assessments of the site with respect to the proposed development have also been carried out and can form the basis of a site capacity study, if so required at a later date.

2. Legislation and Regulatory Consideration

With respect to environmental permitting for any development, the primary legislation is the Natural Resources and Conservation Authority Act (NRCA) (1991), the provisions of which are highlighted in Table 2-1 below. There are several relevant international treaties, national environmental and planning laws, as well as regulations related to developments such as the Mammee River Housing Development. These include regulations for the construction and operation of the development and supporting infrastructure, such as sewage treatment and water supply facilities.

Some of the main statutes are presented below, and a full summary is listed in Appendix B.

Table 2-1: Main Relevant Legal Regulatory and Policy Instruments

LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	RELEVANCE TO PROJECT
LEGISLATION	
Natural Resources Conservation Authority Act, 1991	The Act is responsible for environmental management; governs all pollution activities within Jamaica, the EIA regulatory framework (when applicable). The Act's powers and responsibilities include: Establishing and enforcing pollution control and waste management standards and regulations. Monitoring and enforcing environmental laws and regulations, especially those included in the NRCA, Beach Control, Watershed Protection, and Wildlife Protection Acts. The NRCA Act binds the Crown and as such supersedes all other legislation relating to environmental issues. The Minister is empowered to request an Environmental Impact Statement (EIS) in relation to certain major projects. **The project requires the conduct of an EIA and the preparation of an Environmental Permit as per the Act.**
Beach Control Act, 1956	An act relating to the floor of the sea and the overlying water and to the foreshore and beaches of this island, and to the establishment of a Beach Control Authority for the purpose of controlling and regulating the use of the floor of the sea and the overlying water and of the foreshore and beaches of this island in the interests of the public and of persons who have acquired rights therein and for purposes incidental to or connected with the matters aforesaid. **This project will be required to submit an application if development on the beach is expected.**

Building Act, 2018	It facilitates the adoption and efficient application of national building standards to be called the National Building Code of Jamaica for ensuring safety in the built environment, enhancing amenities, and promoting sustainable development, and for connected matters.

LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	RELEVANCE TO PROJECT
	The project will be required to comply with Building Codes and to submit building permit applications to the St. Ann Municipal Corporation.
Disaster Risk Management Act, 2015	The Disaster Preparedness and Emergency Act established the Office of Disaster Preparedness and Emergency Management (ODPEM) which is responsible for carrying out the provisions of the Act. **The Act outlines the needs for selected developments to have emergency response plans and contingency plans for specific hazards. Mammee Bay development will need to develop these plans for the Construction phase**
Flood-Water Control Act, 1958	This Act makes provisions for the construction, improvement, repair, and maintenance of works for the control of flood water, and for other matters connected therewith. **A Drainage Plan will be required for this project.**
Jamaica National Heritage Trust Act, 1985	The Act makes provisions for governing the operations of the Jamaica National Trust as well as to provide for matters the trust oversees. The Trust, in functioning under the Jamaica National Heritage Act, is responsible for promoting the preservation of national monuments and anything designated as protected national heritage for the benefit of Jamaica. It also carries out related development that is deemed necessary for the preservation of any national monuments or anything designated as protected national heritage. **The site is of historical and cultural importance. As such, the project is required to preserve as much as possible and to have a Chance Find Procedure/Watching Brief.**

National Solid Waste Management Authority Act, 2001	The Act provides for the regulation and management of solid waste. It established the National Solid Waste Management Authority (NSWMA) and outlines the matters connected therewith or incidental thereto. **Solid waste management will be essential in the construction phase and will require the removal and proper disposal of vegetative matter, soil and construction rubble. The NSWMA should be contacted regarding an approved disposal site.**
Town And Country Planning (St. Ann Parish) Confirmed Development Order, 2000	Matters regulated by this order include planning permission for development, control of subdivisions, parking, roads, beaches, etc. and prescribes consultation with national

LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	RELEVANCE TO PROJECT
	authorities by the local planning authority before granting planning permissions and appeals. **The project will be required to submit building permit applications to the St. Ann Municipal Corporation.**
Wildlife Protection Act, 1945	The Act specifically protects designated species of animals and regulates hunting in Jamaica. The Act also regulates the hunting of game birds and provides for the declaration of game sanctuaries and game reserves in which no hunting is required. **The relevant area does not have any designated game parks.**

3. Project Description

3.1. Summary Overview

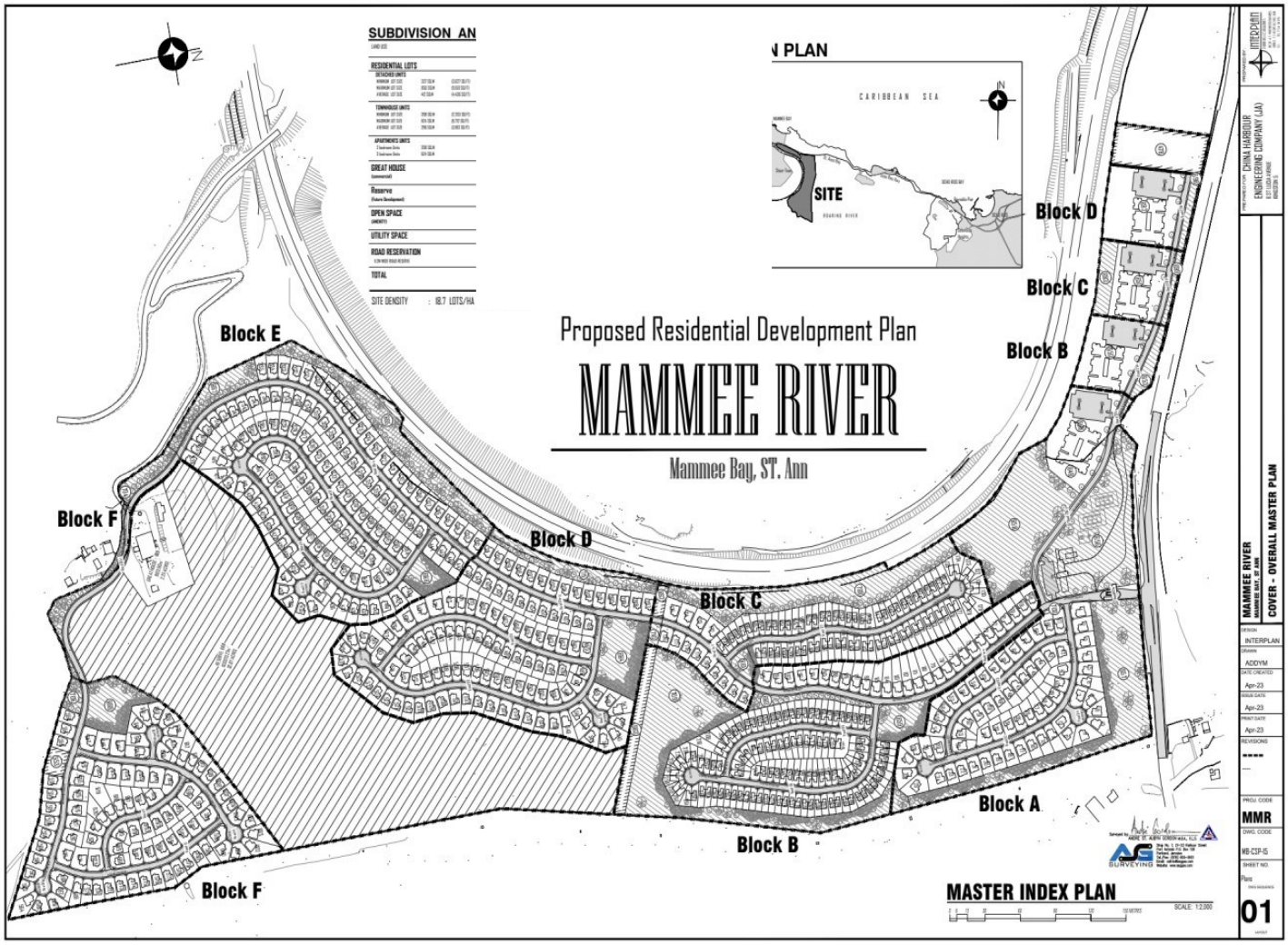
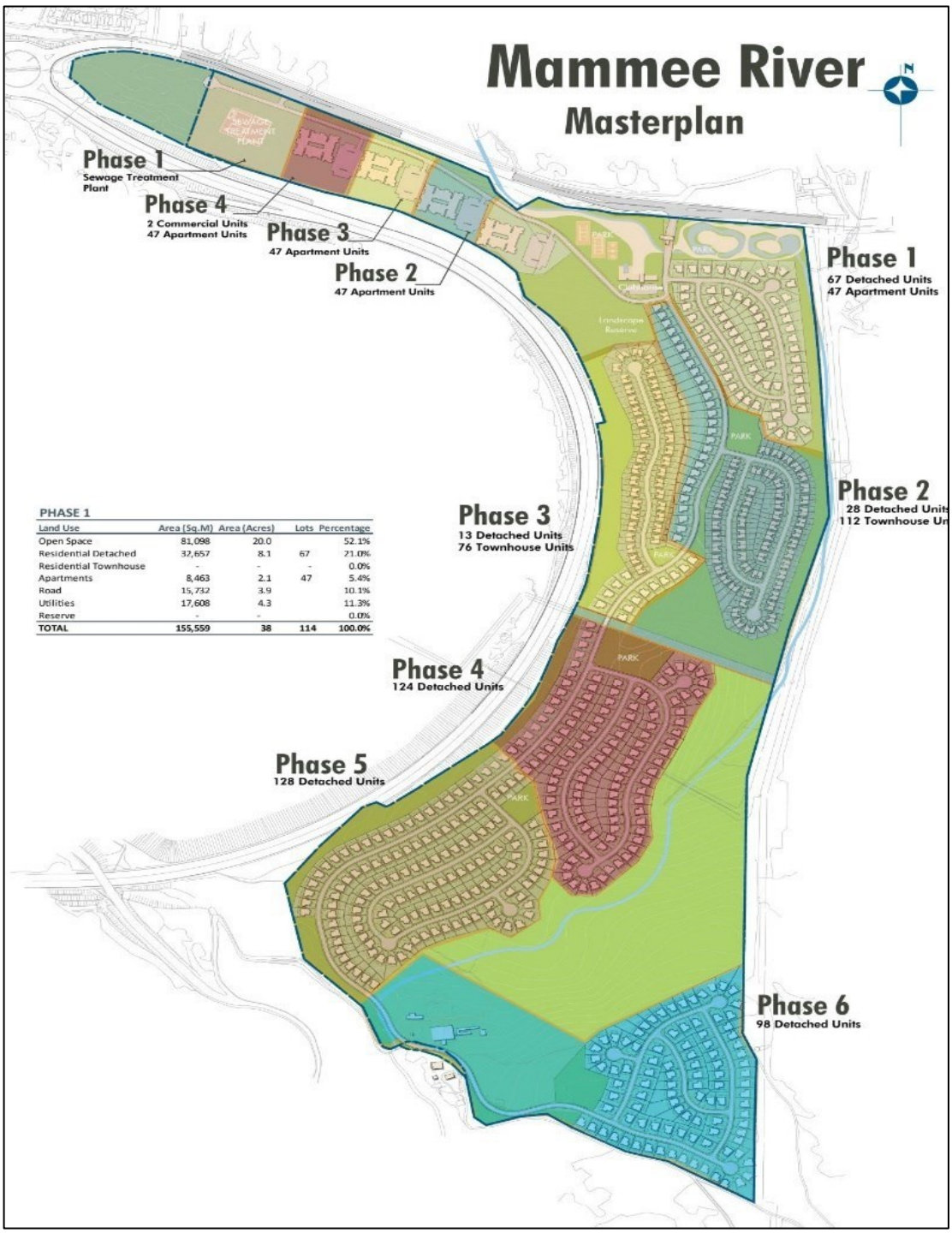


Figure 3-1: Master Development Plan

The Mammee River Housing development project aims to construct a gated community that consists of thirty standard and thirty-nine deluxe three-bedroom bungalow units, and three 47-unit apartment complexes, ranging from one to two bedrooms, across an area of approximately 3.7 acres (See Figure 3-1). With an assumed density of 2.0 persons per bedroom, it is anticipated the development will provide housing for 4,468 persons. The development will feature a clubhouse with a pool, a gym, tennis courts, disability accessibility, parks, landscaping, sidewalks, birdwatching and walking trails, and an underground electrical distribution system. Additionally, the bungalow units will have solar options.

The project will follow a sequence of activities that begins with **site preparation**, which includes surveying, bush clearing, stump removal, land preparation, temporary road construction, and earthworks. The next phase involves **the construction of infrastructure** such as: drainage, and river training to ensure efficient drainage and water management. Construction of an underground electrical grid, potable water mains,

and sewage infrastructure with the sewage treatment plant being built in two phases. Solar power and the use of eco-efficient water and energy management technologies will be integral to the sustainable direction of the project.



PHASE 1

Land Use	Area (Sq.M)	Area (Acres)	Lots	Percentage
Open Space	81,098	20.0		52.1%
Residential Detached	32,657	8.1	67	21.0%
Residential Townhouse	-	-	-	0.0%
Apartments	8,463	2.1	47	5.4%
Road	15,732	3.9		10.1%
Utilities	17,608	4.3		11.3%
Reserve	-	-		0.0%
TOTAL	155,559	38	114	100.0%

Figure 3-2: Site Layout plan and phases of development, as May 26, 2023

3.2. Phases of Development

The development will take place in 6 phases as follows and as shown in Table 3-1, Table 3-2 and Table 3-3, and as illustrated in Figure 3-2 above. A total of 834 mixed units of townhouses, detached units and apartments together with a sewage treatment plant and 2 commercial units will be built over the period. The timing of the development is presented in a Gantt chart in Appendix C.

Table 3-1: Phase development by Type of Unit

PHASES	APARTMENT UNITS	DETACHED UNITS	TOWNHOUSE UNITS	OTHER
Phase 1	47	67		Sewage plant
Phase 2	47	28	112	
Phase 3	47	13	76	
Phase 4	47	124		2 Commercial units
Phase 5		128		
Phase 6		98	`	
TOTAL	**188**	**458**	**188**	**834** mixed housing units **2** commercial units **1** sewage plant

Table 3-2: Project Development by Area

LAND USE	SQ. M	ACRE	LOTS	PERCENTAGE
Open Space	124,832	30.8	13	19.3%
Residential Detached	222,105	34.9	458	34.3
Residential Townhouses	52,981	13.1	188	8.2%
Apartments	31,568	7.8	5	4.9%
Road	63,537	15.7	19	9.8%
Utilities	10,714	2.6	3	1.7%
Commercial	9,121	2.3	1	1.4%
Reserve	133,020	32.9	1	20.5%
TOTAL	**647,877**	**160**	**688**	100%

Table 3-3: Phase Development by Area

LAND USE	SQ. M	ACRE	LOTS	PERCENTAGE
Phase 1				
Open Space	81,098	20.0	3	55.0%
Residential Detached	32,657	8.1	67	22.1%
Residential Townhouses	-	-	-	0%
Apartments	8,463	2.1	2	5.7%
Road	18,855	4.7	5	12.8%
Utilities	6,441	1.6	1	4.4%
Reserve	-	-	-	0
TOTAL	**147,515**	**36**	**78**	**100%**
Phase 2				
Open Space	5,109	1.3	2	7.6%
Residential Detached	15,981	3.9	28	23.6%
Residential Townhouses	30,183	7.5	112	44.6%
Apartments	7,204	1.8	1	10.6%
Road	5,538	1.4	2	8.2%
Utilities	3,633	0.9	1	5.4%
Reserve	-	-	-	0%
TOTAL	**67,648**	**17**	**146**	**100%**
Phase 3				
Open Space	818	0.2	1	2%
Residential Detached	6,355	1.6	13	15.7%
Residential Townhouses	22,797	5.6	76	56.2%
Apartments	6,489	1.6	1	16.0%
Road	3,447	0.9	1	8.5%
Utilities	640	0.2	1	1.6%
Reserve	-	-	-	0%
TOTAL	**40,546**	**10**	**93**	**100%**
Phase 4				
Open Space	8,748	2.2	2	9.2%
Residential Detached	55,354	13.7	116	58.4%
Residential Townhouses	-	-	-	0%
Apartments	9,412	2.3	1	9.9%

Road	21,283	5.3	4	22.5%
Utilities	-	-	-	0%
Reserve	-	-	-	0%
TOTAL	**94,797**	**23**	**123**	**100%**
Phase 5				
Open Space	22,791	5.6	3	24.6%
Residential Detached	62,767	15.5	136	67.8%
Residential Townhouses	-	-	-	0%
Apartments	-	-	-	0%
Road	7,059	1.7	3	7.6%
Utilities	-	-	-	0%
Reserve	-	-	-	0%
TOTAL	**92,617**	**23**	**142**	**100%**
Phase 6				
Open Space	4,207	1.0	1	2.1%
Residential Detached	48,990	12.1	98	24.2%
Residential Townhouses	-	-	-	0%
Apartments	9,121	2.3	1	4.5%
Road	7,355	1.8	4	3.6%
Utilities	-	-	-	0%
Reserve	133,020	32.9	1	65.6%
TOTAL	**202,693**	**50**	**105**	**100%**

3.3. Project Design and Schematics

The schematic plans, including the site drawings, detailed floor plans and elevations for each option of housing solutions offered by this project are shown in Appendix D. Floor plans and renderings are presented in Figure 3-3 to Figure 3-14. The developer has committed to redesigning the clubhouse area to hold a daycare which is an amenity required by the Development and Investment Manual 2007.

3.3.1. Apartment Blocks

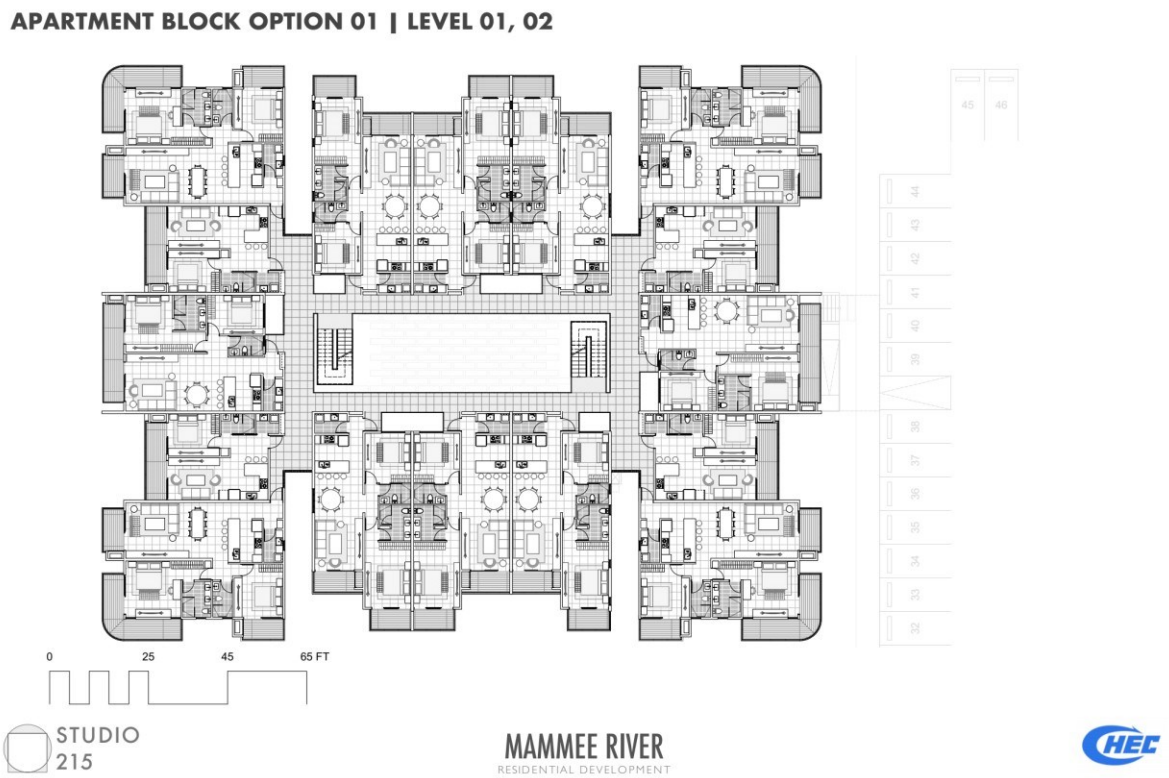


Figure 3-4: Apartment Floor Plan - Option 1

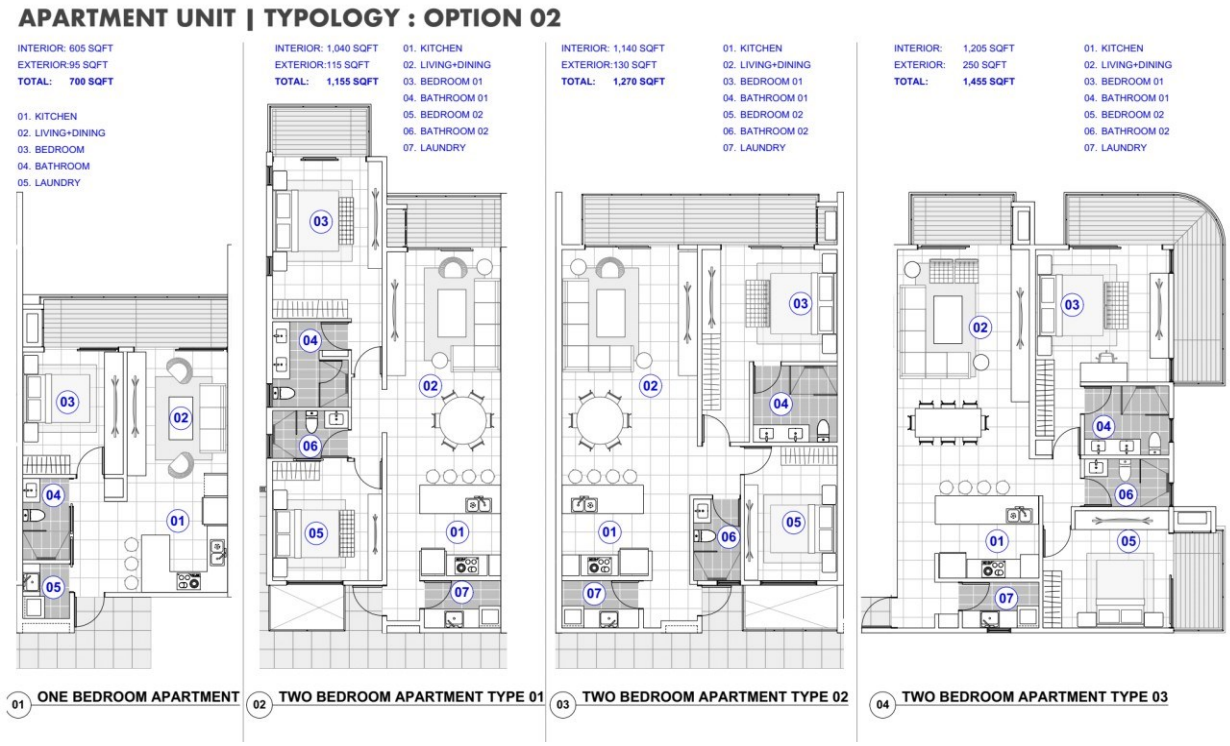


Figure 3-3: Apartment Floor Plan – Option 2

Figure 3-5: Rendering of Apartment Complex

Figure 3-6: Rendering of Apartment Courtyard

3.3.2. Townhouse

The floor plan for the townhouses is illustrated below.

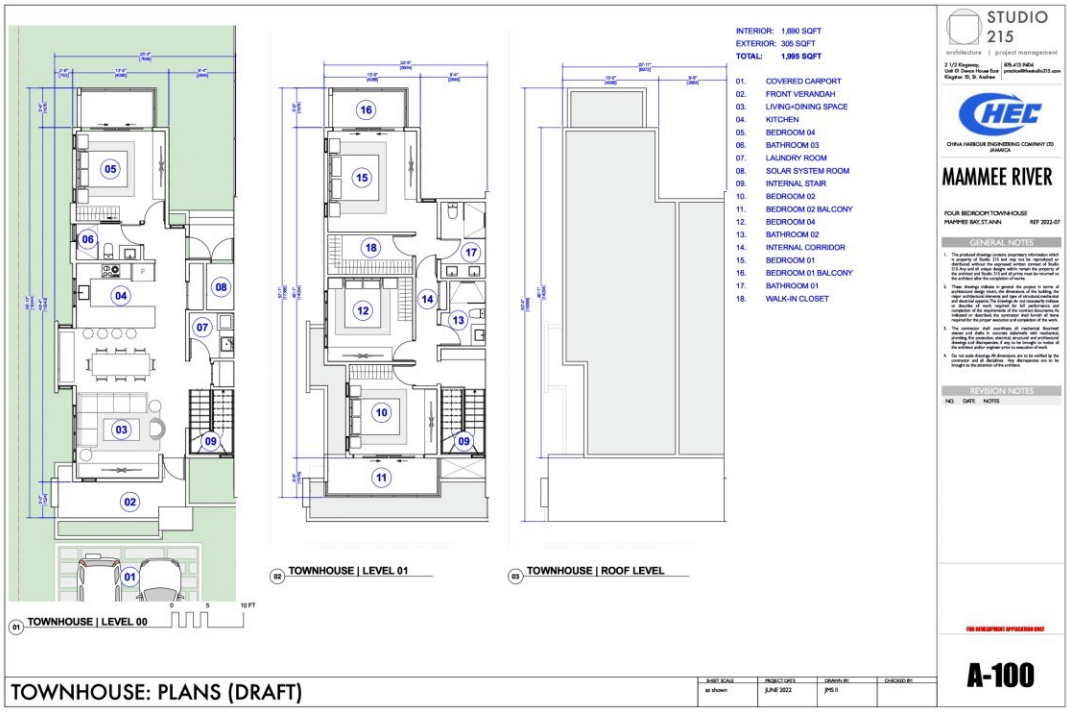


Figure 3-7: Townhouse floor plan

3.3.3. Two-Three Bedroom Bungalows

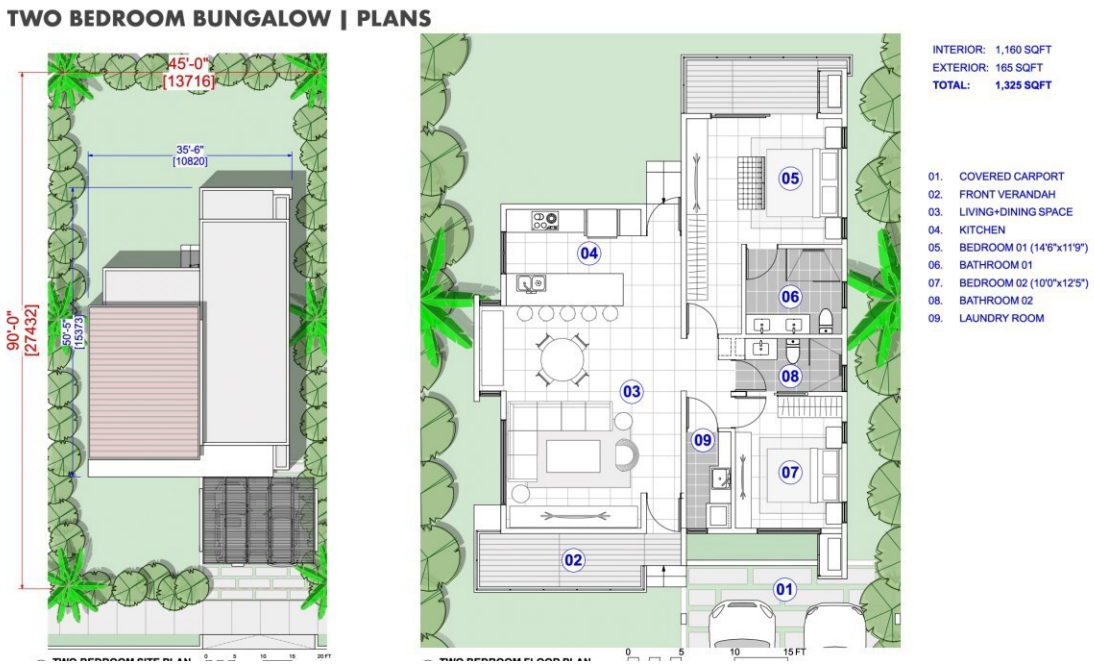


Figure 3-8: Two Bedroom Floor Plan

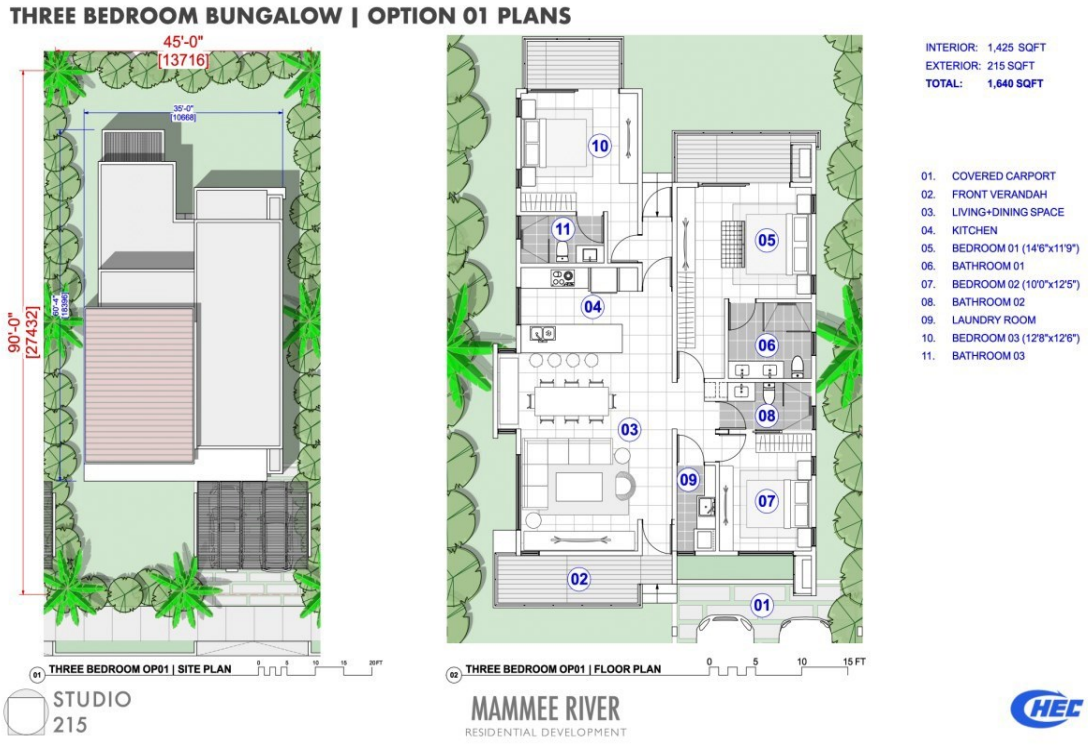


Figure 3-9: Three Bedroom Floor Plan Option 1

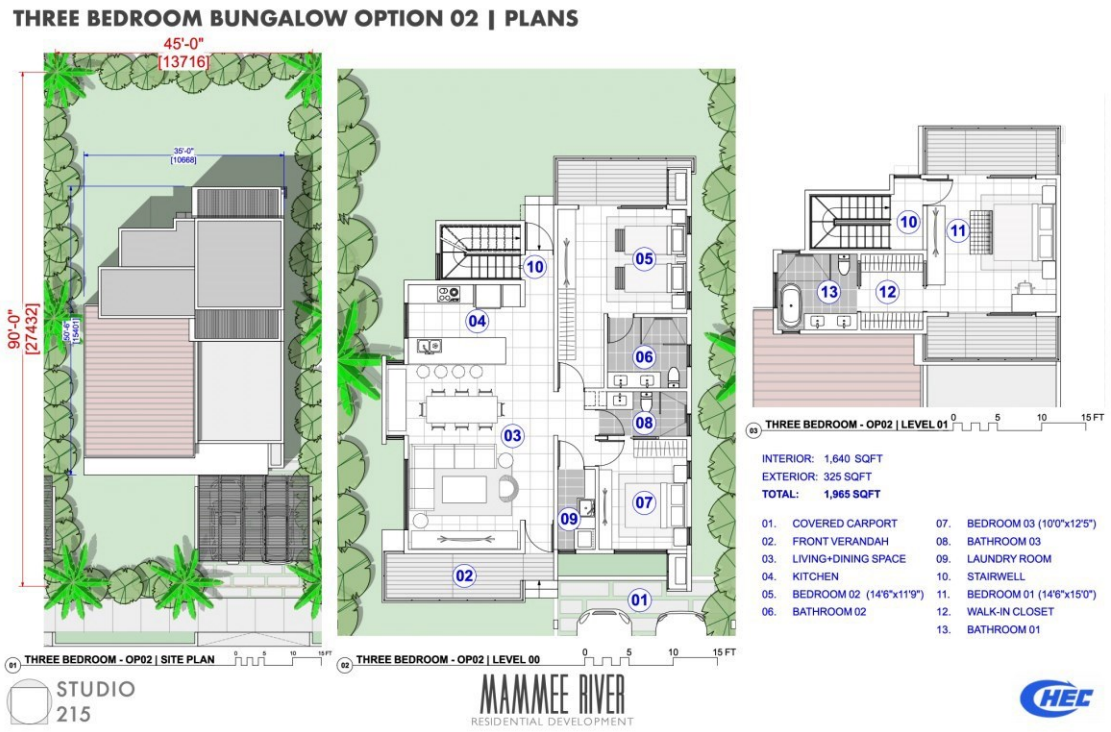


Figure 3-10: Three Bedroom Floor Plan Option 2

Figure 3-11: Rendering of Three Bedroom Townhouse

3.3.4. Clubhouse

*Figure 3-12: Clubhouse Floorplan (*developer will adjust plans to include daycare)*

Figure 3-13: Rendering of Club House Front View

Figure 3-14: Rendering of Clubhouse Pool

3.4. Access Points

The subdivision has two access points. See Figure 3-15 below. The main entrance, point A, is located in the northern section, and the secondary access, point B is situated near the Greathouse in the southern section of the site. Both access points will be used during the construction phase and maintained thereafter. Upon completion of the first phase, the southern access will be utilized for all construction and operational activities.

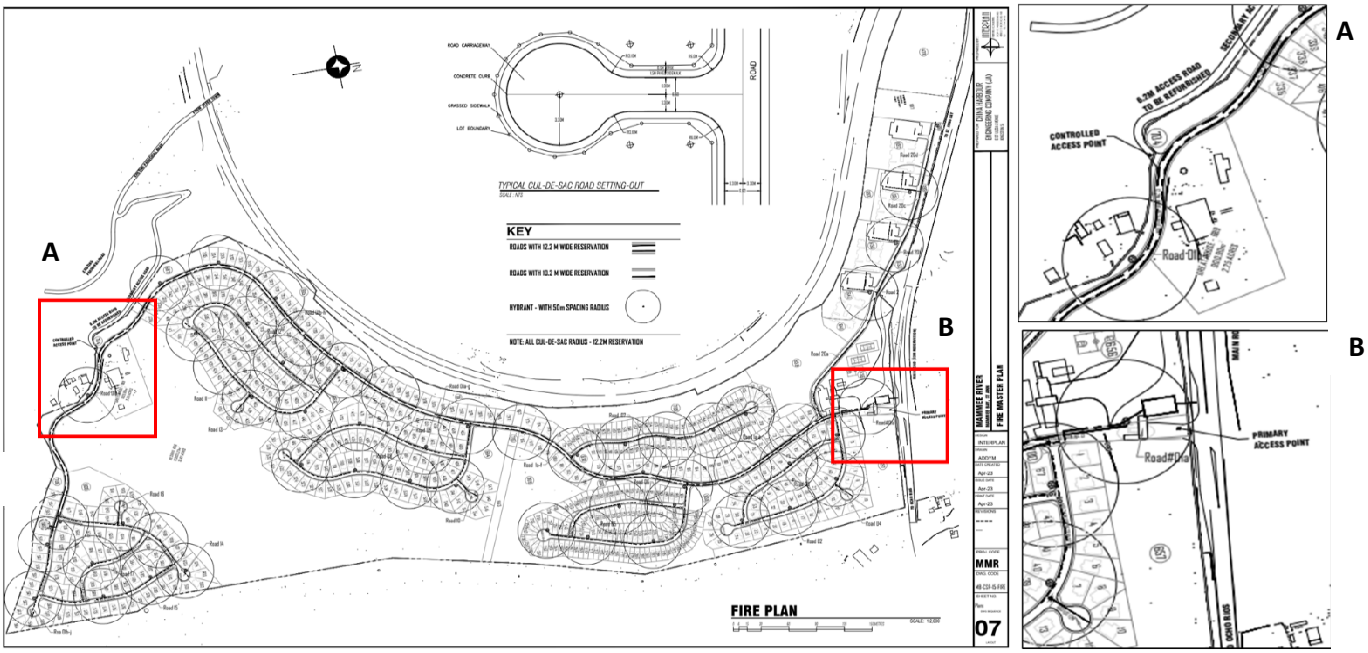


Figure 3-15: Subdivision Access Points

3.5. Building Materials

The Project proposes to use the following materials: mild and high tensile steel, cement, concrete marl, lumber, dump/granite/wash sand, ceramic and porcelain tiles, bitumen concrete and bitumen. See Appendix E for further details.

3.6. Development Alternatives

The developers had considered constructing a luxury villa complex but found that the market and the landscape were best suited for a mixed housing complex which provided a range of housing solutions for a wider segment of the community.

3.7. Topography and Grading Changes

Figure 3-16 illustrates that 49% of the site is occupied by slopes less than 10% and will be the location of the majority of the construction.

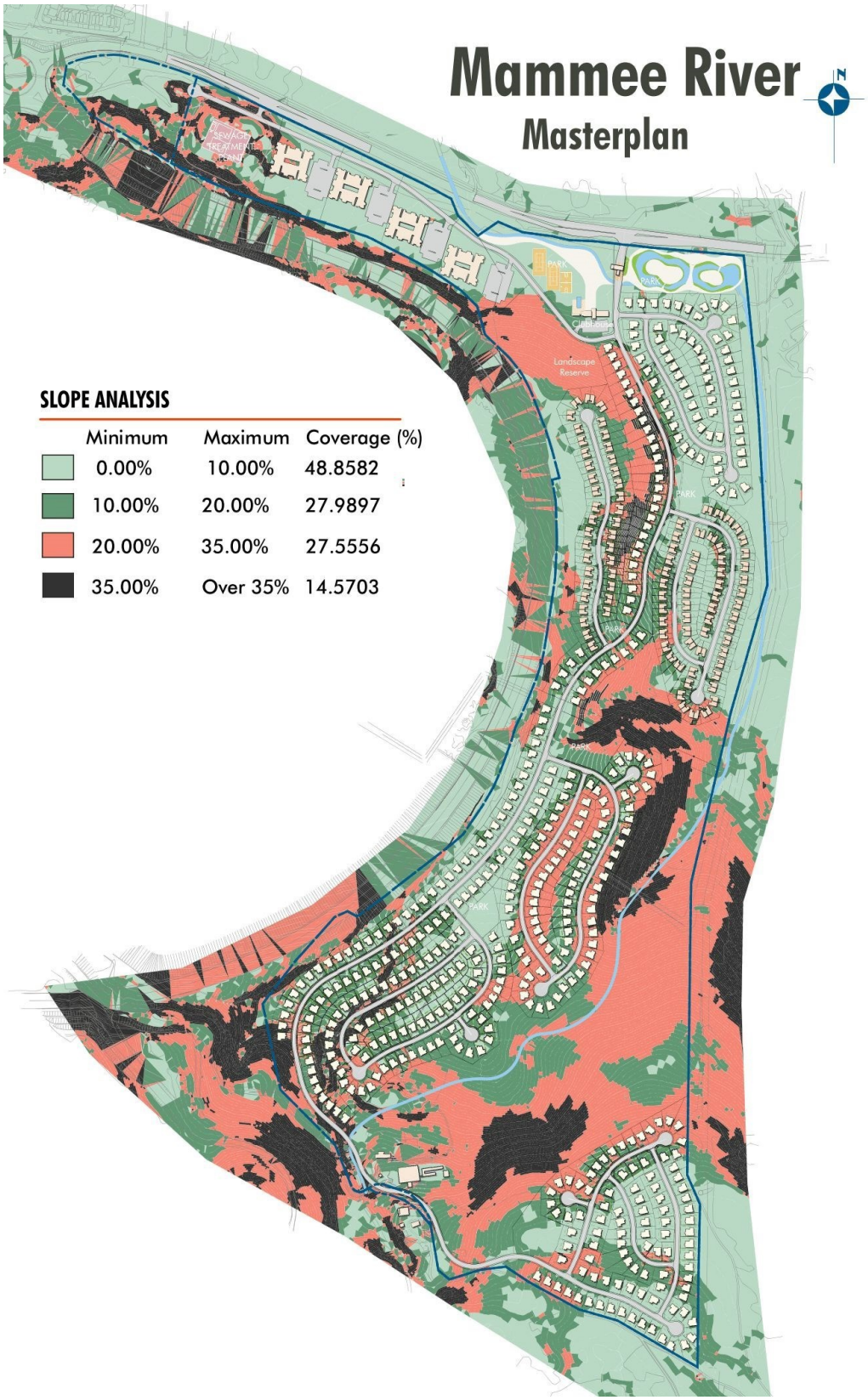


Figure 3-16: Slope Analysis of Mammee River Development Project Area

3.8. Wastewater/Sewage Treatment System

The entire Mammee River Housing Development may have up to 834 new housing units, commercial and shopping areas. A density of 2 people per bedroom was adopted, which is in line with the NEPA Development and Investment Manual. Accordingly, the total number of people living in the development will be approximately 4,000 people. In addition, there will approximately 50,000 sq ft of commercial developments. The commercial developments will include a restaurant and shops.

The calculated sewer flow based on Volume 3, Section 4 of the Development and Investment Manual, is 1,699 m3 /day. The wastewater/sewage treatment plant (STP) will be built during Phase 1 and be constructed in two phases, with the first phase capable of treating 700m^3/d of waste. At the completion of the second phase the sewage system will have a maximum capacity of 1,800m^3/d of waste. This capacity will meet the needs of the development and excess capacity for possible future development on the wider CHEC property.

The wastewater/sewage system has the following purposes:

1. Remove biochemical oxygen demand (BOD5) and total suspended solids (TSS)
2. Oxidize ammonia (NH3)
3. Disinfect the effluent
4. Produce Class B sludge
5. Provide a system that is fairly simple to operate and maintain

The proposed self-respiring Membrane Aerated Biofilm Reactors (MABR) system is ideal for small wastewater treatment plants. The system uses a spirally wound sleeve with an internal air-side spacer, through which low pressure air is blown, and an external water side spacer between wraps of the spiral. The spiral is submerged in a tank into which wastewater is fed continuously and effluent is discharged by overflow. This solution saves energy by eliminating the need to blow compressed air into the depth of the water for aeration, through the implementation of Fluence's patented passive aeration process. See Figure 3-17 below.

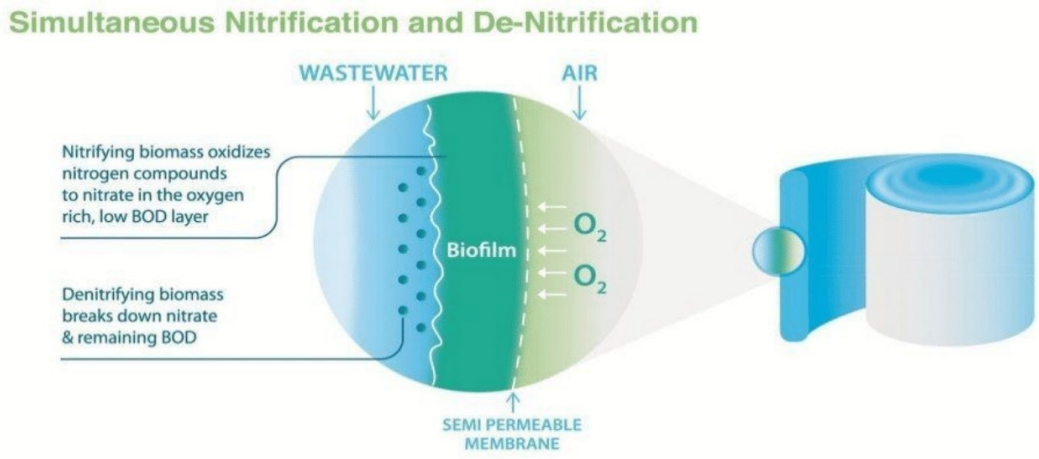


Figure 3-17: Proposed Sewage Treatment Technology

The treatment components for the first wastewater process train will consist of:

- Influent coarse screening
- Influent fine screening
- Grit removal
- Equalization tank
- MABR tanks
- Aeration tanks
- Secondary clarifiers
- UV Disinfection
- Biosolids management system with aerobic digester and sludge drying bed

The benefits of the system include:

- A reduction of up to 90% in energy use for aeration
- Simultaneous nitrification and denitrification
- Low odor and noise for neighborhood-friendly operation
- High-quality water suitable for discharge or use in irrigation
- Simple, low-maintenance operation
- Low operating cost
- Ease of operation-modular construction that will follow the housing implementation
- Provides treatment for all the pollutants and meets the NEPA full requirement for wastewater treatment plants
- Can be used as a “show-case” for sustainable infrastructure in the region
- Reduces the carbon foot-print when compared with a traditional wastewater treatment plan

The treated effluent will be pumped to a holding tank after which it will be channeled to the irrigation network. The land available for irrigation is two times the expected daily flow of effluent. In the event that there is an overflow from the irrigation pond/holding tank, it will be discharged to an earth drain which flows in the environment. The irrigation system has been designed to ensure the height of water from the sprinklers does not rise above 1m, and is a safe distance from buildings and parking structures. (See Figure 3-18 to Figure 3-19). Drip irrigation may be employed in those areas closest to buildings and parking structures not supplied by the sprinkler system.

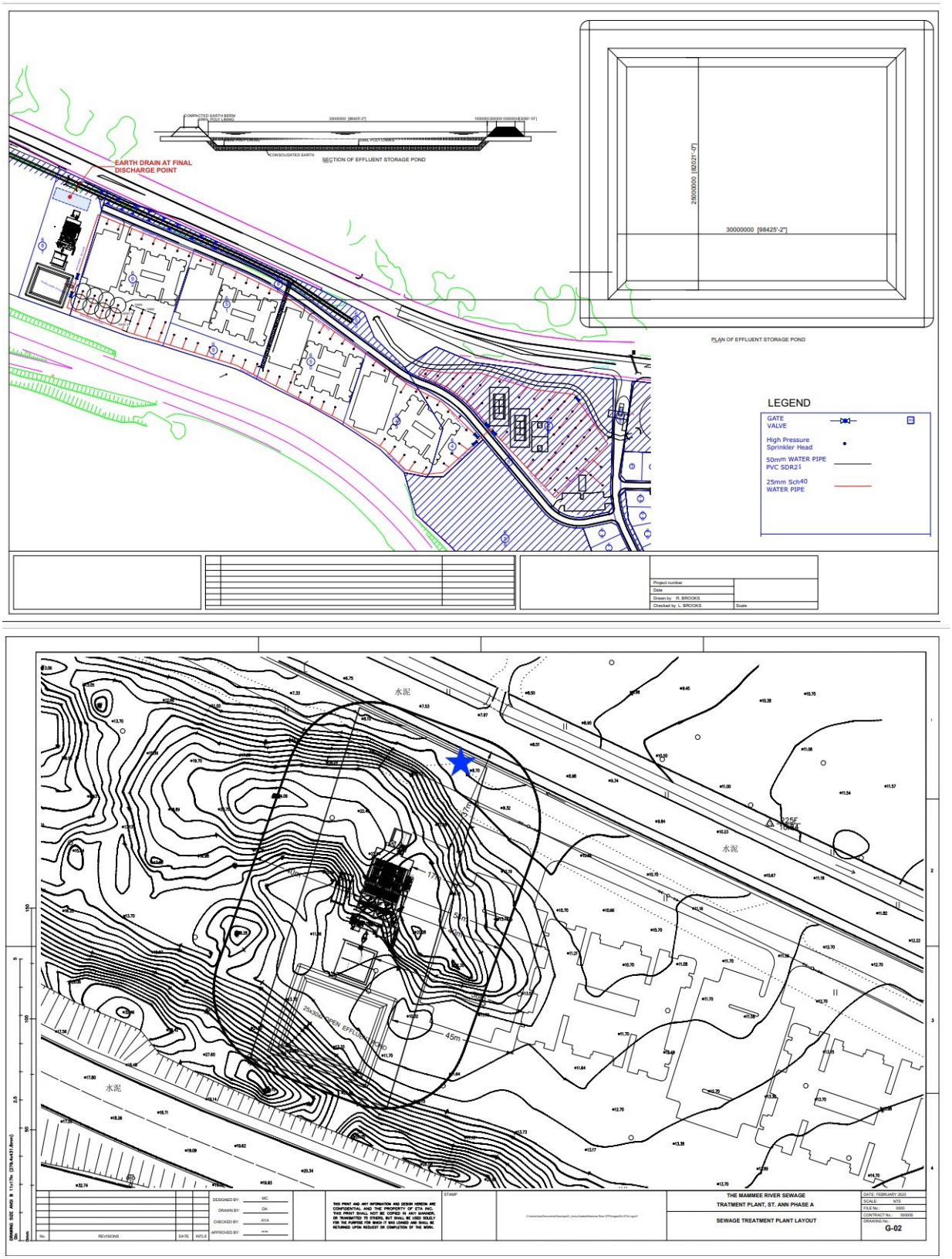


Figure 3-18: A) Discharge Point and Irrigation System B) Discharge point with setback distances

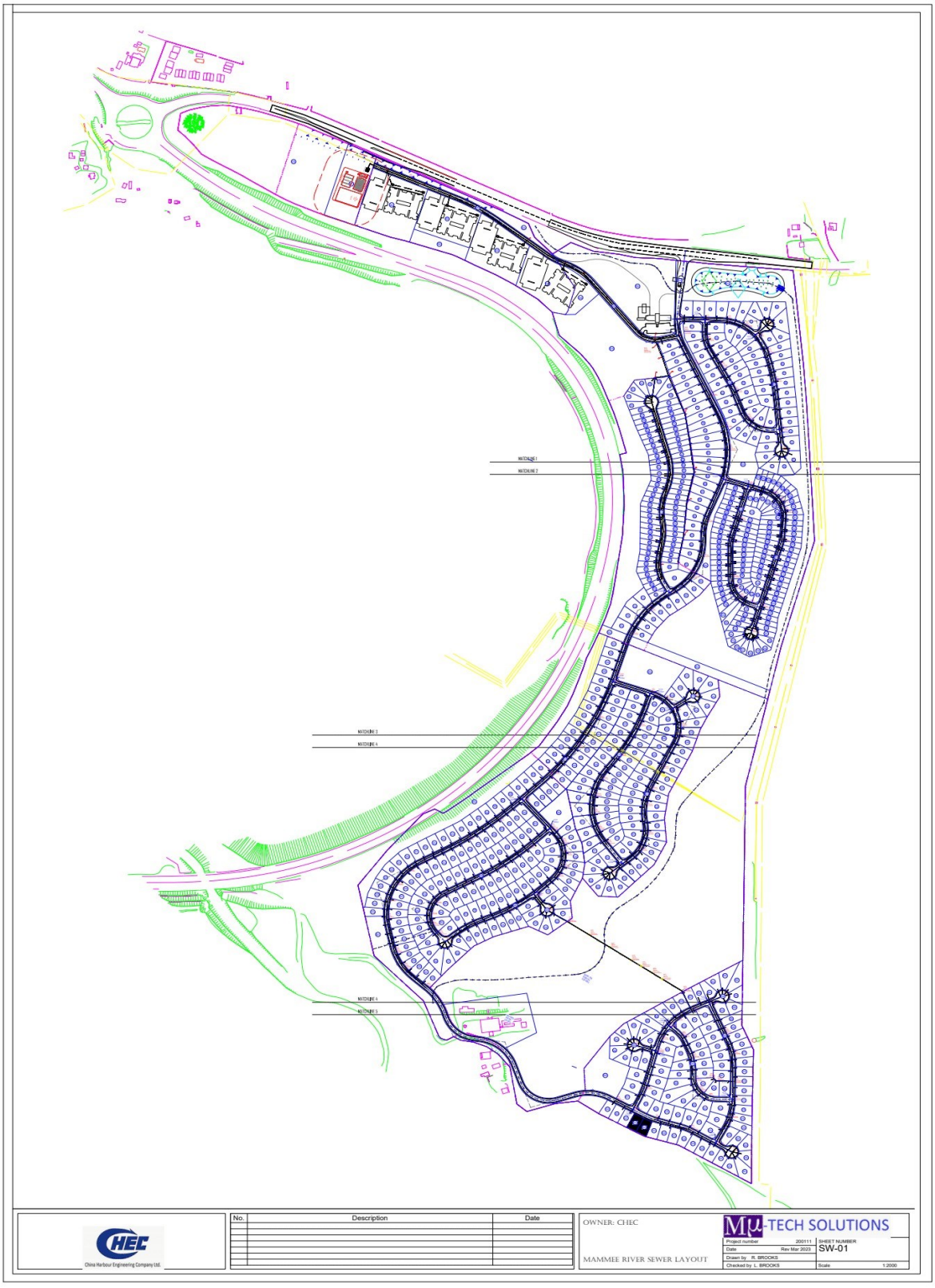


Figure 3-19: Sewage System Layout

3.9. Construction Methodology

Construction of the Development will follow a comprehensive methodology involving the following activities:

3.9.1. Phase 1 Operations

1. **Site Preparation and Support Operations**: The first phase of the project will involve site preparation and support operations. This will include surveying and setting out.; setting up a base camp; bush clearing, stump removal, land preparation; temporary road construction; motorized transport; and earthworks.
2. **Earthworks**: The earthworks will involve activities such as excavation, soil transport, filling, spreading, and compaction. The fill material for phase one will be sourced from phase three.
3. **Structure/Drainage/River Training**: The structure/drainage/river training phase will involve excavation, culvert laying, retention ponds, river channel, backfilling, masonry for structures and ditch lining, plain concrete, reinforced concrete, slope stabilization, and protection. Extensive work will be done with the river training to ensure that phase one will not be affected.
4. **Water supply**: The project will include the construction of potable water systems. The first phase will get water from the NWC main along the main road. The water tanks for the entire development will not be constructed in phase one.
5. **Sewage Treatment**: The sewage treatment plant (STP) will be constructed over two phases, with the first phase able to treat 700m3/d of waste. All lift stations and conveyance systems will be constructed on road A.
6. **Roads**: Only roads in phase one will be constructed.

3.9.2. Additional Operations

Despite only Phase 1 of the Mammee River construction project being scheduled for 2023, there will be some activities that will have an impact on the other phases. For example, site clearance activities will be carried out in Phase 3 simultaneously in order to excavate excess material which will be used to fill Phase 1. In addition, a potable water connection will be made to the National Water Commission (NWC) located on the main road next to the site. All infrastructure will be constructed in reserve road 1A up to the intersection of reserve road 20.

It's also important to note that all culverts and drains to be constructed in Phase 1 will be based on the build-out plan of all six phases. Extensive work on river training will also be required to ensure that Phase 1 is not negatively affected. As the source of the river is located approximately 1km away, a channel will need to be constructed to direct the river flow away from the construction area. Lift stations and the main sewer line to the STP site will also be constructed during this phase.

3.10. Landscaping

There are extensive landscaping plans. See Figure 3-20 to Figure 3-21 . Additional landscaping details for the lagoon, clubhouse, gatehouse, and boundary walls are found in Appendix F. The landscaped portions of the property will include the following species:

Table 3-4 Landscaping Plant Species

COMMON NAME	SCIENTIFIC NAME
African Tulip	*Spathodea campanulata*
Fig tree	*Ficus*
Breadfruit Tree	*Artocarpus altilis*
Lobster claw	*Heliconia*
Mango trees (East India, Julie, Number 11)	*Mangifera indica*
Italian Cypress Tree	*Cupressus sempervirens*
Red Birch	*Bursea simarouba*
Royal Palm	*Roystonea regia*
West Indian Lantana	*Lantana camara*
St. Augustine Grass	*Stenotphrum secundatum*
Sylvester Date Palm	*Phoenix sylvestris*
Crab Grass	-
Yellow Poui Tree	*Tabebuia serratifolia*
Otaheite Apple Tree	*Syzygium malaccense*

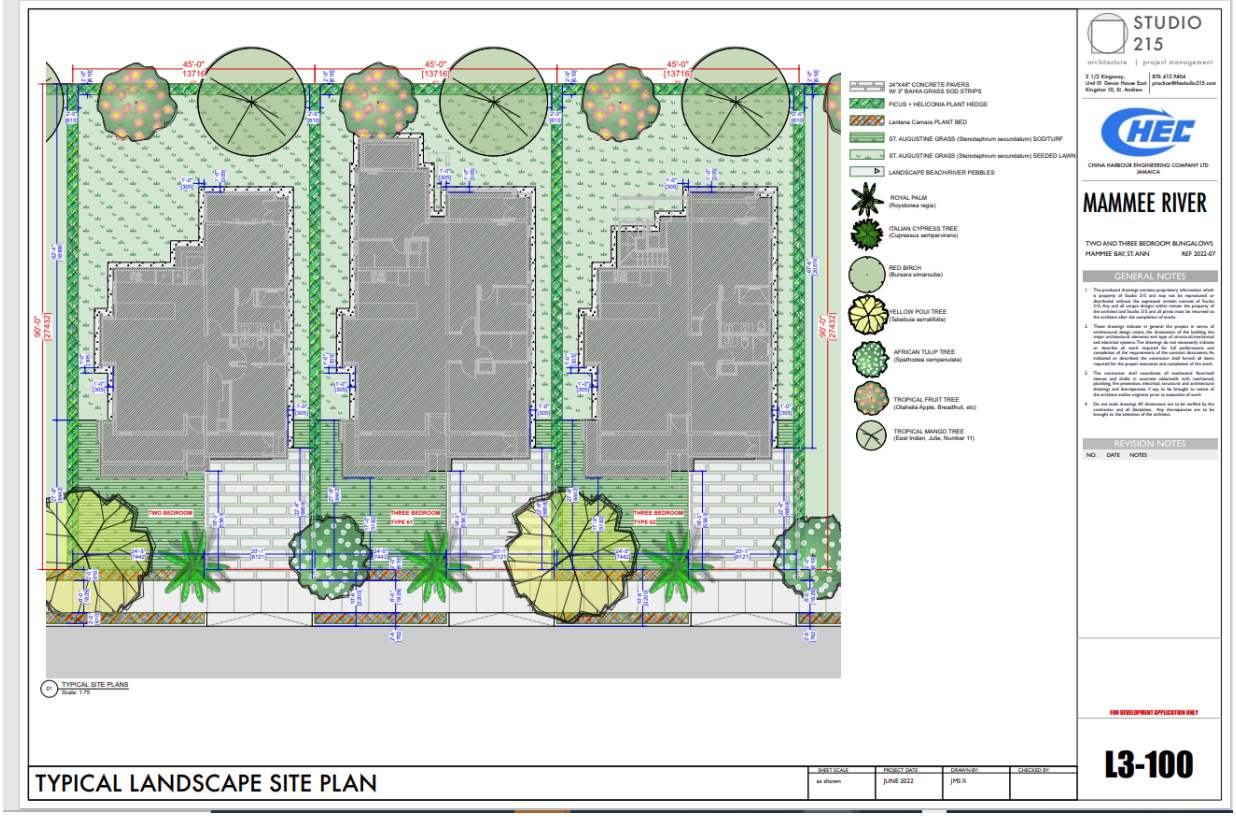


Figure 3-20: Typical Landscaping Schematic

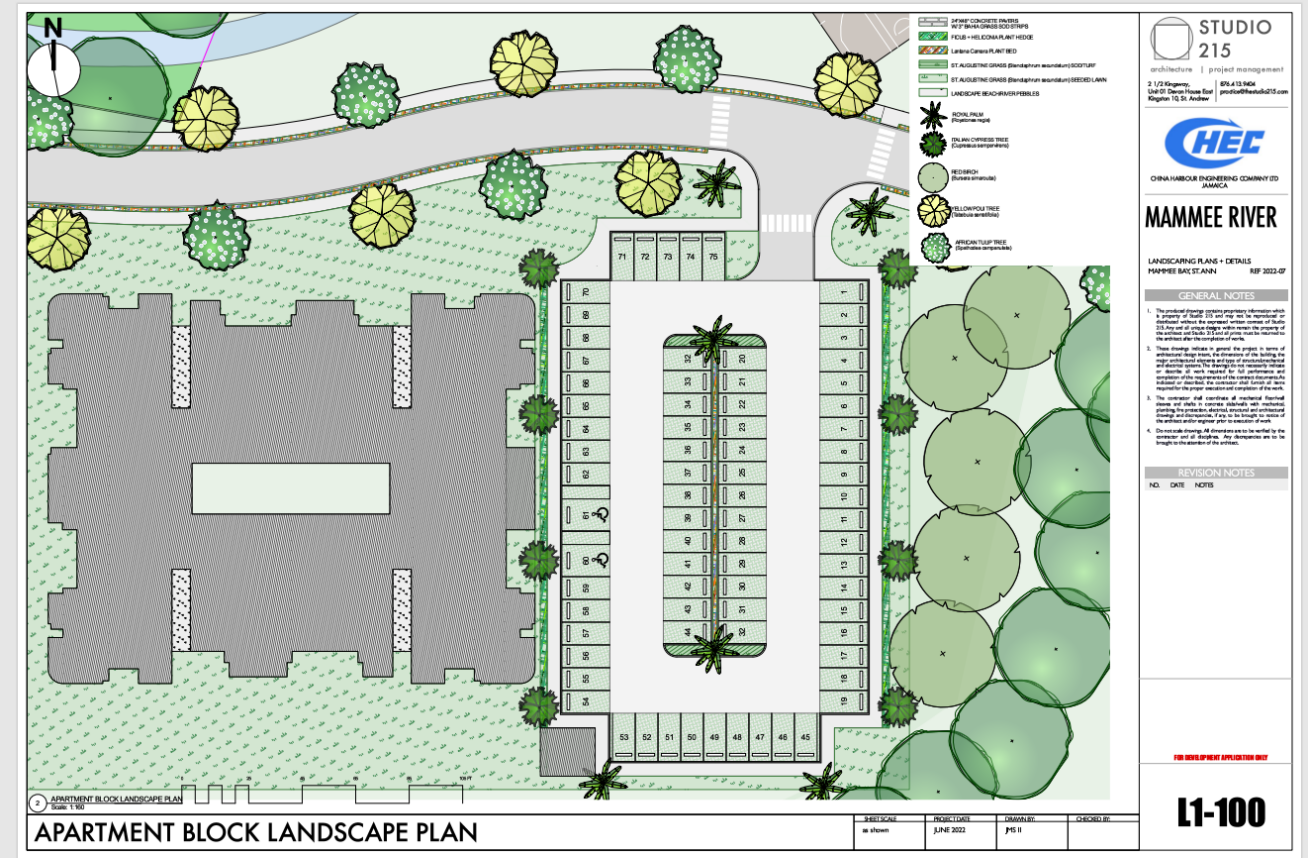


Figure 3-21: Apartment Block Landscaping Schematic

3.11. Drainage

The drainage system is designed to handle projected runoff pre- and post- development for 5, 10, 25, 50 and 100-year storms and provide adequate drainage for the subdivision and mitigate any negative impacts to the beach and near shore areas north of the subdivision. The plans involve realigning a section of the natural drainage and creating a network of pipe sewars to direct the storm runoff to detention ponds for final discharge. (See Figure 3-22 and Figure 3-23for further details) The design also aims to mitigate scouring and erosion from the areas with steep slopes. Outlet locations that are anticipated to have high velocity outflows will have adequate protection to further mitigate against scour and erosion.

The proposed drainage plan involves a bridge that crosses the North Coast Highway, a culvert that crosses and existing local road within the subdivision, and the realignment of the upper section of the natural waterway. The drainage elements are highlighted in the figures below. See Appendix G for full drainage assessment report.

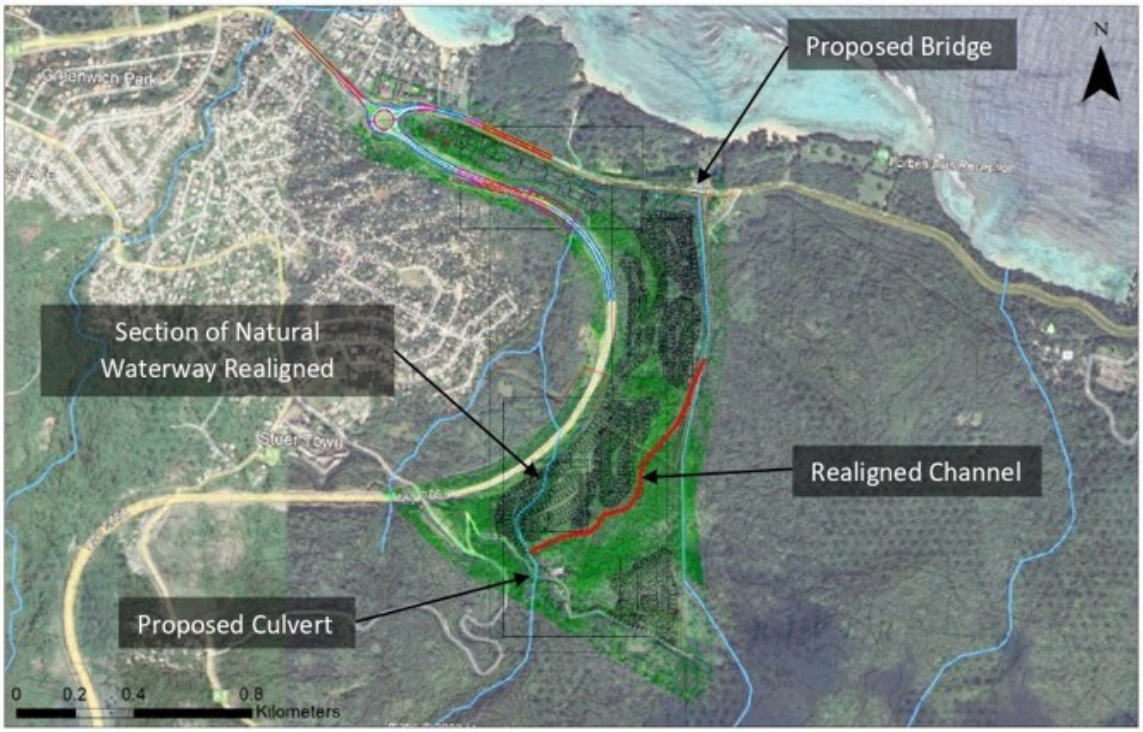


Figure 3-22: Proposed Drainage Features

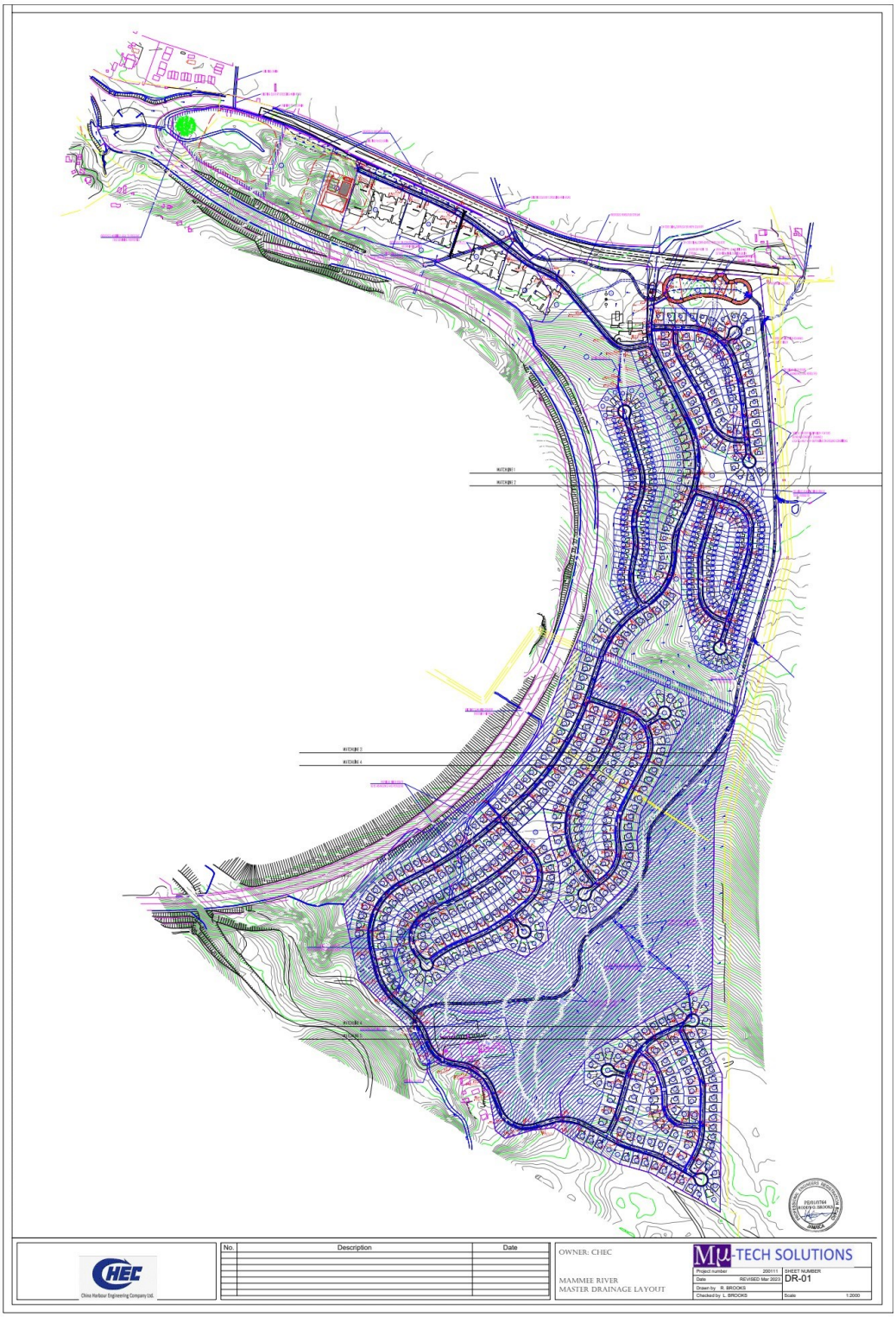


Figure 3-23: Drainage master plan

3.12. Utilities

The proposed residential development has the advantage of being in close proximity to the existing National Water Commission (NWC) water treatment plant to provide potable water for the residents and for fire suppression. The development assumes demand to be 227 liters per person. Calculations show that these demands are met with a minimum pressure of 5PSI during fire flow. The plans also indicate that the tank that is to be provided by the developer will facilitate pressure head and storage of two days capacity. Lastly the plans include a pump station to be provided to pump water from the Ocho Rios Main to the Tank used for the storage reservoir.

The property also has the benefit of being located close to the Jamaica Public Service (JPS) Roaring River Substation, and therefore will be able to connect to this facility to provide electricity to the proposed residential complex. The total expected three phase load draw after diversification is 525kVa. The proposed electrical grid will be buried underground to ensure resilience in the face of tropical storms and hurricanes.

3.13. Waste Management

3.13.1. Construction Phase

3.13.1.1. Waste Composition

During the construction phase, the following types of waste are expected to be generated:

- Wood: Including timber, pallets, and formwork
- Paper and Cardboard: Packaging materials, documents, and office waste
- Plastic Packaging: Wrappers, bags, and containers
- Concrete Brick: Demolition waste and excess concrete.
- Iron and Steel: Scrap metal and reinforcement bars
- Plaster-based Material: Drywall, plasterboard, and ceiling tiles
- Wastewater: Human sewage
- Food and other general waste generated by the workforce.

3.13.1.2. Waste Reduction Strategies

To minimise waste generation, the following strategies will be implemented:

- Efficient Material Management: Accurate estimation and planning to avoid excess materials
- Prefabrication: Utilising off-site prefabrication to minimise on-site waste
- Reusable Packaging: Encouraging the use of reusable packaging materials
- Waste Segregation: Proper segregation of waste at the source for easier recycling
- Appropriate waste receptacles for workforce waste strategically located across building sites.

3.13.1.3. Waste Reuse and Recycling

CHEC will prioritise the reuse and recycling of waste materials through the following measures:

- Reusable Materials: Identifying opportunities to reuse salvaged materials on-site or for other construction projects
- Recycling: Establishing partnerships with local recycling facilities for the recycling of wood, paper, cardboard, plastics, and metals
- Concrete Recycling: Investigating the feasibility of crushing and reusing concrete waste on-site.

3.13.1.4. Waste Disposal

During the construction phase, subcontractors will be responsible for the disposal of waste generated on-site. CHEC proposed to implement the following waste disposal measures:

- Skips and Bins: Strategically placing skips and bins at the construction campsite and construction site for proper waste containment.
- Skip Design: Ensuring skips and bins at the construction campsite are designed and covered to prevent vermin access and minimise odour.
- Regular Emptying: Regularly emptying skips and bins to prevent overfilling and maintain a clean site.
- Approved Disposal Site: Disposing of waste contents at an approved disposal site.
- Approved Contractor employed to supply, and periodically empty portable toilets.

3.13.2. Operational Phase

3.13.2.1. Waste Disposal Responsibility

Upon occupation of the site, the Mammee River Development will assume responsibility for waste disposal until the Homeowners Association (HOA) is fully functional.

3.13.2.2. Waste Collection and Disposal

The following waste management measures will be implemented during the operational phase:

- Approved Waste Disposal Company: Engaging an approved waste disposal company or the requisite municipal waste disposal company for waste collection and disposal.
- Individual Receptacles: Detached homes will have individual waste receptacles for proper waste containment.
- Communal Waste Disposal Site: The apartment complex will have a communal waste disposal site located in the parking area of each site
- Centralised Skip: A centralised skip will be located in the adjoining lot housing the sewage treatment plant, situated in the northwestern section of the site.
- Approved Contractor employed to supply, and periodically empty portable toilets

3.13.2.3. Monitoring and Compliance

To ensure compliance with the Waste Management Plan, CHEC's environmental consultant/ health and safety manager will develop a ticketing system. This system will facilitate effective waste management and verification of disposal at the correct site, and regular upkeep of portable toilet facilities. Regular monitoring will be conducted to assess compliance with the plan's guidelines.

Table 3-5: Waste Management Key Performance Indicators

KEY PERFORMANCE INDICATOR	HOW IT WILL BE MEASURED/MONITORED	RESPONSIBILITY
No waste deposited in the active roadway, waterways or pedestrian walkways	Location of skips etc. away from roadway, waterways or pedestrian walkways for construction waste	Contractor, CHEC Construction Manager
No leakages or spills	Monitor spills, Inspection of the site by the Contractor	Contractor, CHEC Health and Safety Manager

KEY PERFORMANCE INDICATOR	HOW IT WILL BE MEASURED/MONITORED	RESPONSIBILITY
Limited sediment laden run-off during heavy rain	Monitor waterways and beach areas during operations for significant sediment deposits	Contractor, CHEC Construction Manager/ Environmental Consultant
Portable Toilet units maintained in good working condition	Portable toilet units cleared on a consistent basis at a frequency that ensures no spills or mishaps.	Contractor, CHEC Health and Safety Manager
Reuse of waste (construction, organic etc.) where possible	Less waste being delivered to the disposal site	Contractor, CHEC Construction Manager
Approved Contractors	Inspection of licences and documentation	Contractor, CHEC Quality Assurance Manager/ Construction Manager

3.14. Equipment

The equipment and machinery to be involved in this project are as follows:

- Excavators
- Backhoe
- Bulldozers
- Graders
- Trenchers
- Loaders
- Tower Cranes
- Pavers
- Compactors
- Telehandlers
- Feller Bunchers
- Dump Trucks
- Water Trucks

The aforementioned equipment and machinery will be stored on site in the designated areas: Temp A, B, and C, illustrated in Figure 3-24. It should be noted that a batching plant will be erected at the primary campsite, also highlighted in said figure, along with a block factory. An application will be submitted to NEPA for the erection of the batching plant.

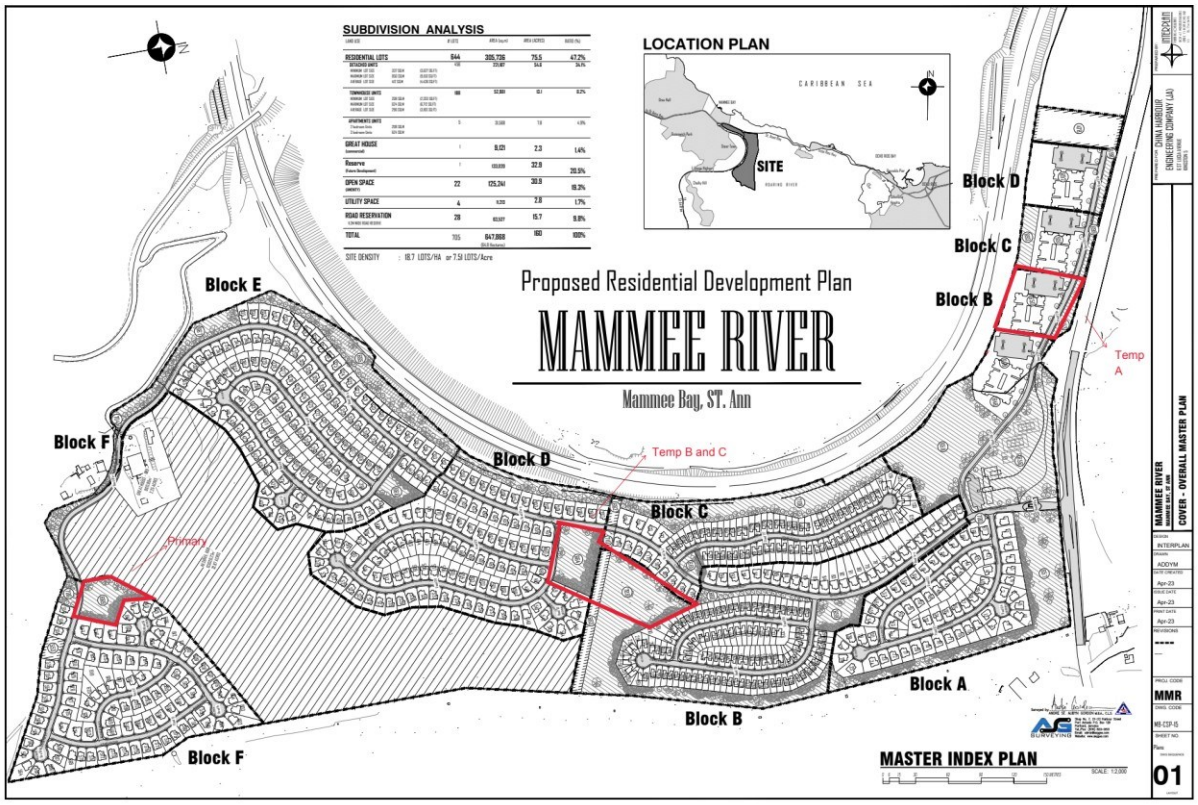


Figure 3-24: Designated Work Areas and Storage Areas

3.15. Workforce

The general workforce will consist of a specialized team comprising of expert, skilled, and unskilled personnel. It is anticipated that the labor force may reach a maximum of 90 workers, depending on the intensity and type of construction activity being undertaken. The workforce will comprise the following members:

Table 3-6: Workforce Breakdown

	POSITION	ROLE
1	Project Manager	Responsible for overall project coordination, including planning, scheduling, budgeting, and ensuring the timely completion of the project.
2	Construction Manager	Oversees day-to-day operations on the construction site, managing the construction team, subcontractors, and suppliers to ensure work is carried out according to plans and specifications
3	Site Supervisor	Responsible for supervising construction activities on-site, ensuring work progresses as scheduled, and coordinating with subcontractors and laborers

	POSITION	ROLE
4	Estimator	Prepares cost estimates for the project, analyzing project specifications and assisting in the procurement process
5	Architect	Ensures compliance with building codes and regulations, coordinates with engineers and consultants.
6	Engineer	Provides technical expertise in civil, structural, mechanical, or electrical fields
7	Scheduler	Develops and maintains the project schedule, tracking progress and communicating the construction timeline
8	Procurement Manager	Manages the procurement process, sourcing materials, equipment, and subcontractors
9	Quality Control/Quality Assurance Manager	Ensures construction work meets quality standards and specifications
10	Health and Safety Officer	Ensures compliance with health and safety regulations, develops safety programs, and conducts inspections
11	Environmental Consultant	Assesses environmental impact, ensures compliance with environmental regulations and recommended mitigation measures
12	Other personnel	Construction- skilled and unskilled workers such as general laborers, carpenters, masons, electricians, plumbers, painters, welders, HVAC technicians, heavy equipment operators, concrete workers, roofers, and surveyors

Temporary accommodation for the workers will be provided in Temp A, B, and C areas highlighted in Figure 3-24 above. These facilities may include temporary dormitories, which are prefabricated, or modular buildings designed to house multiple workers. The facilities will feature sleeping quarters with bunk beds, common areas, dining facilities, and restroom facilities. It should be noted that the implementation of these facilities will be done in phases.

4. Description of the Environment

4.1. Physical Environment

4.1.1. Geology, Topography and Soils

4.1.1.1. Geology

Information from the Mines and Geology Division (MGD) indicate that the geology of the area consists of the Travertine and limestones of the White Limestone and Coastal Group (see Figure 4-1). The predominant geology across the project site is Travertine. Within the project site there are other sections consisting of the Montpelier Formation (Mm) and undifferentiated members of the Coastal Limestone Group.

During the site reconnaissance grainstone[1] textures of the Montpelier Formation were observed, according to the Dunham classification (1962). Limestone with dull chalky texture[2] was also observed during the site reconnaissance. These rocks were observed within the southern sections of the project site (see Figure 4-2).

A geotechnical investigation was conducted for this project (see Appendix H). The investigation conducted indicates that the gently sloping south-eastern section of the site is dominated by deposits of travertine; a yellowish brown, weakly cemented calcium carbonate rich material formed from the precipitation of calcium carbonate from mineralized water. Geological mapping during the geotechnical investigation also reveals that the north-western section of the site is underlain by Elevated Reef (Ql) deposits of the Coastal Limestone Group. This geological formation is exposed as an elevated limestone hillock encountered towards the north-western section of the property. Outcrops of the Elevated Reefs (Ql) were found to be comprised of competent rock material, evident as moderately strong, massive to poorly bedded coralline limestone. Geological Mapping of the property further indicates the southern section of the site which abuts the North-South Highway is underlain by limestones of the Montpelier Formation (Mm). The Montpelier Formation (Mm) is comprised of cream white, well bedded, weak to moderately weak chalky limestone. Exposed outcrops were limited to occasional exposures at the surface as the limestone was largely draped by topsoil throughout the southern section of the site.

[1] Grainstone: Formed of grains that are touching (grain-supported) with a cement. The cement may completely or partially fill the spaces between grains

[2] G. E. Archie, "Classification of carbonate reservoir rocks and petrophysical considerations," AAPG Bulletin, vol. 36, no. 2, pp. 278-298,1952

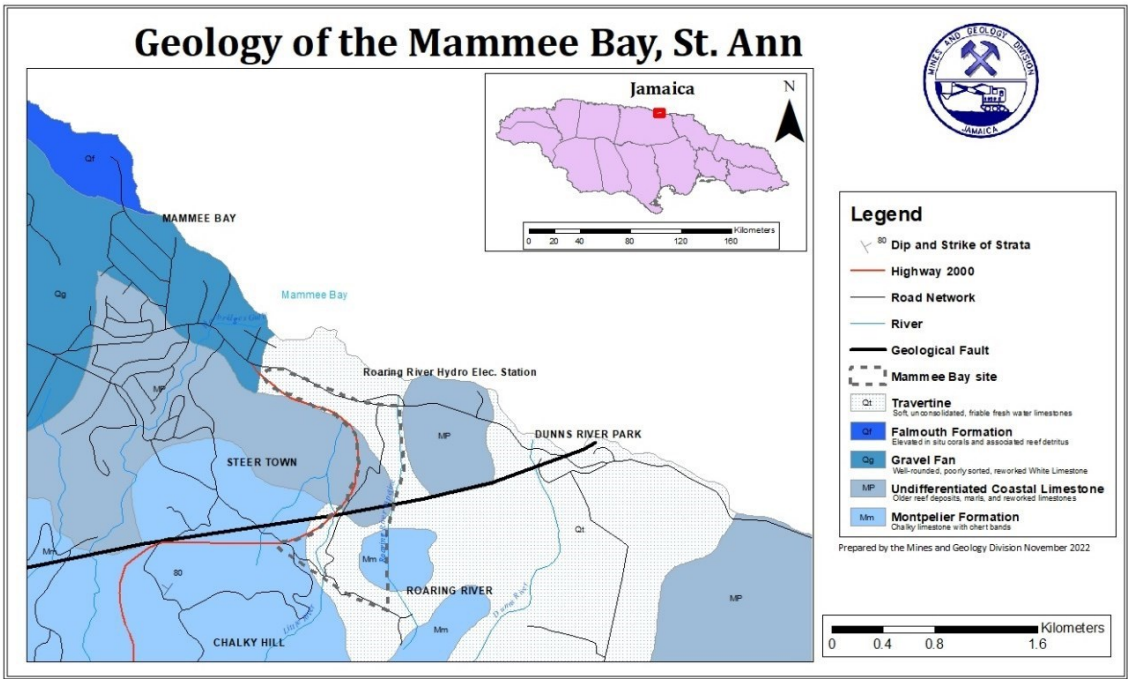


Figure 4-1: Geological Map (Source: MGD)

Figure 4-2: A) Limestone with dull chalky texture observed on site B) Grainstone limestone observed on site

A review of the 1:50,000 Geology Sheet indicates the site is impacted by a northeast to southwest trending fault which dissects the central section of the site. Of note, this fault is relatively young, and does not appear to be seismically active based on the historical records. Nonetheless, this fault line represents a zone of weakness along which displacements can be induced and minor tremors may occur.

According to the Jamaica Cave Register (2020) there are no caves or sinkholes in or in proximity to the

site. There is a low potential for localised cavities on site based on the findings of the geotechnical investigation, however, this is restricted to the locations where boreholes were drilled. It is possible for horizontal variation in the subsurface between the sites investigated.

Based on the geotechnical investigation (Appendix H) the subsurface component of the site is comprised of a combination of fine-grained calcareous Silt and Clay and coarse grained Calcareous Sand and Gravel, underlain by strong to moderately strong Limestone rock material. A detailed breakdown of soils encountered onsite is as follows:

i. Calcareous SAND and GRAVEL: The site is dominated by Coarse-Grained Calcareous Sand and Gravel with varying proportions of Silt and Clay at shallow foundation depth. Of note, coarse grained soils (Sand and/or Gravel) were dominant at shallow foundation depth in all boreholes drilled onsite.

ii. Fine Grained SILT and CLAY: Fine Grained Calcareous Silts and Clays with varying proportions of Sand and Gravel were encountered onsite at various depths in some boreholes.

iii. LIMESTONE ROCK: Moderately weak to Strong LIMESTONE was encountered in some boreholes drilled onsite at varying depths. Refusal was commonly encountered in limestone rock and in many instances, the recovery of soil samples was limited.

Detailed information is presented in the Geotechnical Investigation Report found in Appendix H.

4.1.1.2. Topography

The topography varies across the project site and is influenced by the general geology of the area. In the northern sections, where unconsolidated material is present, the land is very flat and undulating with a very low gradient, while in the southern sections the limestone hilly terrain gradient increases. On the topographical map, the highest point is to the south, with an elevation of ~160 metres above sea level (Figure 4-3). The gradient slopes towards the north reaching an elevation of ~ 20 meters above sea level to the north.

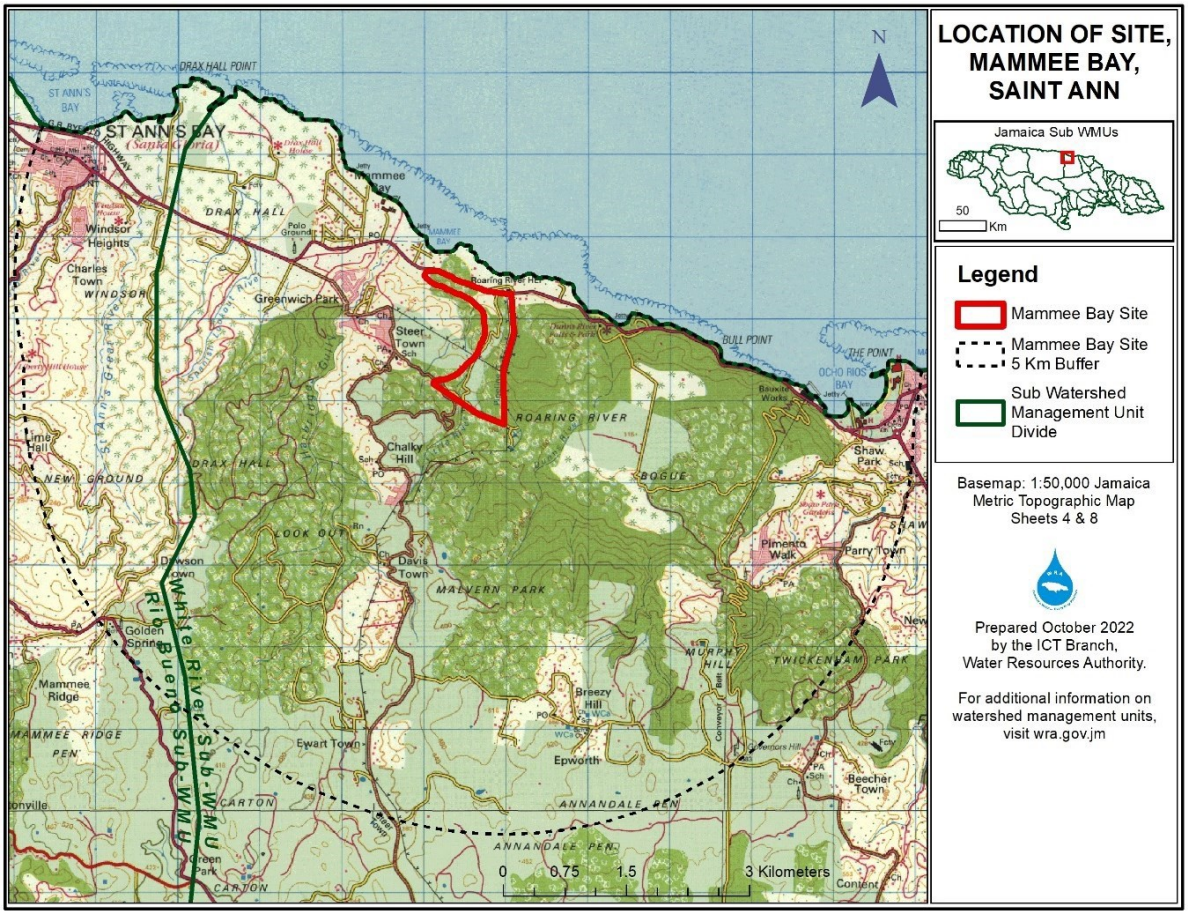


Figure 4-3: Map illustrating the Location of Project Site (in red) on Topographic Map 1:50,0000 (Source: WRA)

4.1.1.3. Soil

Figure 4-4 illustrates the soil texture within and surrounding the proposed project site. The proposed site has three (3) soil textures: stony loam, clay loam and clay with the main texture as the stony loam. During the site reconnaissance visit, stony loam, with subangular to subrounded pebble and granule size limestone clasts were observed within the southern sections of the site.

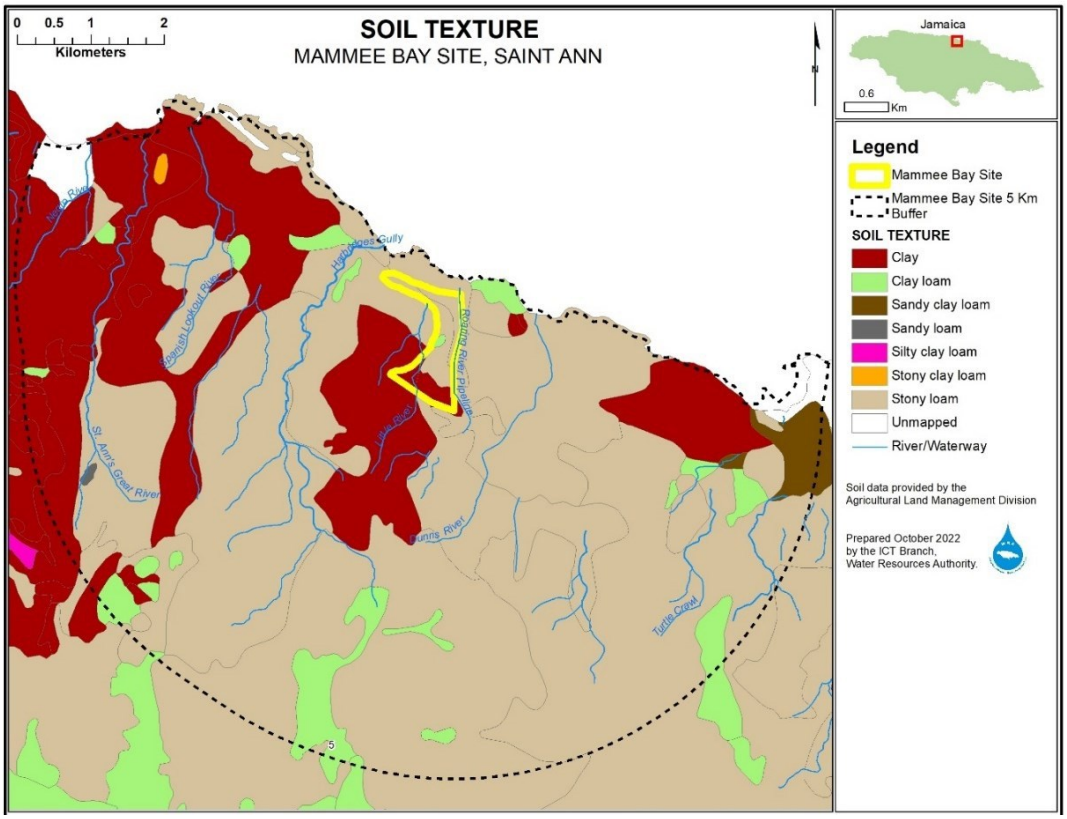


Figure 4-4: Soils Map (Source: WRA)

According to the geotechnical investigations the main texture within the area drilled is gravelly silty SAND or silty GRAVEL. More information can be found in the Geotechnical Investigation in Appendix H.

4.1.2. Hydrology and Drainage

The project site is located in the Rio Bueno Watershed Management Unit (WMU), in the White River Sub Watershed Management Unit (6b). Due to the topography of the area, all the surface water flows north towards the coast. Thus, only the lower course of two rivers/ waterways (Little River and Roaring River) were observed within proximity to the eastern and western boundary of the site. During the site reconnaissance visit it was observed that the Little River is earthen with steep banks. In the most south-eastern section of the property, flow was observed in the Little River, however, in the section further north no baseflow was observed. There was a small stream observed on the northern part of the property heading from Block A to B from the entrance. The absence of baseflow could be as a result of the stream flowing underground into potential solution cavities or other relatively more permeable material such as the sandy GRAVELS or gravelly SAND on site. In proximity to the western boundary of the project site, the Roaring River was observed. In the south-western section, the damming of the river was observed, where the water flows into a pipeline. The pipeline continues toward the coast and passes through a grassy area. This water is used to generate hydroelectricity for Jamaica Public Service (JPS). In areas further north within the flatter elevation, odourless, colourless water was observed. It is important to note, that there are two active surface water resources below the proposed site. Therefore, it is imperative to ensure that

during the construction and operation phase, there is no negative impact on the quality or quantity of the surface water resources nearby.

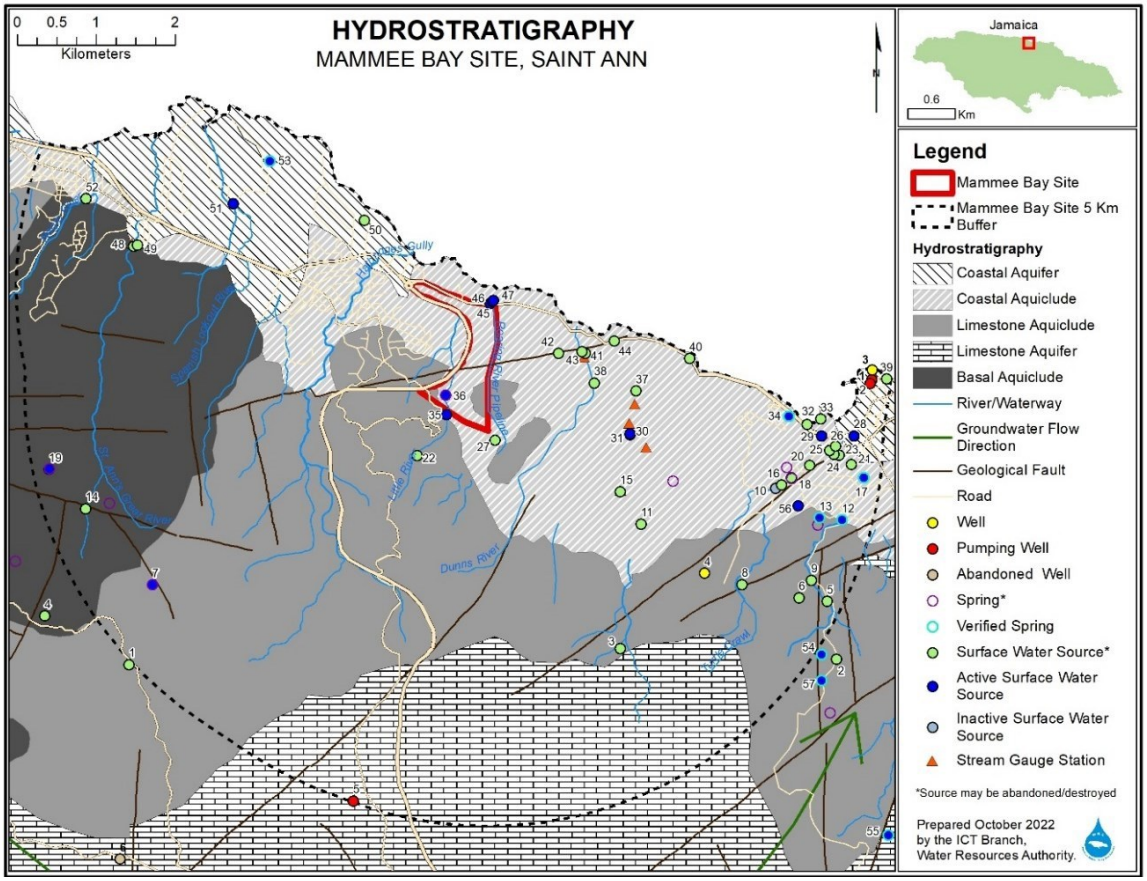


Figure 4-5: Hydrostratigraphic Map (Source: WRA)

The project site is underlain with limestone and coastal aquicludes. The Limestone aquiclude is considered semi-permeable and consists of the Montpelier Formation. On the other hand, the coastal aquiclude typically consists of the Coastal Limestone Group which all are characterized as impermeable except for the Falmouth Formation. Currently there are no wells on or within 2 km of the proposed site. Groundwater was only detected in a few of the boreholes drilled on site in the norther section in Blocks A and C with groundwater levels ranging from 1.8m to 4.5m (6 ft to 15 ft) below ground level. The percolation test results from the geotechnical investigation revealed that the absorptive property of the soil/rock is high to very rapid on the site. The regional groundwater elevation is expected to be relatively high, given the proximity of the site to the coastline. The potential for groundwater contamination is high if wastewater is directly discharged into the subsurface based on the percolation rate.

Despite the absence of aquifers, the area is underlain with limestones with a high possibility of existing karst features (caves and conduits). The semipermeable nature of the limestones makes it susceptible to contamination from point and non-point sources during the construction and operation phase of the project. Additionally, water can dissolve the limestone providing a rapid route for unfiltered contaminants from the point sources.

4.1.2.1. Drainage Assessment

To determine the peak discharge and runoff for the current conditions of the project area, hydrologic and hydraulic assessment were conducted.

The rational method was used to estimate the peak discharge and response to extreme rainfall events. The method used the representative rainfall for each of the return periods: 10-, 25-, 50- and 100-year from the Rockfield Rainfall Station. For large watershed areas existing beyond the boundaries of the subdivisions (Figure 4-6), the Jamaica 2 Method was used to determine runoff for 10-, 25-, 50- and 100-year rainfall events. For runoff estimates within the subdivisions the Rational Method was used.

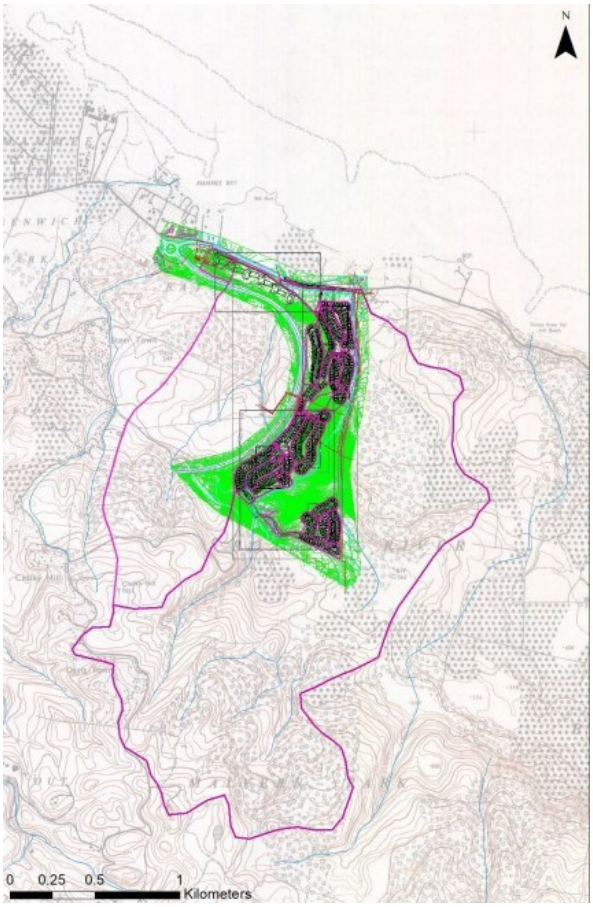


Figure 4-6: Pre-Development offsite watershed areas

According to the Guidelines for Preparing Hydrologic and Hydraulic Design Reports for Drainage Systems of Proposed Developments[3], estimation of 100-year runoff, should be conducted for major drainage systems (big drains, culverts, river channels, gullies). The model was run using the Depth-Duration-Frequency (DDF) and data for Rockfield Ran Gauge Station was used for each return period 10-, 25-, 50- and 100-year. The simulated runoff volumes for the large off-site watersheds are summarized in Table 4-1 Pre- development peak runoff for large off-site watersheds. This shows that currently a peak runoff of 9.7

[3] Ministry of Transport, Works and Housing. National Works Agency, Ministry of Local Government and Community Development. 2016. Guidelines for preparing Hydrologic Design Reports for Drainage Systems of Proposed Developments.

cubic meters per second (cumecs) at the bridge has a 10 percent chance of being equalled or exceeded in any given year. While the Culvert's has a 50 percent chance of experiencing equalled or exceeded peak runoff of 6.4 cumecs in any given year.

Table 4-1: Pre-development peak runoff for large off-site watersheds

Structures		Peak Runoff (m^3/s)				
		5- Year Return Period	10- Year Return Period	25- Year Return Period	50-Year Return Period	100- Year Return Period
Bridge		5.4	9.7	17.7	25.0	33.3
Channel	Upper	1.5	2.8	5.2	7.5	10.5
	Lower	4.8	8.7	16.4	23.7	33.1
Culvert		1.2	2.2	4.4	6.4	6.4

4.1.3. Natural Hazards

4.1.3.1. Seismic Activity

Jamaica, due to its location on the Caribbean Plate margin, is susceptible to seismic activity. Seismicity mapping has indicated that there is a concentration of seismic activities in the country's eastern parishes of St. Thomas, Portland, and Kingston and St. Andrew, which is distant from where the project is located (UWI Mona, 2021)[44]. See Figure 4-7 below.

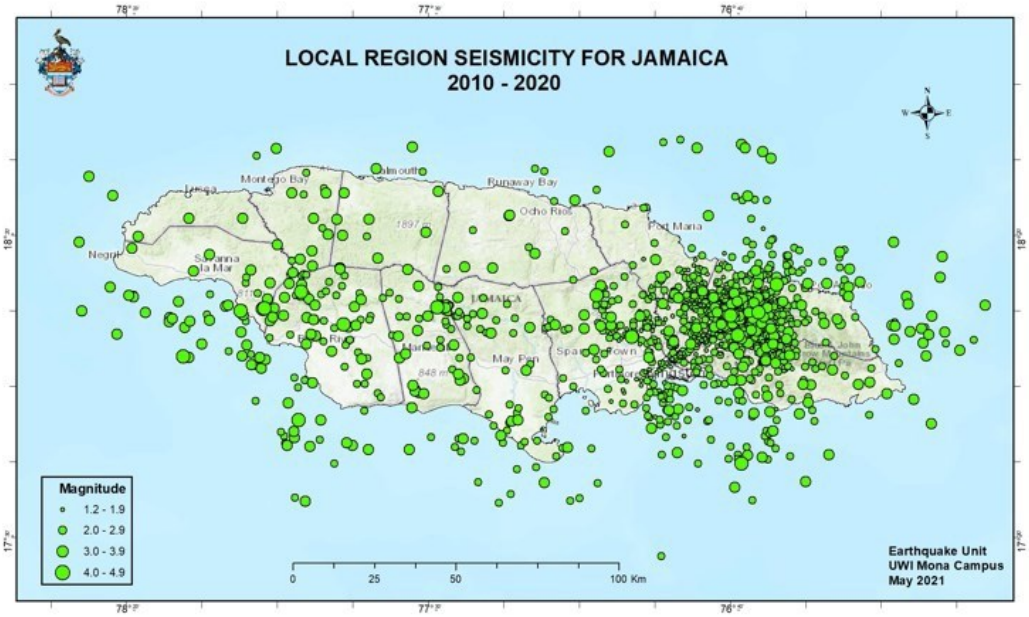


Figure 4-7: Seismic Activity in Jamaica 2010 – 2020 (Source: Earthquake Unit, UWI Mona)

Mammee Bay and its environs have been affected by only 4 of the 13 of Jamaica's most damaging earthquakes in recorded history from 1692-2020 and has reported no major damage from any of these

[4] UWI Mona, 2021. Earthquake Unit. Jamaica Seismicity.

events. (See Table 4-2). However, as mentioned previously, the project location falls within an area which is near to a fault line which has the capacity to generate moderate strength earth movements with magnitudes of up to 7 MMI (see Figure 4-8).

Table 4-2: List of earthquakes impacting the Mammee Bay

Date	Places Affected	Maximum Intensity (MMI)	Observed Impacts
June 7, 1692	Port Royal Kingston, Vere Plains, felt strongly Island-Wide	X	3,000 dead; buildings collapsed; liquefaction, subsidence, landslides and water ejected
March 1, 1957	Montego Bay, St. James and felt island-wide	VIII	4 dead; landslides; bridges damaged; rotation of spires and monuments; springs increased flow and muddied; utility poles and lines broken; breakages of items off shelves
January 13, 1993	Kingston & St. Andrew and felt island-wide	VII	2 dead; items thrown off shelves and broke; most persons were frightened; heavy furniture shifted; water splashed out of containers and pools; much non-structural damage; few cases of structural damage
January 28, 2020	Island-wide and Regional (Cayman & Cuba)	VII	One school closed because previous inspections by The Jamaica Fire Bridge had detected structural weakness. As a pre-cautionary measure after the Earthquake the school was dismissed early. At least two parishes in Western Jamaica reported structural damage to buildings.
October 30, 2020	Portland and felt in many parishes and Regional, US islands, Cuba	Unclassified as yet	Collapsed buildings, minor structural damage in some instances and overturned shelves.

Source: Earthquake Unit, UWI Mona & ODPEM

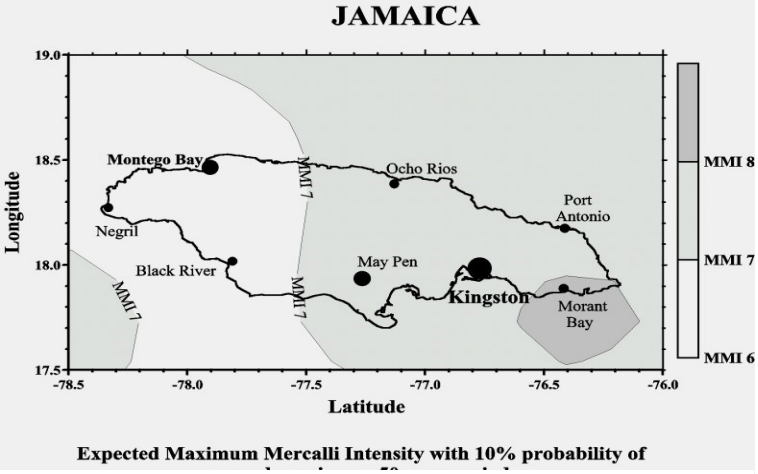


Figure 4-8: Expected Maximum Mercalli Intensity (Source: OAS Caribbean Disaster Mitigation Project)

4.1.3.2. Tropical Storms

Jamaica is highly vulnerable to tropical cyclones due to its location within the Atlantic hurricane belt. The most active period is noted to be between June to November as storms are most likely to develop in the Caribbean Sea and Jamaica's rainy season. Viewed in consecutive 20-year segments since 1870, Jamaica has generally experienced more Category 4-5 hurricanes in the last few decades as compared to earlier periods. The number of storms passing by or directly affecting Jamaica in the 2000s has been its highest since 1940-1959 and includes 11 hurricanes and 11 tropical storms. These storms have caused loss of life and great destruction. Between the period of 2000-2010 the PIOJ estimated that tropical storms cost the economy JMD $111.8 billion dollars (unadjusted for inflation) (PIOJ, 2010)[5]. The project site, being located near the coast, leaves it vulnerable to future storms.

Table 4-3: Hurricanes Affecting Jamaica

TIME PERIOD	NUMBER OF STORMS
1700s	5
1800-1870	4
1870-1899	8
1900-1919	7
1920-1939	3
1940-1969	9
1970-1999	7
2000-2019	11
Total	**54**

(Sources: State of Jamaica Climate 2015, State of Jamaica Climate 2019)

4.1.3.3. Drought

Jamaica's dry season tends to run from December to March. However, the island is experiencing more frequent periods of extended drought conditions in recent years, with half of all parishes being in meteorological drought[6] between November and December 2022.

Between 1900-2018, the parish of St. Ann has experienced less rainfall than the national average for 7 months of the year. This makes the area moderately drought prone. See Table 4-4 and Figure 4-9 below.

Table 4-4: Monthly mean rainfall received St. Ann parish vs Jamaica's Average 1900-2018 (millimetres)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average
St. Ann	177	83	81	89	193	86	78	106	152	187	162	131	122
Jamaica	88	71	78	107	207	107	107	144	184	202	153	102	129

Source: State of Jamaica Climate 2019

[5] https://www.jiejamaica.org/presentations/Assessing%20the%20Costs%20of%20Disasters%20on%20Jamaica's%20Infrastructure.pdf

[6] Meteorological Drought A period of well-below average or normal precipitation (rainfall) that spans from a few months to a few years ODPEM. 2023.

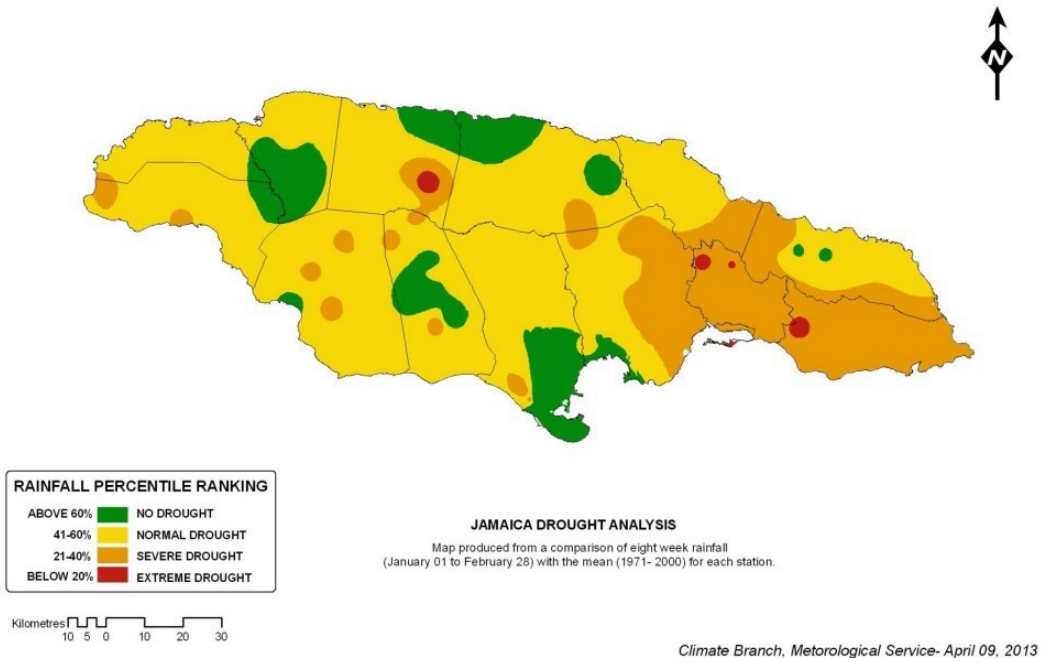


Figure 4-9: Jamaica drought conditions Jan-Feb. 2013 (Source: Meteorological Service of Jamaica - Spence)

4.1.4. Parameters of Climate

4.1.4.1. Temperature

The island experiences the highest temperatures occurring during the summer months of June to September and coolest temperatures occurring from December to March. The annual range of mean monthly temperatures is small (app.~ 3-4 °C), ranging from 23.2 °C to 26.3 °C for 1901-1929 to 23.0 to 27.1 °C for 1990-2019. The mean maximum (daytime) temperatures can reach as high as 31°C during the warmest months for some locations, while mean minimum (nighttime) temperatures can be as low as 18.4 °C during the coolest months. The climate in St. Ann follows the same trend as seen nationally, however, is slightly warmer than the average temperature (See Figure 4-10). The parish on average has a minimum temperature of approximately 22°C and a maximum of 32°C (Climate Studies Group, 2020)[7].

[7] Climate Studies Group, Mona (CSGM), 2020: State of the Jamaican Climate 2019: Information for Resilience Building (Second draft). Produced for the Planning Institute of Jamaica (PIOJ), Kingston Jamaica p. 21

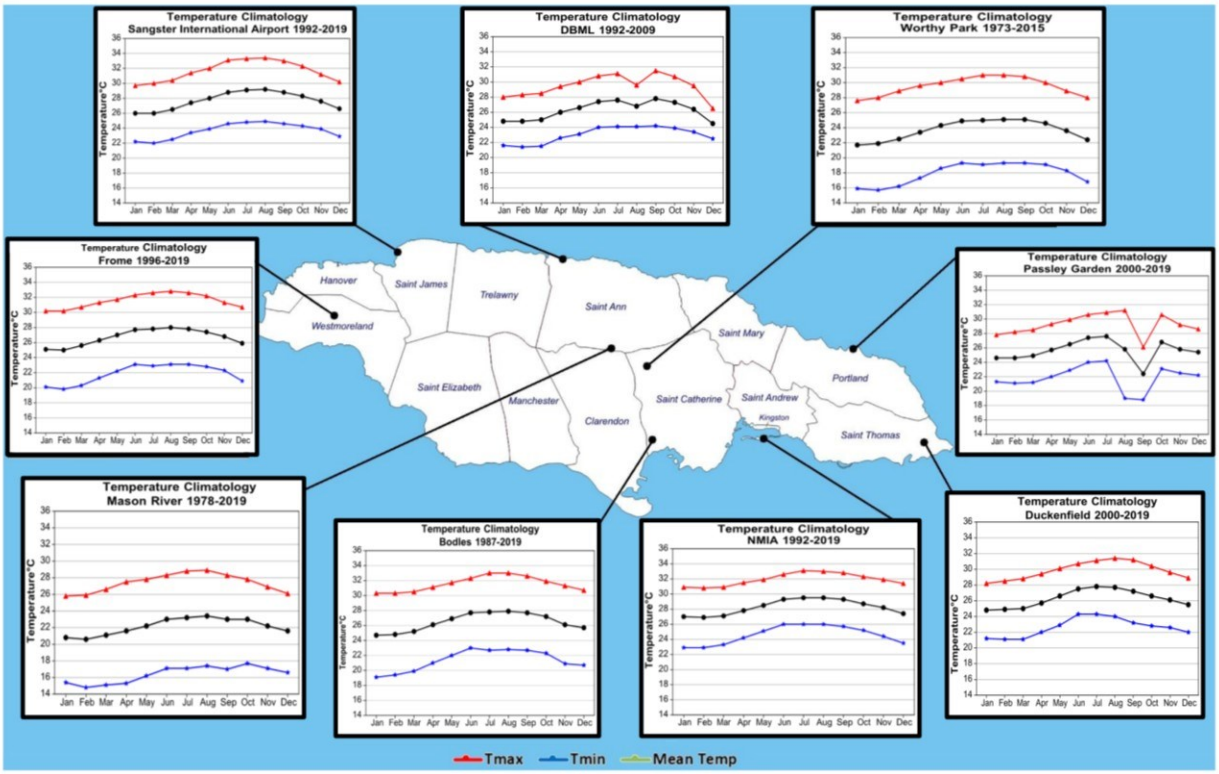


Figure 4-10: Temperature climatologies of 9 meteorological sites across Jamaica (Source: Meteorological Service of Jamaica)

4.1.4.2. Rainfall

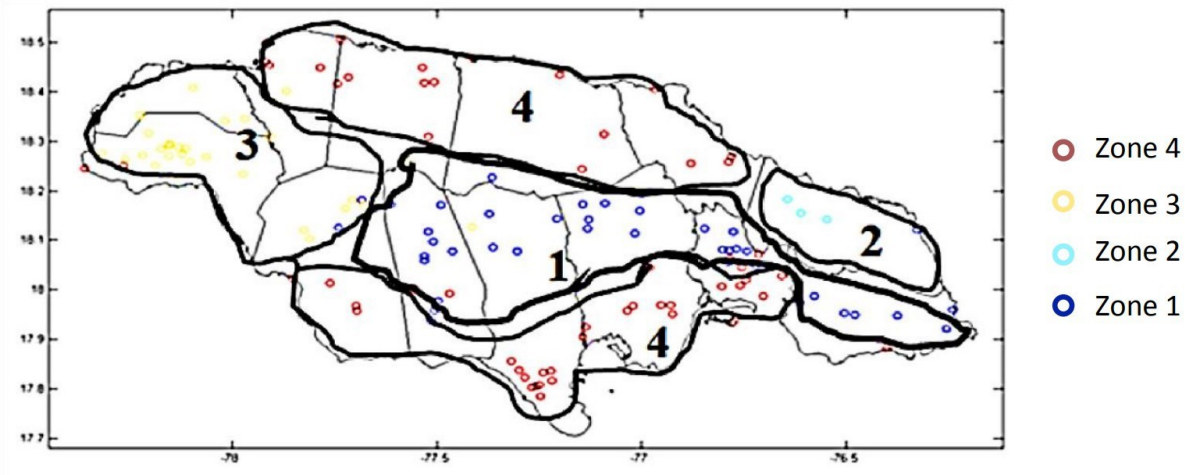


Figure 4-11: Jamaica Rainfall Zones (Source: Meteorological Service of Jamaica)

The project falls in the coastal zone (zone 4), which has an early seasonal peak of rainfall in May, and a late season peak, and mid-summer minimum, a month earlier than the all island average in September and June respectively. The coastal zones are also the driest of all the zones.

4.1.4.3. Wind

The project is located in a low, to relatively low wind velocity zone, with a maximum average velocity of 5 m/s as demonstrated in Figure 4-12.

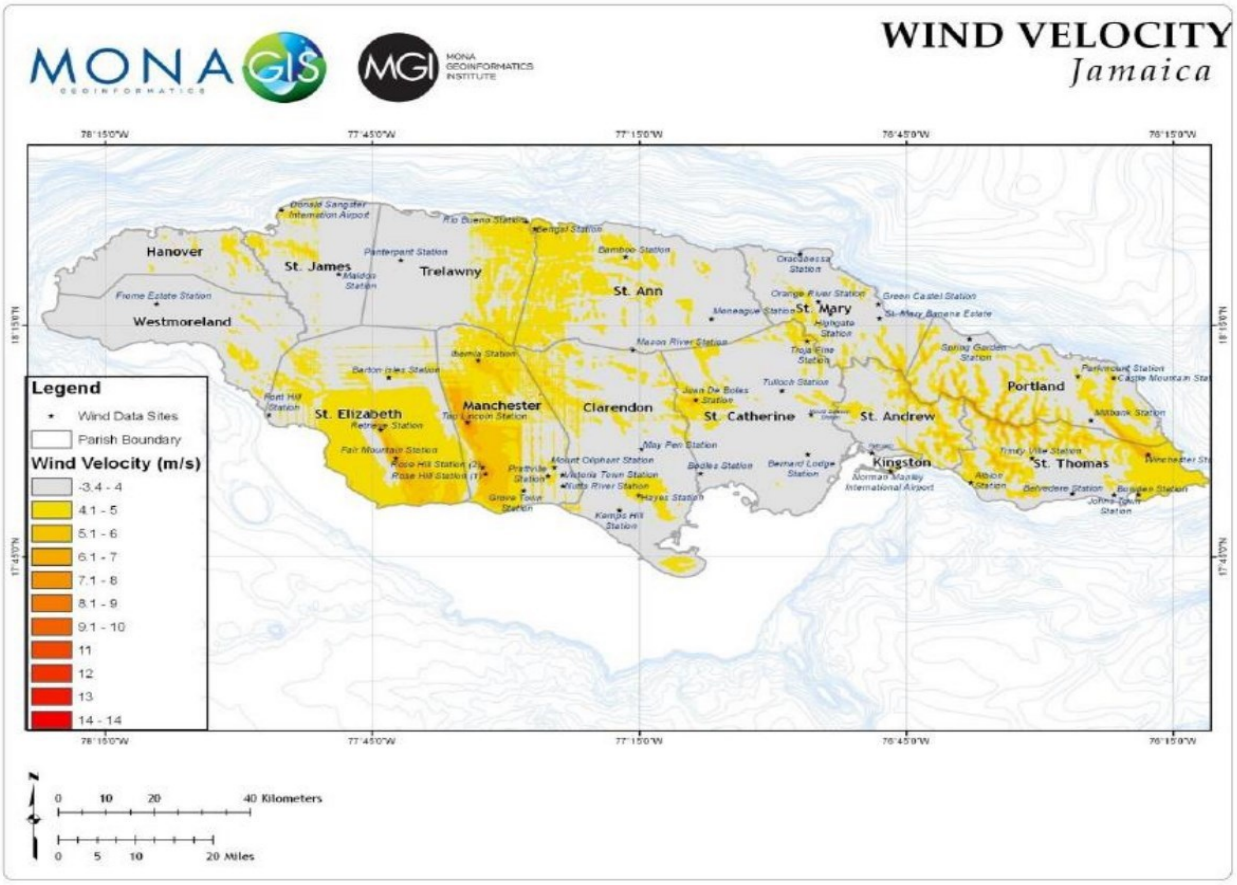


Figure 4-12: Variation of wind speeds across Jamaica (Source: Mona GeoInformatics Institute)

4.1.5. Climate Change

Jamaica, like the rest of the world, has been experiencing a warming trend, with mean temperatures increasing between 1900-2019 by 0.16°C per decade. Temperature increases have been noted across all seasons of the year, with warm nights increasing more rapidly than warm days. However, coastal regions have shown slightly smaller increases in temperature than interior regions.

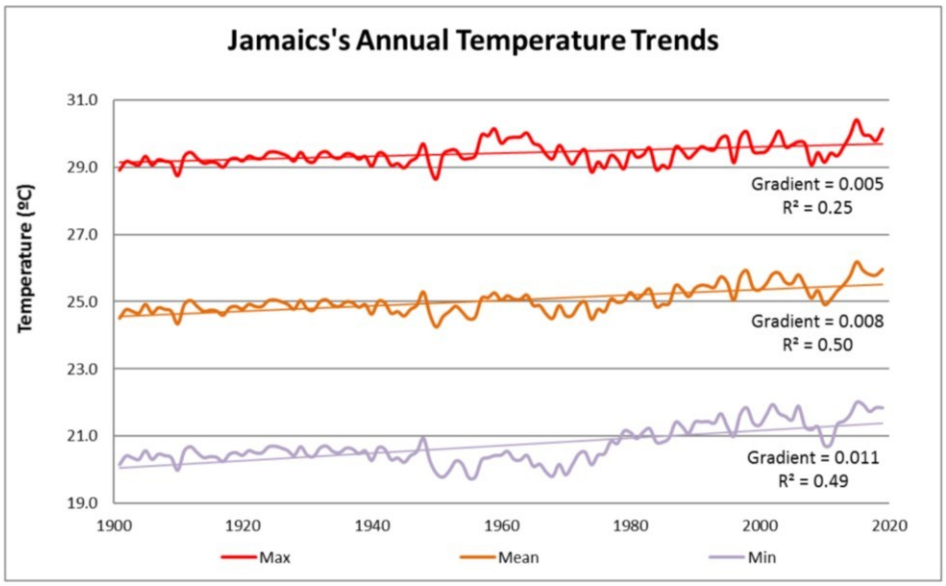


Figure 4-13: Annual maximum, minimum, and mean temperatures for Jamaica, 1900-2019 (Source: Jamaica Climate 2019)

Global Climate Model projections suggest that the 2030s will be up to 4% drier, the 2050s up to 9% drier, while by the end of the century the country as a whole may be up to 21% drier with respect to a 1986-2005 baseline. However, there is spatial variation noted, with the southern and eastern parts of the country tending to show greater decreases as compared the northern (where the project is located) and western ends of the country (Climate Change Group, 2020).

For Jamaica, the projected mean sea level rise for the north coast is 0.58 - 0.87 m by the end of the century, while the maximum rise is projected to be 1.04 m (*ibid*). This information should be used to inform any future development plans of the CHEC property along the coastline currently or in the future.

It is anticipated that there will be no change or slight decrease in the frequency of hurricanes, but there may be an increase in the strength of the storms by the end of the century. Intensity of storms is projected to increase by 2% to 11% with a shift in distribution toward greater wind speeds and potential damages, requiring the project design to consider these anticipated changes.

Jamaica is likely to undergo both a drying and warming trend. Based on this, the island is expected to endure more frequent droughts, rainfall with increased intensity, and rising sea levels. Prolonged rainfall events of more than two days have been associated with 67% of severe flooding events (46% of these were from hurricanes and tropical depressions) (State of the Jamaican Climate, 2019). Any instance of extreme rainfall can cause flooding, requiring the drainage design for this project to consider these anticipated future changes.

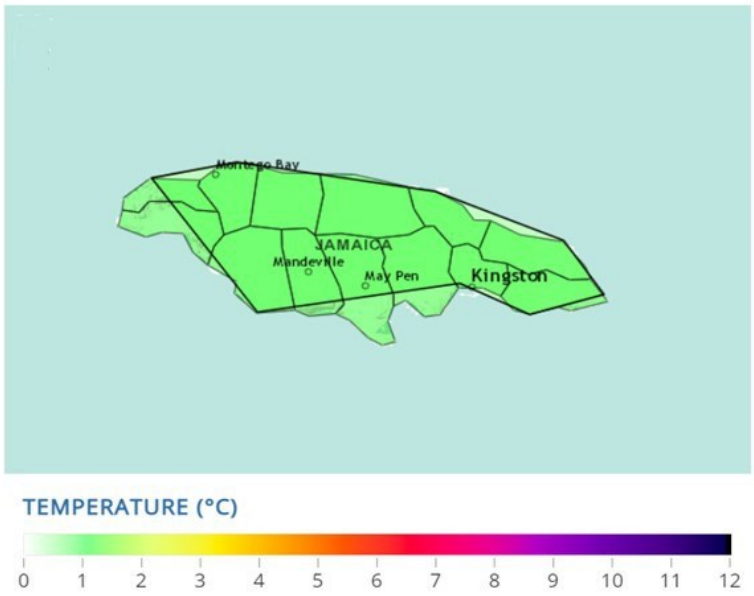


Figure 4-14: Projected Mean-Temperature Anomaly for 2020-2039 (Annual) (Ref. Period 1995-2014) (Source: World Bank, 2023)

4.1.6. Air Quality

Air quality assessments were conducted at nine (9) locations within or at the boundaries of the proposed project location, as well as at areas identified as possible sensitive receptors. The air quality assessment and noise survey locations are identified in Figure 4-15. Please see Appendix U for information on the sampling equipment used during this exercise.

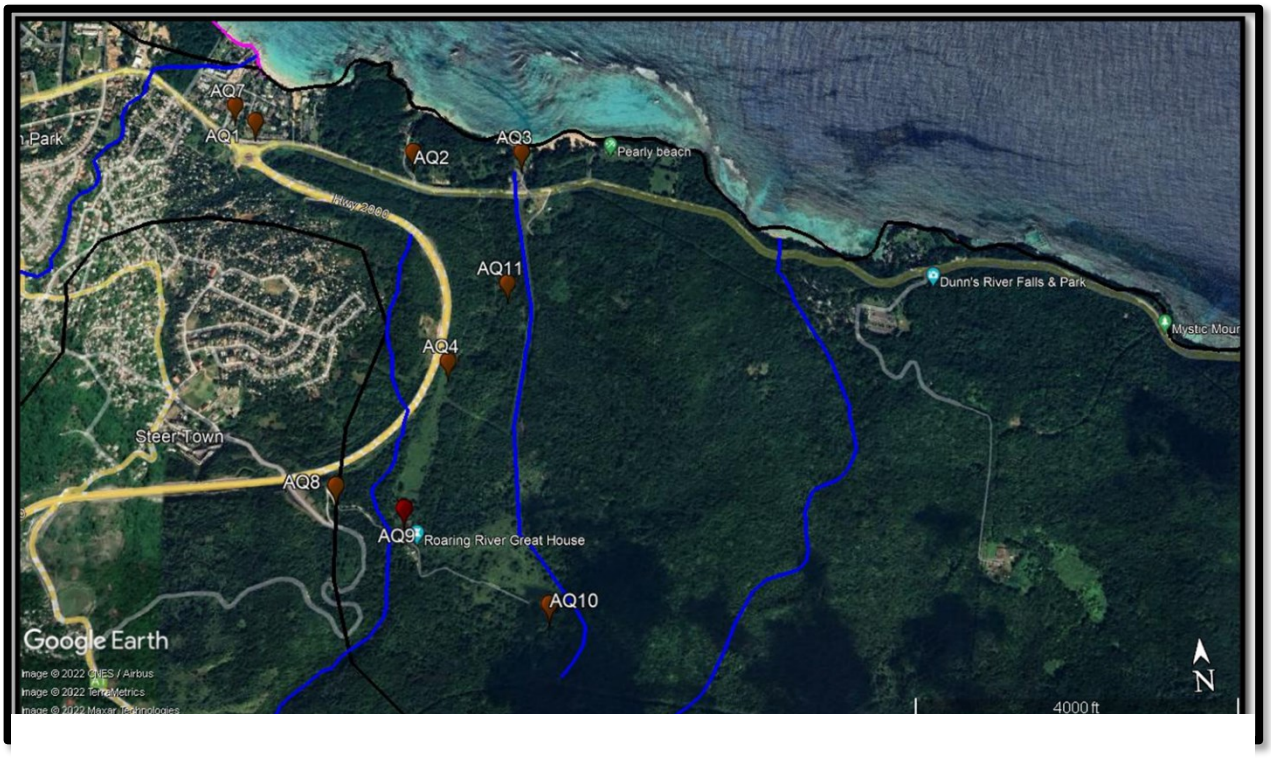


Figure 4-15: Air Quality Assessment and Noise Survey Location

Based on the information obtained from the Meteorological Station of Jamaica, prevailing wind directions in the area for the period 2021 to 2022 originate from ENE, S and SSW which are predominantly characterised as being light winds between 3 and 6 knots (see Figure 4-16). Given this information, communities located to the north and south-west of the proposed project area are likely to experience the greatest impact as it pertains to the activities of the proposed development especially during the construction phase of the project.

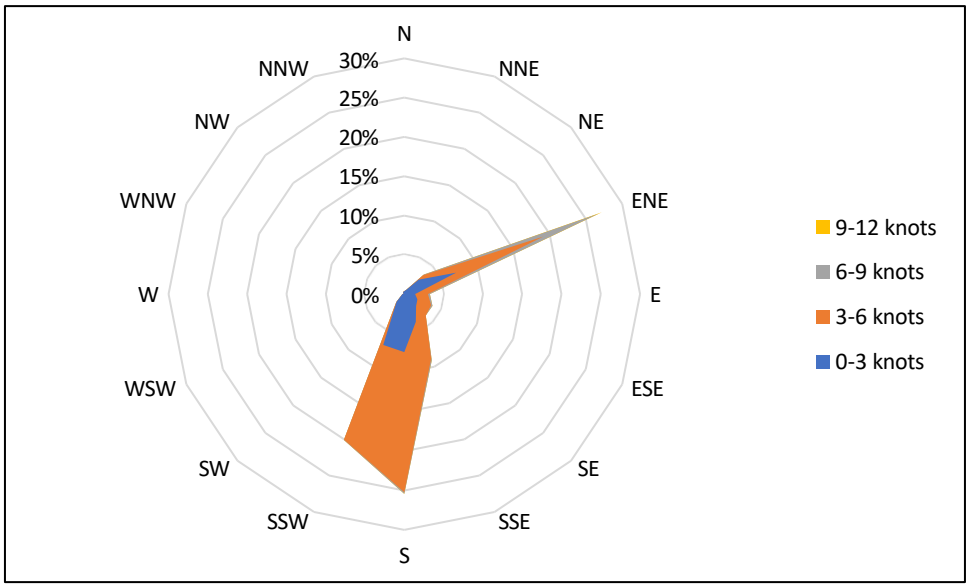


Figure 4-16: Windrose showing Prevailing Wind Directions in the Area (Generated from the Dunn's River Automatic Weather Station (AWS))

For the air quality assessment conducted in October 2022, all PM_{10} measurements were below the 24-hour standard as stipulated by the Ambient Air Quality Standard Regulations for Jamaica and the US EPA (see Table 4-5) of 150 ugm^{-3}. The PM_{10} data ranged from 1.4 ugm^{-3} (Site 1) at the north-western end of the proposed project boundary to 62.3 ugm^{-3} (Site 3) at the Laughing Waters Villa (see Table 4-6). It must be noted that rainfall was experienced in the general area after the pumps were set up which may result in lower concentrations of the assessed air quality parameter. A description of the air quality locations is presented in Appendix Q.

Table 4-5: PM10 Measurements for Air Quality Assessment Conducted in October 2022

LOCATION	PM_{10} Concentration (μgm^{-3} / 24 hr)*
Site 1	1.4
Site 2	3.5
Site 3	62.3
Site 4	60.1
Site 7	5.6
Site 8	6.9
Site 9	9.7
Site 10	5.6
Site 11	12.7

Site 3 was situated directly west of the entrance (which had a security check point) of the Laughing Waters

Villa, east of the Roaring River Hydroelectric Plant and 200 ft away from the busy main A1 Road. Although this sampling station was located at a relatively far distance from the busy main A1 Road, it was located downwind of this main road, unencumbered by trees, and as such may be affected by the particulates produced by the vehicular traffic of this road. Additionally, several cars were observed at the villa itself. If vehicles were traversing in and out of this villa, this could have also impacted the PM_{10} results at this location, especially if there was a delay or wait period at the security post. Site 4, although located in the proposed project area, was located about 100ft to the east of the busy Highway 2000. This area of the sampling site was a less densely vegetated area as compared to the general site location and sections of the highway could be seen from this location suggesting that the particulate matter recorded could be mainly due to vehicular exhausts and emissions. This site could also be noted as being downwind of certain sections of the highway once the wind blows from the SSW direction. It was anticipated that site 1 would also exhibit similar PM_{10} concentrations as compared to those obtained from sites 3 & 4 given its close proximity to the busy A1 Road, however, this was not observed.

Low PM_{10} concentrations as seen at the other sampling locations were expected given their close proximity to densely vegetated areas or being bordered by a dense layer of trees (as seen in the case of site 7). Heavily vegetated areas will act as a buffer of PM_{10} levels in an area as trees and plants act as natural filters and collect particulate matter.

Table 4-6: PM10 Measurements for Air Quality Assessment Conducted between January 31 & February 1, 2023

LOCATION	PM_{10} Concentration (μgm^{-3} / 24 hr)*
Site 1	35.0
Site 2	2.9
Site 3	33.4
Site 4	37.2
Site 7	51.4
Site 8	23.7
Site 9	2.2
Site 10	21.1
Site 11	14.1

Table 4-6 above provides the results for the assessment carried out between January 31, 2023, and February 1, 2023 (during the dry season). There was light rainfall experienced during the sampling session which may impact the level of particulate matter in the area.

Based on the data obtained, there was an increase seen in the particulate matter concentration at sites 1, 7, 8, 9 and 10, whereas there was a decrease seen at sites 3 & 4 and minimal increase/decrease at sites 2 and 11 as compared to those seen in the wet season (see Figure 4-17). All sites where an increase was seen in the particulate matter concentration were located close to roadways, and as such may be influenced by traffic directly or indirectly.

As mentioned previously, rainwater can 'wash out' particulate matter from the air which may result in a lower particulate matter concentration. Important to note as well is that consistent rainfall can also help to prevent the resuspension of particulate matter. Although rainfall was observed during both exercises, heavier rainfall was experienced during the October 2022 exercise which may have been more effective

at reducing the particulate matter in the environment. This may explain the elevated levels of PM_{10} seen at sites 1, 7, 8, 9 and 10. Furthermore, the location of the pump for site 7 was changed in the dry season sampling exercise due to the accessibility of the original sampling location. This pump was placed at the security post of Old Fort Bay, rather than within a residential yard, which would have increased the influence of traffic from a main road at this sampling location.

The decrease observed at sites 3 and 4 could be as a result of the traffic flow during this sampling exercise. Nonetheless, all sampling points for the dry season (January/ February 2023) were compliant with the 24-hour standard as stipulated by the Ambient Air Quality Standard Regulations for Jamaica and the US EPA of 150 ugm^{-3}. As with the wet season assessment, the higher PM_{10} concentrations were observed where sampling points were closer to roadways and the lower PM_{10} concentrations were in areas that were more vegetated.

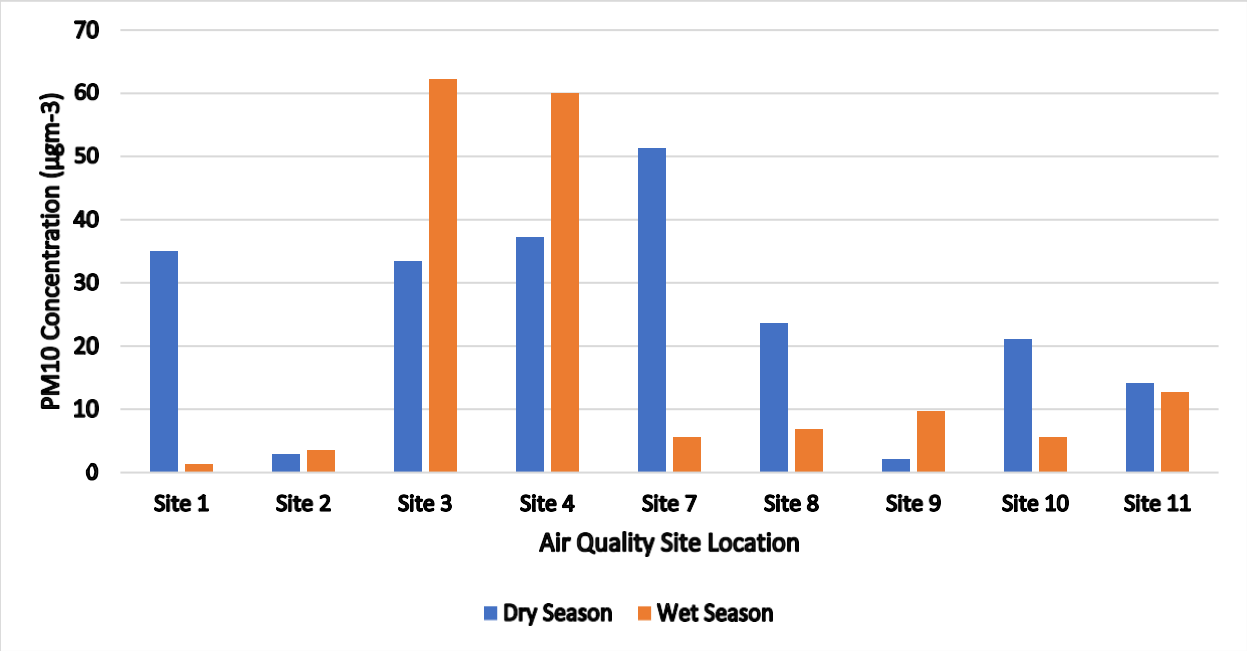


Figure 4-17: Comparison of Particulate Matter Concentrations obtained in Both Seasons

The elevated levels of PM_{10} seen at sites less vegetated and located close to main roads point to a possible increased risk of exposure once the traffic through the area is increased with the proposed development (as there will be an increase in cars and other vehicles), as well as the clearing of the vegetation seen in this area in both the construction and operational phases of the development. The emissions from and operations of vehicles are sources of $PM_{10.}$ The emissions from vehicles which are not properly maintained are expected to be much higher than vehicles which are maintained. Poorly maintained vehicles will have increased inefficiencies in the operations of their engines resulting in the incomplete combustion of fuels and hence the emissions of larger concentrations of fine particulates.

4.1.7. Noise

Daytime noise surveys were conducted at the same locations as where the air quality was assessed The average noise levels ranged from a low of 52.6 (site 11) to a high of 64.4 (site 4) during the noise survey in October 2022 (see Table 4-7), whereas, it ranged from a low of 49.0 (site 11) to a high of 68.1 (site 4) during the dry season assessment (see *Table 4-8*). The average level of noise for all sites exceeded that of the noise standard for residential areas of 55 dBA except for that seen at site 11 in the wet season sampling exercise (October 2022) and for sites 8, 10 and 11 in the dry season exercise.

It must be noted however, that only one survey was conducted for site 11 in the wet season due to rainfall experienced in the area on Day 1 of the sampling survey. For all survey sites except for site 10, noise levels could be attributed to vehicular sounds where at site 10 noise levels could be attributed to natural sounds from nearby streams and fauna (see Appendix R).

Table 4-7: Noise Levels obtained for Each Survey Location (October 2022)

Location	Noise Level (dBA)					NEPA Ambient Noise Standard (dBA) for Residential Areas
	Day 1	Average Noise Level (dBA)	Day 2	Average Noise Level (dBA)	Average Noise Level for each Location (dBA)	
Site 1	59.0		56.9		**57.9**	
Site 2	62.3		65.7		**64.0**	
Site 3	61.0		61.5		**61.2**	
Site 4	72.1		56.6		**64.4**	
Site 7	69.2	**61.0**	59.1	**59.9**	**64.2**	**55**
Site 8	52.7		59.3		**56.0**	
Site 9	53.4		66.8		**60.1**	
Site 10	58.4		60.9		**59.6**	
Site 11	-		52.6		**52.6**	

Table 4-8: Noise Levels obtained for Each Survey Location (January and February 2023)

Location	Noise Level (dBA)					NEPA Ambient Noise Standard (dBA) for Residential Areas
	Day 1	Average Noise Level (dBA)	Day 2	Average Noise Level (dBA)	Average Noise Level for each Location (dBA)	
Site 1	58.0		64.3		**61.2**	
Site 2	62.0		60.8		**61.4**	
Site 3	61.2		67.4		**64.3**	
Site 4	66.4		69.8		**68.1**	
Site 7	58.0	**56.9**	54.9	**59.6**	**56.5**	**55**
Site 8	50.6		53.0		**51.8**	
Site 9	51.1		64.6		**57.9**	
Site 10	54.4		54.1		**54.3**	
Site 11	50.2		47.7		**49.0**	

It should be noted that additional sources of noise will be introduced to the areas during the project's construction and operational phases through increased traffic and use of equipment, however, by implementing the recommended mitigative measures (see section 8), it is expected that the negative impacts that may arise would either be reduced or would be minimal.

4.1.8. Water Quality

Water quality assessments were conducted to determine the existing water quality for specified parameters along the streams and marine environment that the housing development may have an impact on. These assessments were also used to identify and assess current impacts to these waterways. Six (6) grab water samples were collected from freshwater surface waters upstream, within the proposed project vicinity and downstream of the proposed project development area. Four (4) to five (5) grab water samples were collected from the marine water environment that these freshwater surface water samples may drain into or have an impact on. Parameters analysed include:

Table 4-9: Parameters Analysed for the Water Quality Sampling Exercise

Freshwater Samples	
pH (pH units)	Dissolved Oxygen (mg O_2/L)
Conductivity (mS/cm)	Salinity (ppt)
Total Dissolved Solids (mg/L)	Biochemical Oxygen Demand (mg O_2/L)
Faecal Coliform (MPN/100mL)	Nitrate (mg NO_3^-)
Orthophosphates (mg PO_4^{3-})	Total Suspended Solids (mg/L)
Fats, Oil and Grease (mg/L)	
Marine Water Samples	
pH (pH units)	Dissolved Oxygen (mg O_2/L)
Conductivity (mS/cm)	Salinity (ppt)
Total Dissolved Solids (mg/L)	Biochemical Oxygen Demand (mg O_2/L)
Faecal Coliform (MPN/100mL)	Nitrate (mg NO_3^-)
Total Coliform (MPN/100mL)	Enterococci (MPN/100mL)
Fats, Oil and Grease (mg/L)	Orthophosphates (mg PO_4^{3-})

4.1.8.1. Freshwater Quality Assessment

Freshwater samples were collected from the Little River, the Roaring River and/or tributaries of these main rivers (see Figure 4-18). As mentioned in the Hydrology and Drainage section of the report, the proposed project location is within the White River Sub-Watershed Management Unit of the Dry Harbour Mountain Hydrologic Basin. Based on the location of the sampling site, as well as the water quality of the closest river to the sampling site– the Dunn's River (see Figure 4-19) – it is assumed that the water quality of the sites sampled would also be of a similar nature to the Dunn's River which was classified as excellent/ high quality for all parameters tested[8] The rivers in this hydrologic basin are typically small in length and

[8] https://www.wra.gov.jm/wp-content/uploads/2020/06/WRA-Water-Quality-Atlas-2019.pdf

generally rise less than 10 km from the coast[9] as shown in Figure 4-19 below.

1.1.1.1.1 October 2022 Freshwater Assessment

BOD value seen for WQ1. Values that exceeded or were not compliant with this standard are coloured red in Table 4-10.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen consumed by microorganisms as they break down organic matter in a water body. Sources of BOD in a natural water body can include anthropogenic sources such as improperly treated wastewater or natural sources such as soils, leaves and woody debris, dead plants and animals or faecal waste from animals that may use or live nearby to these waters.[10]

As mentioned in Table 14-4 of Appendix S the sample collected from this area was noted as being 'faint yellow and clear'. This colour may come about as a result of naturally dissolved organic compounds known as tannins which are formed when plant material is slowly broken down. This stream runs through a densely vegetated area. This coupled with the fact that plant material in a water body can be a source of BOD in natural waters could possibly explain why there was a higher BOD at this location as compared to the other sampling areas.

Additionally, this sampling area had a higher faecal coliform level (>1600 MPN/100mL) as compared to the other sampling locations which ranged from 13-540 MPN/100mL. Although there is no direct relationship between feacal coliforms and biochemical oxygen demand, higher levels of feacal coliforms do suggest that the water has been recently contaminated by a greater amount of faecal matter from human or animal sources which may also contribute to the BOD seen in a sample. This sampling area was about 15ft south (upstream) of the roadway that leads to the proposed project area and the Roaring River Greathouse; its close proximity to an area that may be impacted by consistent human activities and the presence of domestic pets coupled with the low volume of water in this area may explain the high faecal levels seen at this site. In addition, this sampling area may be a natural drainage point from areas upstream of the sampling location; this means that run-off from the surrounding area may impact the water quality at this location.

Based on earlier site reconnaissance activities, there is evidence of human interactions with these water bodies (e.g., domestic litter, clothing articles and pathways built to cross water bodies). This was also confirmed by the security on the property who informed the team that the rivers on the property and surrounding area are used for recreational purposes. As such, it will be imperative for the housing development (proposed to be constructed) to have a proper waste(water) management program as any activity from the proposed development area may have an impact on the level of and surface water run-off faecal coliform that may be inputted into these freshwater sources especially those river systems downstream of said development.

All sampling areas exhibited low concentrations of fats, oil, and grease (FOG) which ranged from <1 mg/L to 4 mg/L. FOG refers to the substances that are generally immiscible in water and that are commonly used in industrial or daily activities such as cooking and washing. Although no standard exists for the levels

[9] https://www.sam.usace.army.mil/Portals/46/docs/military/engineering/docs/WRA/Jamaica/Jamaica%20WRA%20-%20English.pdf

[10] https://archive.epa.gov/water/archive/web/html/vms52.html

of fats, oil and grease that should be present in a natural water source, the USEPA recommends that surface waters be virtually free from floating oils of both non-petroleum and petroleum nature.[11] During

the assessment, there was no film or sheen observed on the water surfaces of the sampled areas complying with this recommendation from the USEPA.

It must be noted that FOG in natural water bodies is primarily associated with anthropogenic sources; as such, proper waste(water) management at the proposed development area will be crucial to maintain the integrity of the waterways as it relates to this parameter. The sampling area with the highest level of FOG, was at site WQ7 which was taken at a culvert. The road above the culvert is used to access the northern side of the property and other residential homes. It is assumed that day-to-day activities or activities from car maintenance and use may contribute to the FOG concentration detected at this location.

The total suspended solids (TSS) at all locations were relatively low with values that ranged from a minimum of <1.6 mg/L to a high of 7.0 mg/L. The highest TSS values were observed at sites WQ2 (5.5 mg/L) and WQ4 (7.0 mg/L) where the dams for the pipeline and hydroelectric farms are located. The samples collected at these locations appeared slightly cloudy with suspended particles.

The impoundment at WQ 2 and 4 sampling locations may retain sediments as the depth of water is greater and the flow of the water is slower at these locations as compared to the natural water bodies observed. However, additional studies will need to be done to determine if this phenomenon (retention of sediments due to dammed area) occurs at these locations.

The nitrates and phosphate concentrations obtained at all locations were within the specifications of the Draft Jamaica National Ambient Water Quality Standard – Freshwater, 2009 as mentioned earlier. Nitrate concentrations ranged from a minimum of <1.3 mg/L to a maximum of 1.8 mg/L while phosphate concentrations ranged from a minimum of <0.02 mg/L to a maximum of 0.04 mg/L. Differences observed between the nutrient concentrations at the various locations are not practically significant as all nutrient concentrations fall within the standard used to assess the freshwater quality at levels that may be due to random effects of the test method used or the natural environment.

There were no statistical outliers of the *in-situ* data set (pH, DO, conductivity, TDS, and salinity) when compared among each other suggesting a similarity in the source and/ or inputs to these water bodies. Although there were no statistical outliers of the data set, it was observed that site WQ7 had a higher pH (8.27) as compared to the other samples which ranged from 7.64 pH units to 7.99 pH units. As site WQ7 may be a culvert that drains stormwater and rivulets off the site, the increase in pH at this location suggests that there may be an input to the water not characterised . It may be useful to have a river tracing exercise to determine the pathway and channel of each river to gain a better understanding of the flow of the water and to provide a more concrete assessment of any possible impacts to and from the development as it relates to water quality. Whereas the pH seen at this location is still within the standard for freshwater samples in Jamaica, pH needs to be maintained at a level optimal for the biochemical reactions that will occur in an aquatic ecosystem and can have an impact of the type of species found in that water body.

[11] https://www.epa.gov/sites/default/files/2018-10/documents/quality-criteria-water-1976.pdf

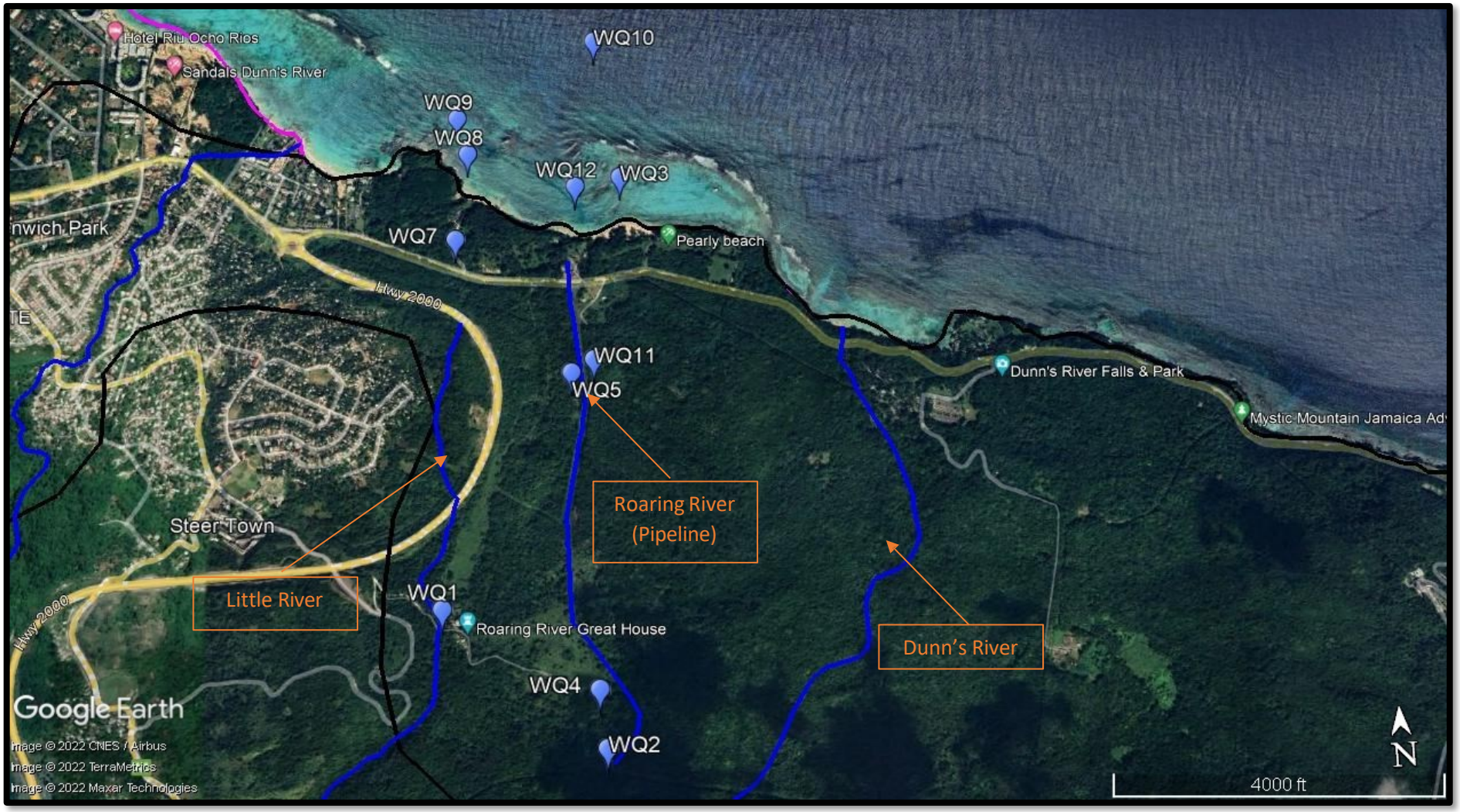


Figure 4-18: Identification of Major Rivers in the Vicinity of the Proposed Project Area

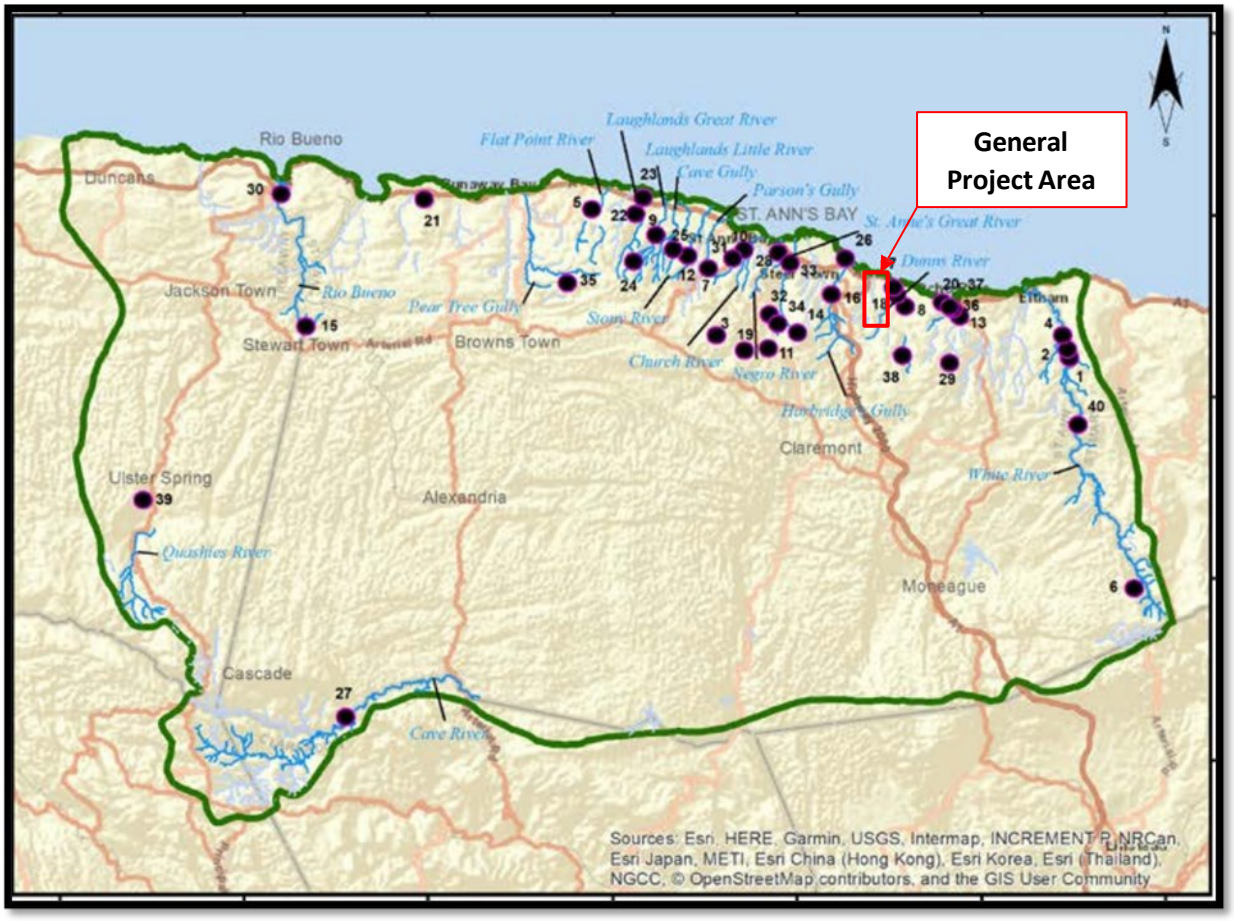


Figure 4-19: Locations of Surface (Freshwaters) Locations sampled by the WRA in the Dry Harbour Mountains Hydrologic Basin in Comparison to Proposed Project Area

Table 4-10: Results of the Freshwater Assessment (October 2022)

Parameter (Units)	WQ1	WQ2	WQ4	WQ5	WQ7	WQ11	NRCA Ambient Water Standard – Freshwater
pH (pH units)	7.84 @ 23.7ºC	7.64 @ 22.6ºC	7.66 @ 22.7ºC	7.70 @ 23.6ºC	8.27 @ 24.8ºC	7.99 @ 24.7ºC	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	7.00 @ 23.7ºC	7.60 @ 22.6ºC	6.80 @ 22.7ºC	6.32 @ 23.6ºC	6.93 @ 24.8ºC	6.40 @ 24.7ºC	-
Conductivity (mS/cm)	407 @ 23.7ºC	330 @ 22.6ºC	331 @ 22.7ºC	312 @ 23.6ºC	348 @ 24.8ºC	380 @ 24.7ºC	**150.0-600**
Salinity (ppt)	0.20 @ 23.7ºC	0.16 @ 22.6ºC	0.17 @ 22.7ºC	0.15 @ 23.6ºC	0.17 @ 24.8ºC	0.18 @ 24.7ºC	-
Total Dissolved Solids (mg/L)	270.40 @ 23.7ºC	224.90 @ 22.6ºC	225.55 @ 22.7ºC	208.65 @ 23.6ºC	227.50 @ 24.8ºC	248.30 @ 24.7ºC	**120.0-300**
Nitrate (mg NO_3^-/L)	1.6	<1.3	<1.3	1.3	1.8	<1.3	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)	0.4	<0.3	<0.3	0.3	0.4	<0.3	-
Orthophosphate (mg PO_4^{3-}/L)	0.02	<0.02	0.04	<0.02	<0.02	0.02	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}P /L)	0.01	<0.01	0.01	<0.01	<0.01	0.01	
Faecal Coliform (MPN/100ml)	>1600	13	33	110	94	540	-
Total Suspended Solids (mg/L)	2.0	5.5	7.0	1.9	2.8	<1.6	-
Biochemical Oxygen Demand (mg O_2/L)	2.9	1.3	1.6	1.6	1.3	1.1	**0.8-1.7**
Fats, Oil & Grease (mg/L)	<1	2	<1	<1	4	<1	-

Similar to the pH, there were no statistical outliers for the total dissolved solids (TDS) levels seen in the water bodies. However, it was observed the TDS at site WQ1 (270.00 mg/L) was higher than that of the other water samples which ranged from 208.65 mg/L – 248.30 mg/L. TDS values consist of parameters which account for the dissolved ions in solution (e.g., Na+, Cl-, OH-, CO3- etc.) and can be impacted by the volume of water present in a water body. It was noted that this stream had a rocky bottom and passed through a well vegetated area. The decay of vegetation can release compounds which contribute to TDS. A more detailed investigation will have to be done to ascertain the reason(s) for the elevated TDS concentration at this location. Although no standard exists for salinity, it is a function derived from conductivity. Therefore, it can be assumed that once the conductivity of the water quality point is within the specifications of the reported standard, then the salinity of that point would also be typical of a freshwater in the Jamaican context. Freshwaters are typically characterised as having salinities of less than 0.5 ppt. As such, all samples collected can be considered of a freshwater nature.

Dissolved oxygen (DO) is an important indicator of the quality of water as it is a necessity for the biological and chemical processes of both plants and animals. A healthy water body is generally characterised on as one that contains a dissolved oxygen concentration above 6.5 mg/L[12], whereas a dissolved oxygen level above 6.0 mg/L is necessary for the support of aquatic life.[13] All locations sampled met or exceeded the level needed to support the functioning of aquatic life.

1.1.1.1.2 January 2023 Freshwater Assessment

Based on the information obtained for the January 2023 sampling exercise, all parameters sampled were compliant with the Draft Jamaica National Ambient Water Quality Standard – Freshwater, 2009 (see Table 4-11).

For parameters assessed where a standard value was not present (e.g., DO, FOG etc.), the values were typical of those for a healthy freshwater system. For example, as described in the paragraph above, DO levels above 6.5 mg/L are generally classified as health water systems. All samples collected exhibited dissolved oxygen levels above this value.

All sampling areas also exhibited low concentrations of fats, oil and grease (FOG) which ranged from <1 mg/L to 4 mg/L and had no floating oils on the surface of these waters indicating the general good quality of these water bodies at the time of the sampling activity. Site WQ2 exhibited the highest levels of FOG (4 ppm) for this sampling assessment which could be due to the use of the water for recreational activities as seen in earlier site visits. Similarly, all sampling sites exhibited relatively low levels of total suspended solids with the highest levels being detected at the impoundment sites (WQ2 and WQ4) and at the culvert (WQ7) which may be impacted by activities from the major roadway located towards the south of the waterway.

1.1.1.1.3 Summary of Results and Comparison to Existing Data

Based on the parameters assessed for both seasons, the general water quality in the vicinity of the proposed project location was of good quality and generally complied with the values highlighted in the Draft Jamaica National Ambient Water Quality Standard – Freshwater, 2009 or with typical levels seen in a freshwater system at the time of the sampling activity. A robust monitoring plan should be implemented to ensure that the activities introduced in the area do not impact these water systems negatively. It should be taken into consideration, however, that the data presented is representative of two sampling exercises.

[12] https://www.enr.gov.nt.ca/sites/enr/files/dissolved_oxygen.pdf

[13] http://www.cotf.edu/ete/modules/waterq3/WQassess3f.html

The WRA had also collected samples between the period of April 2016 and September 2020 at what is referred to as the 'Roaring River nr Ocho Rios'. Based on the information received form the WRA (See Appendix T), the average pH and conductivity obtained during the wet season was 7.86 pH units and 378 mS/cm respectively whereas the average pH and conductivity obtained during the dry season was 7.84 pH units and 407 mS/cm respectively. Both parameters were compliant with the standard applied to freshwater systems as seen from the wet and dry season data obtained which was consistent with the data obtained from the October 2022 and January 2023 sampling exercises.

Table 4-11: Results of the Freshwater Assessment (January 2023)

Parameter (Units)	WQ1	WQ2	WQ4	WQ5	WQ7	WQ11	NRCA Ambient Water Standard – Freshwater
pH (pH units)	7.27 @ 23.1ºC	7.67 @ 22.4ºC	7.72 @ 22.4ºC	7.74 @ 23.4ºC	7.46 @ 23.5ºC	7.79 @ 23.0ºC	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	7.43 @ 23.1ºC	8.02 @ 22.4ºC	7.25 @ 22.4ºC	7.71 @ 23.4ºC	8.33 @ 23.5ºC	8.30 @ 23.0ºC	**-**
Conductivity (mS/cm)	417 @ 23.1ºC	360 @ 22.4ºC	360 @ 22.4ºC	401 @ 23.4ºC	356 @ 23.5ºC	351 @ 23.0ºC	**150.0-600**
Salinity (ppt)	0.21 @ 23.1ºC	0.18 @ 22.4ºC	0.18 @ 22.4ºC	0.20 @ 23.4ºC	0.17 @ 23.5ºC	0.17 @ 23.0ºC	**-**
Total Dissolved Solids (mg/L)	281.45 @ 23.1ºC	246.70 @ 22.4ºC	246.35 @ 22.4ºC	269.10 @ 23.4ºC	237.90 @ 23.5ºC	237.26 @ 23.0ºC	**120.0-300**
Nitrate (mg NO_3^-/L)	1.8	4.0	3.1	1.3	2.0	2.2	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)	0.4	0.9	0.7	0.3	0.4	0.5	**-**
Orthophosphate (mg PO_4^{3-}/L)	0.03	0.04	0.06	0.04	0.04	0.03	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}P /L)	0.01	0.01	0.02	0.01	0.01	0.01	**-**
Faecal Coliform (MPN/100ml)	240	7.8	33	6.8	49	79	**-**
Total Suspended Solids (mg/L)	<1.6	3.2	2.5	<1.6	5.7	<1.6	**-**
Biochemical Oxygen Demand (mg O_2/L)	0.8	0.5	0.7	1.0	0.5	1.0	**0.8-1.7**
Fats, Oil & Grease (mg/L)	<1	4	<1	<1	<1	<1	**-**

4.1.8.2. Marine Water Quality Assessment

The Mammee Bay marine environs, stretching from the east of the Old Fort Bay to Crab Key/ Pearly Beach, was also assessed as a part of the water quality assessment. The descriptions of each sampling location are presented in Appendix S.

4.1.8.1.1 October 2022 Marine Water Assessment

From the sampling activity, it was seen that the marine water samples were non-compliant for pH, nitrates and the microbial parameters, total coliform and faecal coliform, (as compared to the Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009) at two or more sites sampled from during the wet season (October 2022) sampling activity (see Table 4-12). Although these values were non-compliant with the marine water standard, water along the coast in St. Ann, is influenced by streams and/or submarine springs supplied by groundwater seepage[14]. At the sampling location, it was clearly seen where there were various freshwater inputs (e.g., the Laughing Waters River Mouth) into the bay area which may account for the non-compliant pH, nitrate and microbial values seen. As freshwater is less dense than seawater, until both waters are mixed properly, freshwaters will remain at the surface while the denser sea water will remain below. The two distinct layers of water were observed at all the marine sampling points except WQ10 during the wet season sampling activity.

Freshwaters should fall within a pH range of 7.00 and 8.40 pH units based on the NRCA Standard for Ambient Freshwater. From the freshwater assessment, it was seen where the pH values of the streams sampled from ranged from a minimum of 7.64 pH units to 8.27 pH units (at the culvert) whereas the marine water pH samples ranged from a minimum of 7.64 pH units to a maximum of 8.09 pH units. The pH of the Laughing Waters River Mouth at the time of the sampling activity was 7.84 pH units whereas the pH at WQ12 (the sampling point ~350ft north of the Laughing Waters River Mouth) was 7.96 pH units suggesting that freshwater inflows are the most likely cause of the pH levels seen in the bay during this sampling assessment.

Similarly, surface waters in Jamaica are often characterised by high total coliform and faecal coliform values seemingly from the lack of proper waste and wastewater management practices among other activities. Faecal coliform levels ranged from a minimum of 13 MPN/100mL to >1600 MPN/100mL in the freshwater samples collected during the sampling assessment which suggests that continuous inflows into the marine environment may also have an impact on the microbial levels in this bay. In addition to the outflows of the river into the marine environment, it has also been noted that stormwaters and rivulets are also channelled into the Mammee Bay environ[15]. Untreated stormwaters can result in the increased runoff of pollutants and other contaminants into the marine water environment and impacts of this can compound over time especially in areas prone to heavy rainfall. Enterococci was observed at all locations where faecal coliform levels exceeded the marine water standard.

Although, faecal coliform levels exceeded the values stipulated in the NRCA marine water standard, the values obtained for both faecal enterococci and coliform were within the values stipulated by the Ministry of Health, Environmental Health Unit Recreational Bathing Water Monitoring Programme Water Quality Guidelines for Coastal and Freshwaters of 40 MPN/100mL and 100 MPN/100ml respectively. This indicates that the water in this bay is suitable for recreational use at the time of the assessment. However, it must be noted that eating fish or shellfish harvested from waters with high levels of faecal contamination (which

[14] https://iwlearn.net/resolveuid/1540b56ab53b41f397b66cdd529434dc

[15] Mammee River Development Master Plan

both enterococci and faecal coliform are indicators of) can result in human illness.

Nitrate values ranged from a low of 0.02 mgNO3—N/L to a high of 0.11 mg NO3—N/L (at site WQ12). As mentioned before site WQ12 was taken directly north of the Laughing Waters River Mouth. Nitrate concentrations in freshwater samples as typically characterised as being between 0.1 and 7.5 mgNO3—N. It is possible that the high concentration of nitrates seen at this site could have been influenced by the freshwater inflow at this location. The nitrate values seen at all other locations could have been also influenced by freshwater inflows where the seawater dilution effect reduced the concentrations at all other locations. It should be noted that not all freshwater inflows into the bay were assessed.

The marine water collected in the bay was compliant with the NRCA marine water standard for BOD and phosphate. All the samples collected had low levels of dissolved oxygen that were still typical of coastal areas and salinities between 32 and 33 ppt.

The BOD and phosphate values obtained were typical of seawaters as prescribed by the Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009. The phosphate values were undetectable at each sampling location while BOD values ranged from a low of 0.5 mgO2/L to a high of 0.9 mgO2/L indicating that the oxygen levels in this bay are not being rapidly depleted by the breakdown of organic matter.

The DO concentrations observed at these locations could be due to the temperature of the water at the time of sampling, the salt concentration of the samples as well as the time of day the samples were collected (mid-morning). Dissolved oxygen concentrations in tropical marine water environments can range from 4 – 15 mgO2/L, but typically ranges from 5-8 mgO2/L. Unusual DO levels in coastal areas are typically classified as <3.7 mgO2/L. None of the water samples collected were lower than this concentration.

Salinities of marine water samples generally range from 33 ppt to 38 ppt where the average salinity of seawater worldwide is about 35 ppt. All water samples collected ranged between 32 and 33 ppt further underscoring the fact that the waters in the bay area sampled from may be influenced by freshwater inflows.

Table 4-12: Results of the Marine Water Assessment (October 2022)

Parameter (Units)	WQ3	WQ8	WQ9	WQ10	WQ12	NRCA Ambient Water Standard – Marine Water
pH (pH units)	7.79 @ 30.3ºC	8.09 @ 30.3ºC	7.96 @ 30.1ºC	7.64 @ 30.0ºC	7.96 @ 30.1ºC	**8.00-8.40**
Dissolved Oxygen (mg O_2/L)	4.40 @ 30.3ºC	4.30 @ 30.3ºC	4.33 @ 30.1ºC	4.92 @ 30.0ºC	4.22 @ 30.1ºC	-
Conductivity (mS/cm)	54.9 @ 30.3ºC	55.5 @ 30.3ºC	55.3 @ 30.1ºC	55.4 @ 30.0ºC	55.5 @ 30.1ºC	-
Salinity (ppt)	32.35 @ 30.3ºC	32.88 @ 30.3ºC	32.87 @ 30.1ºC	32.94 @ 30.0ºC	33.01 @ 30.1ºC	-
Total Dissolved Solids (mg/L)	32305 @ 30.3ºC	32760 @ 30.3ºC	32760 @ 30.1ºC	32825 @ 30.0ºC	32890 @ 30.1ºC	-
Nitrate (mg NO_3^-/L)	0.18	0.09	0.09	0.09	0.50	-
Nitrate as Nitrogen (mg NO_3^-N/L)	0.04	0.02	0.02	0.02	0.11	**0.007-0.014-**
Orthophosphate (mg PO_4^{3-}/L)	<0.02	<0.02	<0.02	<0.02	<0.02	-
Orthophosphate as Phosphorus (mg PO_4^{3-}P /L)	<0.01	<0.01	<0.01	<0.01	<0.01	**0.001- 0.003**
Enterococci (MPN/100mL)	11	<1.8	<1.8	2.0	33	-
Total Coliform (MPN/100ml)	1600	23	17	220	920	**2-256**
Faecal Coliform (MPN/100ml)	49	4.5	<1.8	21	33	**<2-13**
Biochemical Oxygen Demand (mg O_2/L)	0.8	0.9	0.7	0.5	0.9	**0.0-1.16**
Fats, Oil & Grease (mg/L)	4	2	4	1	<1	

4.1.8.1.2 February 2023 Marine Water Assessment

During the dry season assessment (February 2023), it was observed that all marine water samples collected were non-compliant for the nutrient parameters, nitrates, and phosphates (see Table 4-13). Whereas the samples exhibited high microbial levels and low pHs (as compared to the Ambient Marine Water Standard) for the wet season assessment, this was not seen in the dry season assessment. The seawater during the dry season sampling activity was extremely turbulent which may have resulted in the greater mixing of the marine water and freshwater inflows. This may explain the difference seen in the dry season assessment as compared to the wet season assessment with respect to pH and the microbial content.

Similarly, the nitrate values in the marine waters collected ranged from 0.02 -0.04 mg NO3—N/L as compared to the previous range of 0.02 -0.11 mg NO3—N/L. Although phosphates were detected in the marine environment, the values ranged from 0.01-0.02 mg PO43—P which is close to the detection limit of the method that was used. It should be noted as well that the volume of water from freshwater inflows into the bay may decrease during the dry season due to reduced rainfall.

The average salinity obtained during the wet season was 32.81 ppt while the average salinity obtained during the dry season was 33.46 ppt (with the exception of WQ8) indicating a slightly higher amount of dissolved solids present in the dry season exercise as compared to the wet season. WQ8 was not included in the determination of the average as it is expected that all sampling points would exhibit similar salinities and the value obtained at this point may have been a result of turbulent water and where the probe was placed. The dissolved oxygen levels in the dry season assessment were greater than those seen in the wet season assessment, but this again may be most likely due to the turbulent waters during the sampling activity.

4.1.8.1.3 Summary of Results

In conclusion, the results obtained from the marine water sampling assessment indicate that the water in this bay may be impacted by freshwater inflows as reflected in the pH, salinity, nitrate, and microbial values obtained from one or both sampling activities. This points to an increased risk to the marine water environment to inflows that may include improperly treated sewage or other waste streams. Although the faecal coliform value at the sites sampled were elevated during the wet season assessment as compared the NRCA marine water standard, both the faecal coliform and enterococci values for all sites were within the guideline stipulated for recreational use by the Ministry of Health indicating the general suitability of the water for bathing purposes. The BOD levels in the water for both sampling exercises were compliant with the NRCA marine water standard. The difference in nutrient values obtained during the wet and dry season may be due to the difference in freshwater inflows into the bay during these seasons.

It must be noted that for the sampling assessment on both the freshwater and marine water samples, the parameters tested include those that would indicate sewage contamination of the waterways as the client may discharge treated sewage. Other pollutants, such as pesticides, if lawn applications are done at the proposed development may also be channeled into both freshwater and marine waterbodies. As such, once maintenance plans and wastewater treatment processes are finalised, monitoring programmes should be tailored to monitor possible outputs from these also.

Table 4-13: Results of the Marine Water Assessment (February 2023)

Parameter (Units)	WQ3	WQ8	WQ10	WQ12	NRCA Ambient Water Standard – Marine Water
pH (pH units)	8.10 @ 23.2 ºC	8.06 @ 24.0ºC	8.09 @ 24.1ºC	8.10 @ 27.1ºC	**8.00-8.40**
Dissolved Oxygen (mg O_2/L)	9.86 @ 27.2 ºC	6.10 @ 26.3ºC	6.15 @ 27.1ºC	7.53 @ 27.1ºC	-
Conductivity (mS/cm)	53.3 @ 27.2 ºC	47.38 @ 26.3ºC	53.4 @ 27.1ºC	53.1 @ 27.1ºC	-
Salinity (ppt)	33.56 @ 27.2 ºC	29.94 @ 26.3ºC	33.34 @ 27.1ºC	33.48 @ 27.1ºC	-
Total Dissolved Solids (mg/L)	33280.00 @ 27.2 ºC	30036.50 @ 26.3ºC	32500.00 @ 27.1ºC	33215.00 @ 27.1ºC	-
Nitrate (mg NO_3^-/L)	0.18	0.09	0.09	0.14	-
Nitrate as Nitrogen (mg NO_3^-N/L)	0.04	0.02	0.02	0.03	**0.007-0.014-**
Orthophosphate (mg PO_4^{3-}/L)	0.05	0.02	0.03	0.04	-
Orthophosphate as Phosphorus (mg PO_4^{3-}P /L)	0.02	0.01	0.01	0.01	**0.001- 0.003**
Enterococci (MPN/100mL)	2.0	7.8	<1.8	1.8	-
Total Coliform (MPN/100ml)	22	79	6.1	23	**2-256**
Faecal Coliform (MPN/100ml)	3.7	1.8	2.0	<1.8	**<2-13**
Biochemical Oxygen Demand (mg O_2/L)	0.6	0.6	0.8	0.2	**0.0-1.16**
Fats, Oil & Grease (mg/L)	<1	<1	<1	<1	

4.2. Biological Environment

4.2.1. Flora

This section entails the results derived from inland vegetation surveys conducted on October 19, 2022. The property for proposed development is an undulating 64.8 ha parcel of land with a mixture of modified secondary woodland found mainly along the perimeter of the property. Along the interior of the property is a relatively narrow strip of grassland where paths have been created to facilitate access to various sections of the property.

Surveys were conducted across the property to account for the varying types of ecological communities that were present. During the survey, notes were taken of the plant species encountered and the land-use types observed. Stops were made at regular intervals to conduct walk-throughs for more thorough investigations. Plant species encountered during the field surveys were identified in-situ or samples collected and taken to the University of the West Indies (UWI) Herbarium for later identification.

Literature by Asprey & Robbins (1953), Adams (1972) and Parker (2003) were also used to assist in plant identification and vegetation classification. The entire sampling process was aided by ArcGIS Field Maps application to capture coordinates of important changes to the landscape within the site boundary.

Figure 4-20: Location of the site boundary within which ecological surveys were conducted

Given the size and varying vegetation communities identified across the site, this report will categorise the major vegetation communities and list the indicative and ecologically important plant species identified during the survey. The field assessment covered the areas towards the north, central and within the region of the Roaring River Great House towards the south of the property but excludes the ornamental vegetation immediately surrounding the Great House. See Appendix L for Tree Survey Report.

A total of 108 plant species were identified, 43 of which are trees, 16 shrubs, 28 herbs, 7 shrubby herbs, and 10 epiphytes and climbers, and 4 fern (see Figure 4-21 below). Together, they made up the primary constituents of the flora assessed. Plants such as *Bidens pilosa* (Spanish Needle), *Desmodium adscendens*

and *Bryophyllum pinnatum* (Leaf-of-Life) were some of the most abundant herb/shrubby-herb species encountered. These species were observed at the forest fringes and across the grasslands where their distribution may have been assisted by passing animals, and persons traversing the property. Ferns were also common in the wetter areas along the river across the northernmost section of the site, with *Nephrolepsis* sp., *Thelypteris sp.* and *Polypodium phyllitidis* (Cow Tongue Fern) thriving in the often shaded and moist conditions present. *Panicum maximum* (Guinea Grass) was common, with *Wedelia trilobata* (Marigold), *Stachytarpheta jamaicensis* (Vervine) occurring mainly on the fringes.

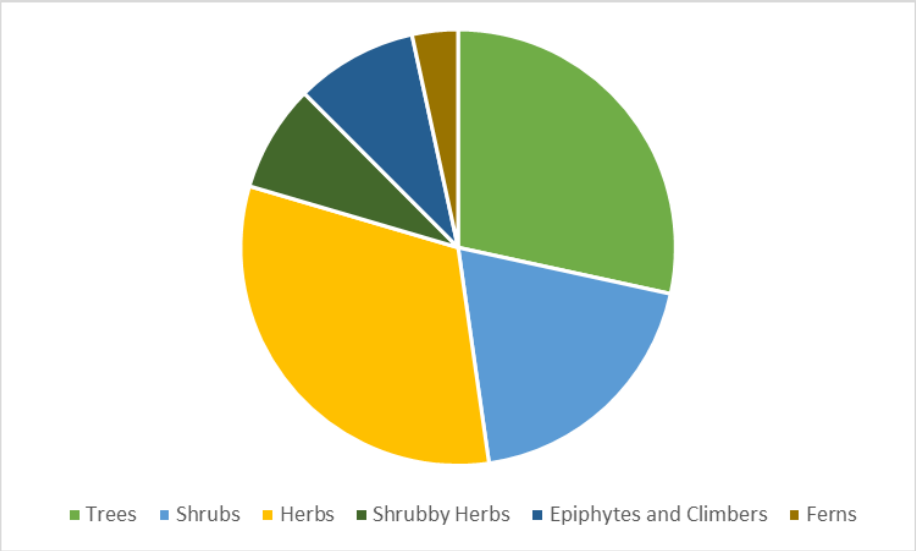


Figure 4-21: Types of flora observed during the study

Shrubs accounted for 15% of the plant species encountered and tended to occur on the ruinate grasslands. Species such as *Lantana camara* (Wild Sage), *Allamanda cathartica* (Yellow Allamanda) and several *Sida* spp. (Broomweeds) were commonly identified. *Piper* spp., and *Chromalaena odorata* (Christmas Bush) were also common. Trees accounted for 40%. Species, such as *Ficus* sp. (Fig), *Comocladia pinnatifolia* (Maiden Plum), *Cecropia peltata* (Trumpet Tree) and *Nectandra antillana* (Long-leaved Sweetwood), were widely distributed throughout the site as well as *Terminalia catappa* (West Indian Almond), *Spathodea campanulata* (African Tulip Tree) and *Delonix regia* (Poinciana). Woodland stature and species composition (including the presence of epiphytes) varied depending upon the prevailing ecological conditions (i.e., level of anthropogenic influence, canopy cover, moisture, substrate, etc.). A total of 25 tree species were encountered. Tree height of most individuals ranged between 10-15m and DBH has a wide range with several thin, likely young trees, less than 15cm with older trees >25cm to over 400cm. The largest trees were fig trees.

The occurrence of epiphytic and climbing species was quite limited in comparison to the percentages of other growth forms; however, *Ipomoea* spp. were quite ubiquitous and *Centrosema virginianum* were common climbers, and *Hohenbergia* sp. and *Hylocereus triangularis* are endemic. Lichens and mushrooms, although not common, tended to occur on the trunks of some trees in damp, forested areas (see Figure below).

Commonly occurring endemic flora species was the *Lantana jamaicensis, Grias cauliflora, Omphalea triandra, Roystonea princeps, Terminalia latifolia, Tabebuia platyantha, Hohenbergia* sp. and *Hylocereus triangularis*. Coincidentally, many of the endemic species encountered, were found primarily within the shaded forested areas. In these locations a mesic environment appeared to prevail.

Figure 4-22: Samples of ecological vegetation across the site

Table 4-14: List of trees recorded across the site

Species Name	Common Name	DAFOR	Conservation Status	Habit
Terminalia catappa	West Indian Almond	A	Naturalized	
Terminalia latifolia	Broadleaf	R	Endemic	
Tabebuia rosea	Pink Poui	O	Common	
Tabebuia platyantha	Endemic Poui	O	Endemic	
Spondias mombin	Hog Plum	R	Common	
Spathodea campanulate	African Tulip Tree	F	Invasive	
Simarouba glauca	Bitter Damson	F	Common	
Samanea saman	Guango	A	Naturalized	
Roystonea princeps	Morass Royal; Royal Palm	O	Endemic	
Psidium guajava	Guava	F	Common	
Piscidia piscipula	Dogwood	F	Native	
Pimenta dioica	Pimento	O	Common	
Omphalea triandra	Pop Nut	R	Endemic	
Nectandra sp.	-	O	Common	
Nectandra antillana	Long-leaved Sweetwood	F	Common	
Leucaena leucocephala	Lead Tree	F	Common	
Haematoxylum campechianum	Logwood	F	Introduced; Naturalized	
Guazuma ulmifolia	Bastard Cedar	R	Common	
Grias cauliflora	Anchovy Pear	F	Endemic	
Gliricidia sepium	Quick Stick; Aaron's Rod	R	Common	
Ficus maxima	Fig	F	Common	Tree
Ficus aurea	-	R	Common	
Ficus americana	Jamaican Cherry Fig	O	Introduced	
Fagara martinicensis	Prickly Yellow, Yellow Hercules	F	Common	
Delonix regia	Poinciana	A	Introduced	
Cupania glabra	Wild Ackee		Common	
Comocladia pinnatifolia	Maiden Plum	F	Native	
Cocos nucifera	Coconut	O	Naturalized	
Clusia sp.	-	O	Common	
Chlorophora tinctoria	Fustic Tree	R	Common	
Ceiba pentandra	Silk Cotton Tree	R	Native	
Cedrela odorata	West Indian Cedar	O	Introduced; Common	
Cecropia peltata	Trumpet Tree	D	Common	
Catalpa longissima	Yoke Wood	F	Common	
Cassia emarginata	Senna Tree	O	Common	
Cassia fistula	Golden Shower Tree	F	Introduced	
Bursera simarouba	Red Birch	F	Common	
Brosimum alicastrum	Breadnut	O	Common	
Bambusa vulgaris	Bamboo	F	Invasive	
Andira inermis	Cabbage Bark Tree	R	Introduced	
Acacia tortuosa	Wild Poponax	F	Common	
Adenanthera pavonina	Crab Eye Tree			

Species Name	Common Name	DAFOR	Conservation Status	Habit
Artocarpus altilis	Breadfruit	O	Introduced	

Table 4-15: List of other flora types recorded across the site

Species Name	Common Name	DAFOR	Habit
Allamanda cathartica	Yellow Allamanda	A	Shrubs
Chromolaena odorata	Christmas Bush	F	
Colubrina asiatica	Hoop Withe	A	
Cordia bifurcate	-	O	
Cordia bullata	Black Sage	A	
Desmanthus virgatus	Wild tantan	F	
Lantana camara	Wild Sage, White Sage	A	
Lantana jamaicensis	-	R	
Piper amalago var. nigrinodum	Black Jointer	O	
Piper sp.	Piper	F	
Pisonia aculeata	Cockspur	F	
Sida acuta	Broomweed	D	
Sida sp.	-	A	
Solanum erianthum	Wild Susumber	F	
Solanum turvum	Susumber/Gully Bean	A	
Thunbergia alata	Black-eyed Susan	F	
Asclepias curassavica	Red Top, Redhead	O	Herbs
Bidens Pilosa	Spanish Needle	D	
Bryophyllum pinnatum	Leaf-of-Life	A	
Cenchrus echinatus	Southern sandbur	F	
Clitoria sp	Butterfly Pea	F	
Colocasia esculenta	Dasheen	F	
Commelina diffusa	Water Grass	F	
Conyza canadensis	Canada Fleabane	O	
Desmodium adscendens	Tick-clover; Sweetheart	F	
Desmodium sp.	Beggars lice	O	
Euphorbia cyathophora	Dwarf Poinsettia	O	
Euphorbia heterophylla	Milkweed	F	
Heliotropium angiospermum	Dog's Tail	F	
Heliotropium indicum	Scorpion Weed, Wild Clary	O	
Hohenbergia sp	-	O	
Lippia strigulosa	-	F	
Lippia stoechadifolia	Fogfruit	F	
Mimosa pudica	Shame-o-lady, Shame Weed	A	
Musa sapientum	Banana	O	
Panicum maximum	Guinea Grass	A	
Plumbago sp.	Leadword	F	
Rhynchospora nervosa	Star Grass	F	
Saccharum officinarum	Sugar Cane	A	

Species Name	Common Name	DAFOR	Habit
Stachytarpheta jamaicensis	Vervine	F	
Stenotaphrum secundatum	Crab Grass	F	
Syngonium auritum	Five finger	A	
Vernonia sp.	Bitter leaf	O	
Wedelia trilobata	Marigold	F	
Abutilon sp.	Velvet leaf	A	Shrubby Herbs
Borreria verticillata	Wild Scabious	F	
Cassia ligustrina	Privet	F	
Cassia occidentalis	Dandelion	D	
Catharanthus roseus	Periwinkle	F	
Ruellia sp.	Wild Petunia	O	
Turnera ulmifolia	Ram-goat Dashalong	A	
Polypodium phyllitidis	Cow tongue fern	F	Ferns
Adiantum sp	Maidenhair Fern	F	
Thelypteris sp.	Maiden Fern	A	
Nephrolepsis sp.	Sword Fern	D	
Abrus precatorius	Crab Eyes, Red Bead Vine, Wild Liquorice	F	Epiphytes & Climbers
Centrosema virginianum	Spurred Butterfly Pea	A	
Hohenbergia sp.	Endemic Bromeliad	F	
Hylocereus triangularis	Endemic Epiphytic cacti	F	
Ipomoea sp.	Sweet Pea	A	
Momordica balsamina	Cerasee	A	
Passiflora sp.	Passion Flowers	O	
Phaseolus vulgaris	Red Peas	F	
Philodendron scandens	Wicker Vine	F	
Tournefortia volubilis	Chigger Nut	D	

In areas where high instances of anthropogenic influence were observed, agricultural crops such as *Musa sapientum* (Banana), *Artocarpus altilis* (Breadfruit), *Dioscorea sp.* (Yam), *Colocasia esculenta* (Cocoa), *Cocus nucifera* (Coconut), *Colocasia esculenta* (Dasheen) and *Citrus* spp. (e.g., orange, lime and grapefruit) were frequently seen. Ornamental plants such as Croton, Delonix regia (Poinciana), Ixora sp., Agapanthus africanus (African Lily) and Hibiscus rosa-sinensis (Shoe Black) in areas closer to the great house.

4.2.2. Fauna

Faunal survey were conducted within each vegetation zone across the property, primarily grasslands and secondary forest. The Line transect census method was used for the avifauna survey which entailed walking slowly for a given distance or time period along selected routes, noting all the birds seen or heard in the area (Wunderle 1994)[16]. The method was carried out across the entirety of the site.

[16] Wunderle, J M. "Census methods for Caribbean land birds." Gen. tech, 1994: S0-98.

A map of the specified area was provided and several sections were selected for specimen collection. At each stop the GPS locator was used to mark the points and we were allotted time to venture out on a set route for a protracted period of time. The macro habitats were first identified and pictures taken. The micro-habitats were then identified and pictures taken when necessary. Once the habitats had been identified, the list of reptiles and amphibians of Jamaica was used to determine which species are expected. This was repeated at each stop throughout the specified area. Several minor stops were made along the way for further specimen collection or identification. The method was carried out along trails and foot paths across the sites.

51 species of birds were identified during the study, 15 endemic, 29 resident, 2 introduced, and 5 migrant. Fourteen of Jamaica's Amphibians were recorded from the study site, 11 of which are endemic. Seventeen reptiles were recorded inclusive of 11 endemic species and 1 native. The majority of invertebrates recorded were dominated by the Homoptera (plant bugs) and the Lepidoptera (butterflies and moths). The Little River runs across the site, as a small intermittent stream with significant dry areas in the low rainfall seasons. Just outside the eastern boundary of the site is the Roaring River which is a more significant water body. The overall biological composition of the Roaring River was normal for a high gradient stream with low to moderate impacts. Representatives from thirteen macroinvertebrate taxonomic groups were found, with gastropod (snails) dominating, followed by various insect groups, and crustaceans. No fish were collected; these appeared to be limited in range and abundance, as a result of the desiccation of long stretches of the river. The Little River exhibits the expected invertebrate fauna expected of an unpolluted intermittent limestone stream.

Avifauna

Overall, approximately 51 species of birds were identified during the study. Of that number 15 are endemic, 29 resident, 2 introduced and 5 migrant. The mixture of grassland and woodland environment encouraged various types of birdlife. There was a mixture of birds identified in the survey which are typical of species of both dry and wet limestone forest. Birds such as Caribbean Dove, Parakeets, Hummingbirds, Jamaican Woodpeckers, Orioles and Warblers which are typical of dry Limestone forest were observed. Several birds typical of cultivated areas were observed such as grass quits, kingbirds, doves, vireos and flycatchers (Downer and Sutton, 1990)[17].

While other species that are normally found in wet forests such as the Jamaica Crow were present. 9 forest dependent and 7 non-forest dependent of the islands endemic birds were identified in the area. The high number of endemic forest specialist suggests that the forest is in good health.

Table 4-16: List of birds observed across the site

Scientific Name	Common Name	Status	Ranking
Falco sparverius	American Kestrel	Resident	R
Setophaga ruticilla	American Redstart	Migrant	O
Tachornis phoenicobia	Antillean Palm-Swift	Resident	O
Chordeiles gundlachii	Antillean Nighthawk	Migrant	F
Coereba flaveola	Bananaquit	Resident	F
Tyto alba	Barn Owl	Resident	R
Cypseloides niger	Black Swift	Resident	A
Mniotilta varia	Black-and-white Warbler	Migrant	R
Melanospiza bicolor	Black-faced Grassquit	Resident	O

[17] Downer, Audrey, and Robert Sutton. Birds of Jamaica. Cambridge: Cambridge University Press, 1990.

Scientific Name	Common Name	Status	Ranking
Vireo altiloquus	Black-Whiskered Vireo	Resident	O
Leptotila jamaicensis	Caribbean Dove	Resident	R
Bubulcus ibis	Cattle Egret	Resident	A
Tyto alba	Common Barn Owl	Resident	R
Columbina passerina	Common Ground Dove	Resident	O
Tyrannus dominicensis	Gray Kingbird	Resident	O
Loxigilla violacea	Greater Antillean Bullfinch	Resident	R
Quiscalus niger	Greater Antillean Grackle	Resident	A
Forpus passerinus	Green-rumped Parrotlet	Introduced	R
Todus todus	Jamaica Tody	Endemic	R
Corvus jamaicensis	Jamaican Crow	Endemic	O
Myiopagis cotta	Jamaican Elania	Endemic	R
Euphonia Jamaica	Jamaican Euphonia	Endemic	F
Saurothera vetula	Jamaican Lizard-cuckoo	Endemic	R
Anthracothorax mango	Jamaican Mango	Endemic	R
Icterus leucopteryx	Jamaican Oriole	Resident	R
Eupsittula nana	Jamaican Parakeet	Endemic	O
Todus todus	Jamaican Tody	Endemic	R
Vireo modestus	Jamaican Vireo	Endemic	R
Melanerpes radiolatus	Jamaican Woodpecker	Endemic	O
Tyrannus caudifasciatus	Loggerhead Kingbird	Resident	O
Mimus polyglottos	Northern Mockingbird	Resident	O
Parkesia noveboracensis	Northern Waterthrush	Migrant	R
Dendroica discolor	Prairie Warbler	Migrant	R
Crotophaga ani	Smooth-billed Ani	Resident	O
Trochilus polytmus	Red-billed Streamertail	Endemic	R
Buteo jamaicensis	Red-tailed Hawk	Resident	R
Geotrygon montana	Ruddy Quail Dove	Resident	R
Myiarchus validus	Rufous-tailed Flycatcher	Endemic	R
Myiarchus barbirostris	Sand Flycatcher	Endemic	R
Crotophaga ani	Smooth-billed Ani	Resident	O
Myiarchus stolidus	Stolid Flycacther	Resident	R
Spindalis zena	Stripe-headed Tanager	Resident	R
Lonchura malacca	Tricolored Munia	Introduced	F
Carthartes aura	Turkey Vulture	Resident	F
Mellisuga minima	Vervain Hummingbird	Resident	O
Columba leucocephala	White Crowned Pigeon	Resident	O
Turdus aurantius	White-chinned Thrush	Endemic	F
Zenaida asiatica	White-Winged Dove	Resident	O
Tiaris olivacea	Yellow-faced Grassquit	Resident	F
Loxipasser anoxanthus	Yellow-shouldered Grassquit	Endemic	O
Zenaida aurita	Zenaida Dove	Resident	O

Herpetofauna

A large percentage of the Jamaican herpetofauna are terrestrial and were typically found in conjunction with stonewalls, large trees and bromeliads present across the site. The large trees provide sanctuary for

arboreal Anolis and geckos. The bromeliads are home to herpetofauna that are known to inhabit this form of vegetation.

Fourteen of Jamaica's Amphibians were recorded from the study site and sixteen reptiles were recorded from the study site (see Table below). Eleven species of amphibians were endemic and several have been categorized as vulnerable, endangered and critically endangered by the IUCN. There are also eleven endemic reptile species and one native species. The Limestone Forest Galliwasp and Heward's Galliwasp are endangered, and the Jamaican Boa is vulnerable.

The Cane Toad (*R. marina)* was seen throughout the area. The Jamaican Rock Frog (*E. cundalli)* was found in rock walls and in log piles. E. gossei was found throughout the area and was heard making calls when the area became overcast or after rains had stopped. *E. jamaicensis* was found in most bromeliads searched throughout the area. The colouration varied from one specimen to the next. *E. johnstonei* and *E. planirostris* was found near the Great House. *E. pantoni* was heard calling from the edge of forested areas. The Osteopilus species were heard but never seen. Their calls were heard coming from bromeliads. *Celestus* is found throughout the area with *C. crusculus cundalli* being the most abundant in the forested areas. *C. barbouri* was identified throughout the area however is rarely seen and is found only in pocket populations. *Anolis garmani, A. grahami graham, A. opalinus, A. lineatopus merope and A. sagrei sagrei* were identified throughout the area. The other geckos seen in the area include *A. praesignis praesignis* and *H. mabouia*.

Invertebrates

Larger specimens such as butterflies and spiders were recorded directly. Material was identified using appropriate literature or the collections at the University of the West Indies and the Institute of Jamaica. A DAFOR rating was established for all recorded species.

12 species of invertebrates from the Lepidoptera (butterflies and moths) were recorded, four of which were endemic (see table blow). Because the habitat has been disturbed for decades several of the species found here are common species identified in open habitats and mesic forests (like the grasslands and secondary forests across the site). 17 species of snails were identified, two of which are known endemics (*Pleurodonte lucerne* and *Thelidomus aspera*).

Bats

Ten species of bats were identified using the Kaleidoscope Pro Acoustic software. For the study, presence /absence was used to represent the bat species detected in the study area. The acoustic data was not used to generate relative abundance, although the number of calls varied from the sample site.

The Jamaican Fruit Bat, *Artibeus jamaicensis*, was detected at a site at the Fig tree and the Almond tree on the property. However, their calls are faint and difficult to pick up in the field. Of the 8 insectivorous bats detected, 4 are known to forage in forested areas. While the other 4 species are known to forage in open areas. The fish-eating bat was detected on two sections of the property. It was detected at a pool at Little River and at a stream on the property assumed to be Roaring River. A special search of the vegetation was carried out for tree roosting species, such as the Jamaican fig eating Bat (*Ariteus flavescens*). No bat was observed roosting in the trees in the study area. In addition, no caves or rock holes where bats used were observed in the study area. Nine species were identified by the auto-ID file in Kaleidoscope Pro software and further verified by experts. There were 2 unidentified bat calls. (See Appendix K for Nocturnal Ecology Survey Report)

Figure 4-23: Samples of fauna observed

Table 4-17 List of amphibians, reptiles, Lepidoptera and bats observed across the site.

[IUCN Categories - Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR)]

Scientific Name	Common Name	Conservation Status	IUCN	DAFOR Rating
Amphibians				
Rhinella marina	Cane toad	Introduced	LC	F
Eleutherodactylus cundalli	Jamaican Rock Frog	Endemic	VU	O
Eleutherodactylus gossei gossei	Jamaican Forest Frog	Endemic	VU	D
Eleutherodactylus grabhami	Jamaican Pallid Frog	Endemic	EN	R
Eleutherodactylus jamaicensis	Jamaican Bromeliad Frog	Endemic	CR	A
Eleutherodactylus johnstonei	Lesser Antillean Whistling Frog	Introduced	LC	A
Eleutherodactylus junori	Rock Pocket Frog	Endemic	CR	R
Eleutherodactylus pantone	Jamaican Yellow-Bellied Frog	Endemic	-	O
Eleutherodactylus planirostris	Greenhouse Frog	-	LC	O
Eleutherodactylus sisyphodemus	Leaf Mimic Frog	Endemic	CR	R
Osteopilus crucialis	Jamaican Snoring Frog	Endemic	VU	R
Osteopilus marianae	Yellow Bromeliad Frog	Endemic	EN	R
Osteopilus ocellatus	Jamaican Laughing Frog	Endemic	NT	R
Osteopilus wilder	Green Bromeliad Frog	Endemic	VU	R
Reptiles				
Celestus barbouri	Limestone Forest Galliwasp	Endemic	EN	R

Scientific Name	Common Name	Conservation Status	IUCN	DAFOR Rating
Celestus crusculus	German Galliwasp	Introduced	LC	O
Celestus hewardii	Heward's Galliwasp	-	EN	R
Chilabothrus subflavus	Jamaican Boa	Endemic	VU	R
Aristelliger praesignis	Croaking Lizard	Endemic	LC	O
Hemidactylus mabouia	Tropical House Gecko	Introduced	LC	O
Sphaerodactylus argus argus	Ocellated gecko	Native	LC	O
Sphaerodactylus goniorhynchus	Jamaican Forest Sphaero	Endemic	NT	R
Anolis garmani	Jamaican Giant Anole	Endemic	LC	F
Anolis grahami graham	Graham's Anole	Endemic	LC	F
Anolis lineatopus	Stripefoot Anole	Endemic	LC	O
Anolis opalinus	Bluefields Anole	Endemic	LC	F
Anolis sagrei	Brown Anole	Introduced	LC	F
Anolis valencienni	Jamaican Twig Anole	Endemic	LC	R
Hypsirhynchus funereus	Jamaican Black Groundsnake	Endemic	LC	R
Typhlops jamaicensis	Jamaica Worm Snake	Endemic	LC	O
Butterflies and Moths				
Eurema nise	Mimosa Yellow	Introduced	-	O
Phoebis sennae sennae	Cloudless Sulphur	Introduced	LC	O
Ascia monuste eubotea	Antillean Great White/Cabbage Butterfly	-	-	O
Heliconius simulator	Jamaican Zebra Longwing	Endemic	-	O
Dryas iulia delia	Julia Longwing	Endemic	-	F
Dione vanillae	Gulf Fritillary	-	LC	O
Anartia jatrophae jamaicensis	Jamaican White Peacock	-	-	F
Mestra dorcas	Jamaican Mestra	Endemic	-	O
Urbanus proteus	Long-tailed Skipper	Introduced	-	R
Leptotes cassius theonus	Cassius Blue	Introduced	-	O
Dione vanillae insularis	Tropical Silverspot	-	-	A
Calisto zangis	Jamaican Satyr/Calisto	Endemic	-	O
Bats				
Artibeus jamaicensis	Jamaican Fruit Bat	Native	LC	R
Eumops glaucinus	Wagner's Bonneted Bat	Native	LC	R
Molossus milleri	Pallas' Mastiff Bat	Native	LC	R
Moormops blainvillei	Antillean Ghost-faced Bat	Native	LC	R
Noctilio leporinus	Fishing Bat	Native	LC	R

Scientific Name	Common Name	Conservation Status	IUCN	DAFOR Rating
Nyctinomops macrotus	Big Free-tailed Bat	Native	LC	R
Pteronotus macleayii	MacLeay's Mustached Bat	Native	LC	R
Pteronotus parnellii	Parnell's Mustached Bat	Native	LC	R
Pteronotus quadridens	Sooty Mustached Bat	Native	LC	R
Tadarida brasiliensis	Free-tailed Bat	Native	LC	R

Table 4-18: List of land snails observed across the site

Land Snails	
Pleurodonte lucerne	F
Dentellaria invalida	F
Thelidomus aspera	F
Zachrysia provisora	D
Cyclochittya chittyi	F
Sagda spei spei	R
Urocoptis brevis	R
Urocoptis sp.	R
Alcadia atrinolabris	R
Alcadia hirsute	R
Lucidella aureola	F
Lucidella depressa	R
Eutrochatella pulchella	F
Hemitrochus graminicola	F
Parachondria fascia fascia	R
Varicella sp	R
Apoma agnesianum	O

The construction associated with the proposed housing development will result in extensive removal of vegetation and excavating the land which will result in the loss of habitat and greenery. Many species play key roles in the environment and all measures should be employed to reduce habitat disturbance. The Little River is in good condition and all effort should be made to incorporate the stream and its surrounding vegetation into the development. Care should also be taken to limit the introduction of construction pollutants to the river.

The construction associated with the proposed housing development will result in the removal of vegetation and excavating the land which will result in the loss of habitat and greenery. However, the species occurring here are ubiquitous, and are therefore capable of surviving a large variety of habitats and can return to remaining habitats following construction. No species requiring specific conservation measures were identified. However, many species play key roles in the environment and all measures should be employed to reduce habitat disturbance. The Little River is in good condition and all effort should be made to incorporate the stream and its surrounding vegetation into the development. Care should also be taken to limit the introduction of construction pollutants to the river.

4.2.3. Ecological Synthesis

The site prior to development currently consists of at least 88 species of flora and 85 species of fauna, inclusive of endemics, natives, introduced and common species. The various species of flora ranges across trees, shrubs, herbs, epiphytes, climbers, and ferns throughout both grassland and forest habitats. The disparity in growth forms and type observed across the site is driven by the availability of water from streams that flow adjacent to the property and from the varying levels of exposure to sunlight. This level of exposure decreases significantly in the forested areas due to the 65-80% canopy cover which has also encouraged soil moisture retention and provided conditions that facilitate the growth of moisture-loving plants. In these locations a mesic environment appeared to prevail. With the presence of such differing habitats and environmental conditions, a variety of fauna were in turn identified from groups including avifauna, amphibians, reptiles, butterflies, moths, and snails.

Given the microclimate of the site and limited disturbance from the current activities, the ecological communities, particularly in the forested areas have had the ability to grow relatively undisturbed and have not shown any signs of stress. In its present state, with no significant limiting factors to affect the growth of flora and restrict the growth and distribution of fauna, the forested areas are able to thrive until a threshold of resource usage is reached. The grassland areas are however, periodically maintained to facilitate access to and from the northern to southern sections of the property. As such, only a few trees were observed in this area with the remaining flora consisting of mainly herbs and shrubs.

The proposed development is seeking to construct residential units, townhouses, and apartments with the installation of supporting utilities and road access. These changes in land use will result in a conversion of 102.6 acres of the total 167 acres of land area within which land clearing, construction activities and replacement to mainly impermeable surface are likely to occur. The remaining open space and reserve areas which serve as the main vegetated zones account for just under 40% of the project area. Such changes therefore will result in loss in the quantity of trees, shrubs and herbs that act as a food source and habitat due to the removal of a portion of the forested zone and grasslands. This in turn reduces the available space and resources for flora and fauna to undertake their growth and ecological functions. Several commonly occurring endemic species like the *Lantana jamaicensis* that were encountered were found primarily within the shaded forested areas and so were epiphytic plants and moisture-dependent organisms. Further to this, the proposed species of trees to be replanted are mainly ornamental and fruit trees including the Christmas Tree Palm, Italian Cypress tree, Heliconia, Ficus, mango trees, apple and breadfruit trees. These, however, being of differing characteristics will not offer the same ecological functions as the groups of trees that will be removed. Nevertheless, the fruit trees may attract more fruit eating organisms that can facilitate the dispersal of seeds and broaden the distribution of fruit trees across the property (with room for competition among species). In essence, with the proposed changes in physical features associated with the development, the maximum load that the site was once able to sustain will significantly reduce as the maximum number of individuals of species of flora and fauna identified declines.

The site prior to development currently consists of at least 88 species of flora and 85 species of fauna, inclusive of endemics, natives, introduced and common species. The various species of flora range across trees, shrubs, herbs, epiphytes, climbers, and ferns throughout both grassland and forest habitats. The disparity in growth forms and type observed across the site is driven by the availability of water from streams that flow adjacent to the property and from the varying levels of exposure to sunlight. This level of exposure decreases significantly in the forested areas due to the 65-80% canopy cover which has also encouraged soil moisture retention and provided conditions that facilitate the growth of moisture-loving plants. In these locations a mesic environment appeared to prevail. With the presence of such differing habitats and environmental conditions, a variety of fauna were in turn identified from groups including

avifauna, amphibians, reptiles, butterflies, moths, and snails.

4.3. Heritage

The property of the Mammee River Housing Development Project as outlined in the scope encompasses sections of two properties, the Mammee Bay estate and Roaring River estate. Defining landmarks are the Mammee Bay Waterwheel (that is, the Mammee Bay estate mill house) in the northern part of the property, and the Roaring River great house in the south. Other structural features include ruins of the Mammee Bay great house, the Mammee Bay estate aqueduct, and ancillary buildings of the Roaring River great house. Behind the Roaring River great house, a Taíno site over which the great house and the great house ancillary building seem to have been constructed.

As the Mammee River Housing Development Project comprises two historical estates, this present document follows this natural division and treats each of these original properties separately.

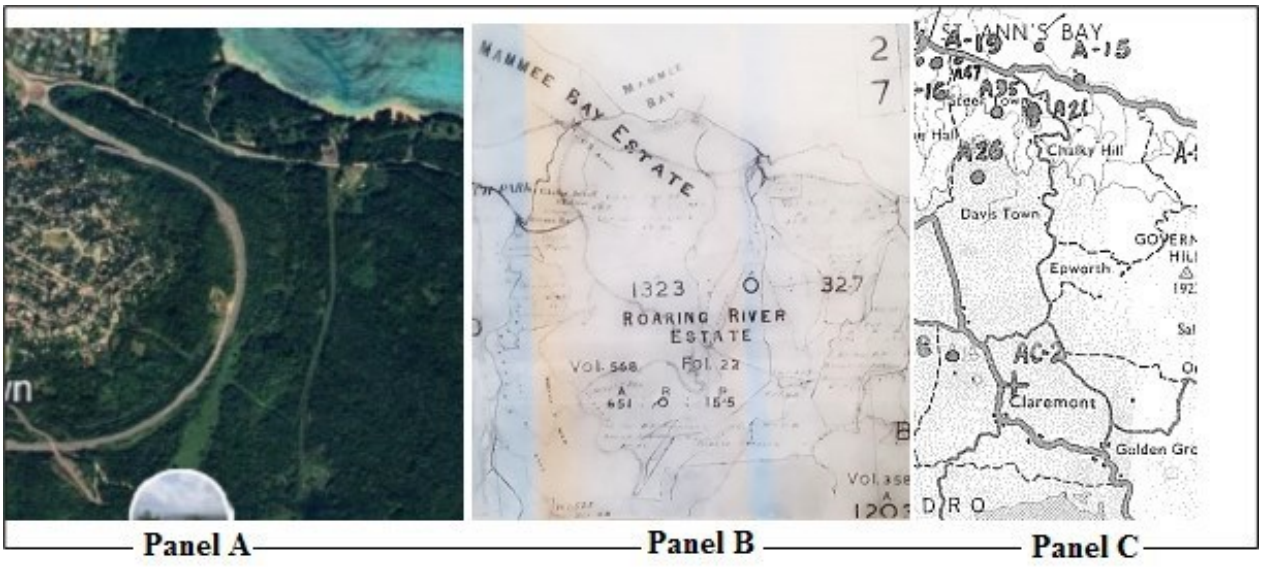


Figure 4-24: Panel A. Google Earth image of the area; Panel B. Cadastral map of the area showing estates of Mammee Bay and Roaring River; Panel C. Taíno map of the area showing A15 – Little River in the north and A21- Bellevue – Chalky Hill south of the site (Google Earth Reference accessed by Conolley November 5 2022. National Land Agency cadastral map. Accessed by Conolley 2022. Lee Taino map accessed by Conolley 2022.)

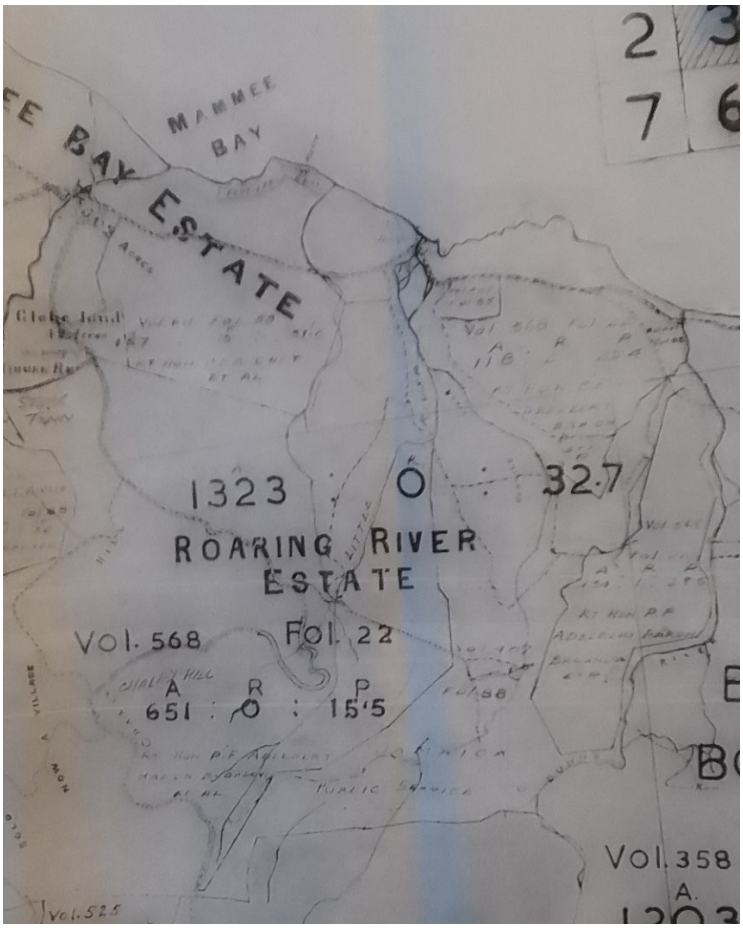


Figure 4-25: Cadastral maps of Mammee Bay and Roaring River estates (National Land Agency Cadastral map. Accessed by Conolley 2022.)

Research of archival maps were conducted in a very limited way at the National Library of Jamaica where, as a result of COVID normal access was problematic. Map research, however, was for the most part conducted at the National Land Agency maps section. Access to the Jamaica Archives due to COVID was not available.

The forthcoming publication by Peter Espeut, the Encyclopaedia Place Names of Jamaica whose publication draws from primary sources was particularly helpful during this period of COVID-19 when many Government research facilities were ether closed or had very limited access.

4.3.1. Location/Project Area

The land on which the Mammee River Housing Development Project has slated for construction is situated on parts of the early estates of Mammee Bay and Roaring River. Both of these early properties were sugar estates and situated on land previously inhabited by Jamaican indigenous peoples. The properties are adjoining and are situated on the coast between the towns of St. Ann's Bay and Ocho Rios. Neighbouring major properties are Drax Hall in the west and Dunn's River in the east.

Figure 4-26: Mammee River Housing Development Site (Adapted area in Red by Conolley and associated text by Conolley. Conolley photo 2022.)

The project area is bordered by woodland in the south, which comprises old parochial roads and bridlepaths leading to other parts of the property, and adjoining properties. The western part of the project area is bordered by the Steer Town Road and the North South Highway.

4.3.2. Mammee Bay Estate

Mammee Bay Estate is located between the Drax Hall property and Roaring River. Historically, Mammee Bay was a sugar estate and milled cane by means of a water mill and cattle mill. The water mill exists now as ruins close to the intersection of the north coast highway and the Edward Seaga Highway – the north-south toll road linking Mandela Highway in the south to the northern side of the island. Before Mammee Bay estate's use as a sugar plantation, it was inhabited by two known indigenous cultures, Ostionan Ostionoids, commonly referred to as the Redware culture and the Meillacan Ostionoids known as the Taínos. The Redware peoples lived on the coast where the Little River empties into the sea and where residential buildings have long been erected. To the east and west of them were Taíno habitation sites.

The property has a heritage of agriculture and defence. Crop Account records for the period 1762- 1765 under the Hemmings family, show that in addition to sugar, the Mammee Bay Estate also produced molasses and rum as well as cocoa, ginger, cotton, pimento and coffee. Later, in 1766, under the ownership of Thomas Wynn, the property expanded into livestock numbering 53. In 1792, there were 135 enslaved people on this property, some of whom helped in defence of the island. The Mammee Bay estate extended to the coast where a fort was established to protect against attacks. In 1795, the militia along with armed enslaved labour from this Mammee Bay estate and the adjoining Drax Hall Estate, sustained and beat off an attack from the sea, at this fort. The enslaved labour who fought with the militia were granted an award of 40 pounds for their role in the combat (Espeut: 2019).

Throughout the years, ownership changed at Mammee Bay Estate: in 1810, John Perry held the property; then it went into receivership seven years later, in 1817, held by receivers Perry and Andrews; in 1824 John Lugg took ownership when it continued in sugar cane but added indigo; it was later owned by the Pratt family

and then by Arthur Collard in the mid-1900s when the property was subdivided and hotels emerged. This was its beginning as a resort area.

Presently, Mammee Bay is a well-known and sought-after tourist resort area close to Ocho Rios boasting numerous hotels and bed and breakfast facilities. It is generally regarded as part of the greater Ocho Rios area.

4.3.2.1. Heritage Sites on the Mammee Bay Section of the Mammee River Site

There are a number of heritage structural features, now in ruins on the Mammee Bay estate site. There is the mill house with a waterwheel used to power the milling of the cane, the aqueduct which conveyed water from the river to the watermill and great house, and the residence of the property owner or property overseer.

Figure 4-27: 27 Google map showing heritage locations of the aqueduct, the mill house (commonly called the waterwheel) and the great house ruins (Google Earth Reference Accessed by Conolley November 5 2022. Adapted area in Red by Conolley and associated text by Conolley. Conolley photo 2022.)

4.3.2.2. Mammee Bay Estate Waterwheel (mill house)

The Waterwheel and its immediate environs are owned and under the management of the Urban Development Corporation (UDC). However, it has been included in this report because of the possibility of the waterwheel's management and upkeep being transferred to the developers in the future. The area in and around the mill house is currently being landscaped and prepared as a visitor attraction. However, for safety, aesthetic, and for purposes of historic authenticity these ruins should be stabilized by strengthening and capping the walls. Such a repair can be effectively done by use of compatible material (not Portland cement) such as originally used in this building, namely, lime mortar for sealing/capping, repointing, and relaying stones. The correct material to be used for this purpose is lime mortar, made from aggregate mixed with lime putty. Also, there should be a storyboard erected providing information on the Mammee Bay estate history including that of the Redware culture people of Little River. The Redware culture was the earliest inhabitants of the island having arrived here circa 650 AD. The Taínos arrived some two hundred years later in 850 AD. It is suggested that the storyboard should have an audio- visual component.

Figure 4-28: The Mammee Bay Estate mill house ruins also known as the waterwheel (Conolley photo 2022.)

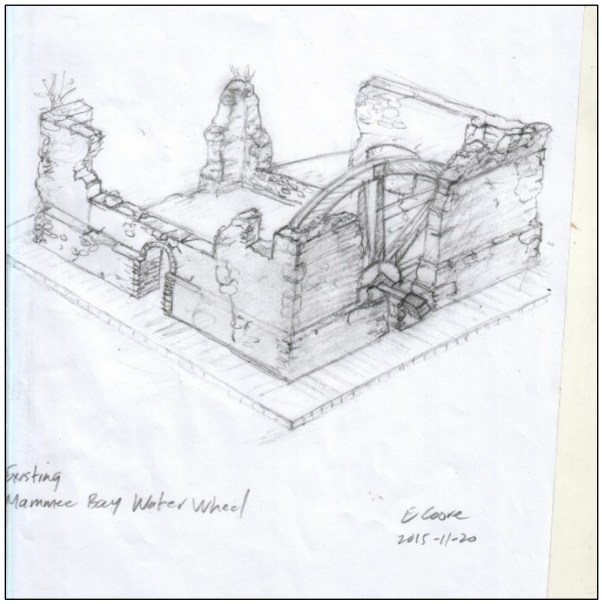


Figure 4-30: Jamaica National Heritage Trust (JNHT) sketch of present condition of the mill house with waterwheel1 (JNHT sketch.)

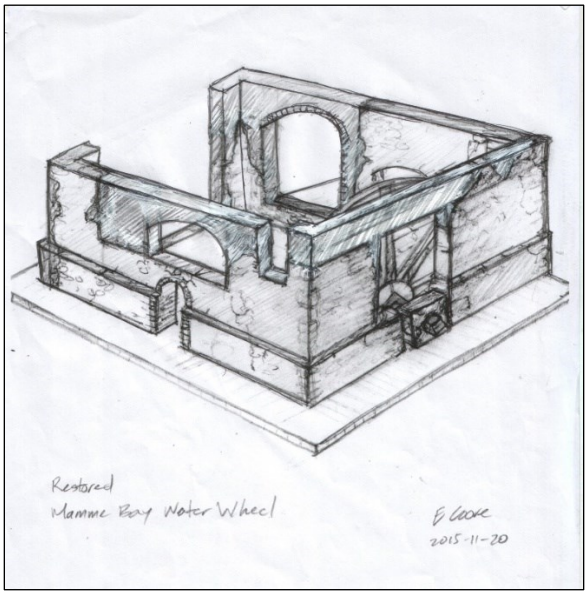


Figure 4-29: Jamaica National Heritage Trust (JNHT) sketch of restored condition of the mill house with waterwheel 2 (JNHT sketch.)

The water wheel has on its northern side a channel/drain to drain the water from the land on the southern side of the road. This channel was constructed at about the same time as the construction of the Mammee Bay round-a-bout for the north/south toll road to drain water from the upper area of the roadway as well as that of seasonal streams. This canal/duct runs on an approximate west/east axis.

Figure 4-31: Canal north of the waterwheel (Adapted area in Red by Conolley and associated text by Conolley photo 2022.)

Figure 4-32: Concrete water channel north of the waterwheel (Conolley photo 2022.)

Figure 4-33: Concrete water channel north of the waterwheel – drains seen at base of wall (Conolley photo 2022.)

It has a cross drain at the water wheel running under the road to empty into the sea via another built drain/canal. At the precise point where the cross drain collects the water has been constructed a raised area which blocks about 75% of the inlet opening for the cross drain. The implication of this is that flooding may occur in this area. The recommended mitigation is to remove the raised area to allow free passage of the water into the cross drain.

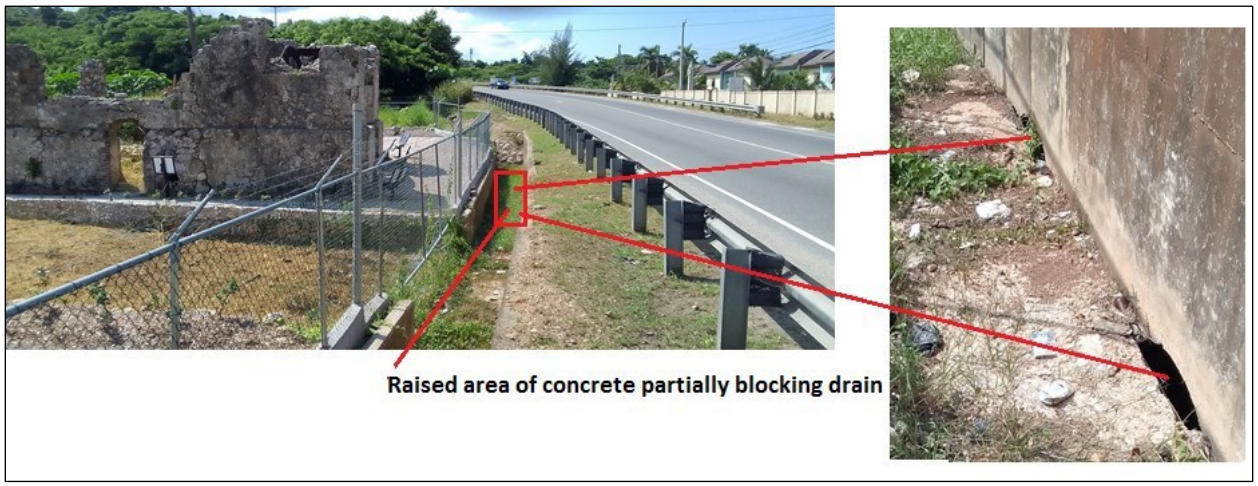


Figure 4-34: Water Channel drainage 1 (Adapted area in Red by Conolley and associated text by Conolley. Conolley photo 2022.)

Figure 4-35: Water channel drainage 2 (Adapted area in Red by Conolley and associated text by Conolley. Conolley photo 2022.)

Figure 4-36: Drain on northern side of the north coast highway (Conolley photo 2022.)

4.3.2.3. Mammee Bay Estate Great House

Great houses, or plantation houses occupied by the owner of overseer were usually constructed on an elevated area of the property providing a view of the estate. Mammee Bay Estate great house was no different. The building is no longer intact and existing walls are overcome by trees and shrubs. A record of its role in the operation of the property should be noted in the storyboard that ought to be erected at the Waterwheel.

4.3.2.4. Mammee Bay Estate Aqueduct Ruins

Sugar estates in Jamaica of this period 17th and 18th century used a variety of mills to grind sugarcane. The most reliable and common was the animal mill turned by oxen, mules or horses. There were windmills used in areas where a near continuous wind could be relied on. On properties where rivers were available, such as Mammee Bay estate, a water mill would be established. The water mill was powered by a waterwheel which was supplied from a nearby (and sometimes not very near) river. This required a method of channeling the water from the river course to the mill. In the case of Mammee Bay, there was an aqueduct constructed of cut stone extending from the river, south of the mill, to the waterwheel. When the water was too low to turn the mill, they resorted to the animal mill. Present condition: The aqueduct is currently in dense shrubs but is still relatively intact in spite of tress growing in and around it. Mitigation: Information on the aqueduct should be a part of the narrative placed on a storyboard about the Mammee Bay estate.

Figure 4-37: Drainage system from the western to eastern sides of Edward Seaga Highway (North/South Highway). Upper photograph shows drain channel under the highway; lower photograph shows small canal on the western side of the highway leading southwards to the area (Conolley photo 2022)

Figure 4-38: Mammee Bay Estate aqueduct ruins 1 (Conolley photo 2022.)

Figure 4-39: Mammee Bay Estate aqueduct ruins 2 (Conolley photo 2022.)

Figure 4-40: Mammee Bay Estate aqueduct ruins (Conolley photo 2022.)

4.3.3. Roaring River Estate

Roaring River Estate located between Mammee Bay estate and Ocho Rios originally comprised 840 acres of land, patented by Richard Penhallow in the 1600s. It was later owned by Robert Pughe who increased the acreage to 1,069 acres in 1724. It was subsequently, in 1817, owned by the heirs of Alexandre McBean and William McBean who improved its fortunes. It was eventually sold to Sir John Pringle, circa 1905, and bequeathed to his daughter, Minna Simson. At this time the property was a cattle pen with over 300 head of cattle. In 1943, she, Minna Simson, sold the property of some 1,300 acres to the electric power company, the Jamaica Public Service Company, who had an interest in the river for the establishment of a hydroelectric plant. Through a process of lease-back and subleases the beachfront area of the property underwent numerous ownership changes through Ruth Lewis Farkas in 1970, to the Jamaica Government in 1985. A beachfront cottage was constructed there in the 1950s and through series of changes and improvement became the resort cottage for the Jamaican government. From the early 1900s, this property earned its popularity as a location for filming, providing a set for movies such as *Saturday Island, A Daughter of the Gods, Treasure Island* and *Dr. No*. The southern part of the property had a different history. Where the great house was situated, some 900 acres, was bought from the Jamaica Public Service Company in 1950 by Lord Brownlowe who remodeled the great house, (which was built by the Pringles) and established a horticultural garden reputed to be among the best in the Caribbean.

4.3.3.1. Heritage Sites on the Roaring River Estate section of the development site

Figure 4-41: Roaring River Estate Heritage Sites (Google Earth Reference Accessed by Conolley November 5 2022. Adapted area in Red by Conolley and associated text by Conolley. Conolley photo 2022.)

Heritage sites on this Roaring section of the property comprise the Roaring River estate great house, the ancillary buildings around the great house and a Taíno habitation site. The present conditions of these buildings vary.

The Taíno site has been eroded over time and part of it possibly under existing great house and other surrounding buildings. A simple monument should be erected in this vicinity to memorialize the early peoples, the Taínos.

4.3.3.2. Roaring River Estate Great House

Present condition: The great house itself is barely habitable and in need of significant repairs. The ancillary buildings are in a similar state and in need of significant repairs and repurposing.

Figure 4-42: Roaring River Estate great house – view from the western approach (Conolley photo 2022.)

Figure 4-43: Roaring River Estate great house 1 (Conolley photo 2022.)

Figure 4-44: Roaring River Estate great house 3 (Conolley photo 2022.)

4.3.3.3. Roaring River Estate Ancillary Buildings

Figure 4-45: Roaring River Estate ancillary building northwest of great house (Conolley photo 2022.)

Figure 4-46: 46 Cluster of ancillary buildings due south of great house and also location of Taíno site (Conolley photo 2022.)

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Figure 4-47: Ancillary building east of great house (Conolley photo 2022.)

4.3.3.4. Roaring River Taíno Site

There is a Taíno habitation site on the hill close to the Roaring River great house overlooking the sea. This type of hillside location is typical of Taíno habitation spots. Also typical was their desire to have a nearby source of potable water. With numerous rivers and springs in the area, this desire would be fulfilled. The site also provided a good lookout point for identifying hostile vessels approaching by sea from a distance. Such elevated areas also had the advantage of a light breeze which kept mosquitoes away.

It is likely that some of the great house ancillary buildings were constructed on the site as much of the site has disappeared.

The recommendation here is to erect a simple monument to memorialize the Taínos of this site. Such a memorial would include a narrative of the site.

Figure 4-48: Wild cane, seen here in the area, was one of the building materials used by the Taíno for constructing siding for their houses (Conolley photo 2022.)

Figure 4-49: Jamaica Public Service Company's transmission lines on eastern part of the Roaring River property (Conolley photo 2022.)

See Appendix I for a summation of impact and mitigation measures for all heritage sites

4.3.4. Summary

The Mammee River Development Project occurs in an area of St. Ann renowned for its scenic topography and waterways. It is also set in a location of cultural interest and value. As such it is of particular value to the heritage of the island. This section and the appendix I outline the cultural impact that such a project could have on this cultural landscape and how permitted activity can be mitigated to limit or eliminate the potential threat. The wider area comprises an indigenous people's settlement on the coastline at the mouth of the Little River. These people, referred to as the Redware culture, represented the earliest known cultural group to occupy the island dating circa AD 650. They were precursors of the better known Taínos who arrived on the island some two hundred years later, circa AD 850. This Little River site has succumbed to the ravages of the coastline which has eroded a part of the site. Additionally, significant residential construction in the area of and on the site itself has resulted in further damage. To the east of the property is the famous Dunn's River Falls.

However, since the initial assessments were conducted, based on the original development plans submitted the developers have since informed the analysts that the aforementioned heritage sites and features will be wither returned or remain under the domain of the UDC, an therefore would no longer be a part of the CHEC development areas.

The sites, namely the Roaring River Great House, the ruins of the Mammee Bay Gret House, some of the Ancillary buildings of the Roaring River Great House, the Mammee Bay Aqueduct Ruins, and the Graves of the Roaring River Great House have been recorded and mitigation measures noted. However, the onus for expediting mitigation measures will be with the property owners.

Additionally, there are no recommendations for watching briefs. The purpose of the watching brief was to determine the presence of historic sites. Watching briefs initially were recommended for three areas, namely 'the area surrounding the Roaring River Great House, the area surrounding the Mammee Bay Great House Ruins, and the Mammee Bay Waterwheel during capping of the walls. Firstly, a subsequent salvage archeology exercise conducted in the vicinity of the Roaring River Great House has obviated the need for a watching brief in this part of the property. (See Appendix J for full report). Secondly, the developer has indicated that they are no longer responsible for the property surrounding the Mamme3e Bay Great House Ruins. This makes a watching brief unnecessary at this time. Finally, the Waterwheel capping, while requiring a watching brief to ensure proper delivery of the strength of the capping was never the responsibility of CHEC. Consequently, all three recommendations or watching briefs have been withdrawn.

4.4. Socio-economic Environment

4.4.1. Research Design

For this socioeconomic assessment a mixed methods approach (a combination of quantitative and qualitative data collection methods) was employed using both key informant interviews with businesses within the area, and field surveys with residents in the area. This approach was utilized to allow for a detailed exploration of the local perception of this proposed housing and subdivision project in Mammee Bay, St. Ann and its potential impacts on social, aesthetic, and historical assets, and to gather information on existing infrastructure in the project area.

In accordance with the NEPA EIA regulations, the data was collected within a 2 km sphere of influence of the project boundary of the proposed development. As the proposed site is in the region known as Roaring River, which is along the entrance ramp Lydford to Mammee Bay leg of the Highway 2000, the sphere of influence includes communities such as Mammee Bay East, Greenwich Park, Chalky Hill, and Steer Town.

Figure 4-50: Mammee River Sphere of Influence

4.4.2. Research Sample

A convenient sampling technique was used to collect quantitative data from local community members. A sampling frame of 5% of the households was utilized to generate a sample of 153 households. This sampling technique provided a case study on the demographic perceptions of the residents within the area of the proposed development. However, the community was oversampled resulting in an increase of 53 households and a total sample of 206 households. This data was collected within the districts of , which are among the twelve districts within Steer Town. Chalky Hill borders the Steer Town community.

4.4.3. Method of Data Collection

This socioeconomic assessment/ study commenced with a site reconnaissance on August 15, 2022, which gave the project team the opportunity to acquaint themselves with various aspects of the project area.

Following this exercise, a windshield survey was conducted on September 29, 2022 in the four selected communities. The windshield survey was an investigative study conducted by the project team inside a vehicle documenting distinguishing features of each community within the study area. These features included the physical characteristics, socioeconomic classification, existing civic and social amenities, land use and livelihoods and evidence of growth in housing stock.

Questionnaires were also drafted and orally administered using the Kobo Toolbox Platform (See Appendix M). Respondents who were not available in the field were subsequently contacted via telephone and their responses were registered on the Kobo Toolbox Platform. This allowed for the centralized collection of information, whereas the key informant interviews were collected using semi-structured interviews conducted face-to-face within the area.

4.4.4. Limitations to the study

The assessment was conducted in accordance with the typical requirements of a socioeconomic assessment and the information provided at the time. Recent information has indicated however that the development is a luxury and premium residential development with a high-income target market, which was not considered and reflected in the surveys conducted or the impacts and mitigative chapters of this report. Therefore, the characterization of the proposed development as a solution to address a long-standing housing need is not applicable.

Additionally, the ESL project team sought to gain the perspectives of the Planning Division of the St Ann Municipal Corporation about the proposed development during the study, however, despite numerous attempts, we were unable to secure this consultation.

4.4.5. Data Analysis

Analysis of the data was facilitated via Microsoft Excel software. This allowed for detailed analysis of the data and the exploration of differences in the variability of responses. This was supplemented by the data found in the Social Development Commission Community Profiles for the Steer Town Community, and the 2011 census on housing and population produced by the Statistical Institute of Jamaica.

4.4.6. Land Use Patterns (Current and Potential)

As represented in the figure below, Roaring River where the project site is located, is dominated by secondary woodland. However, within the area there are scattered fields and secondary woodland.

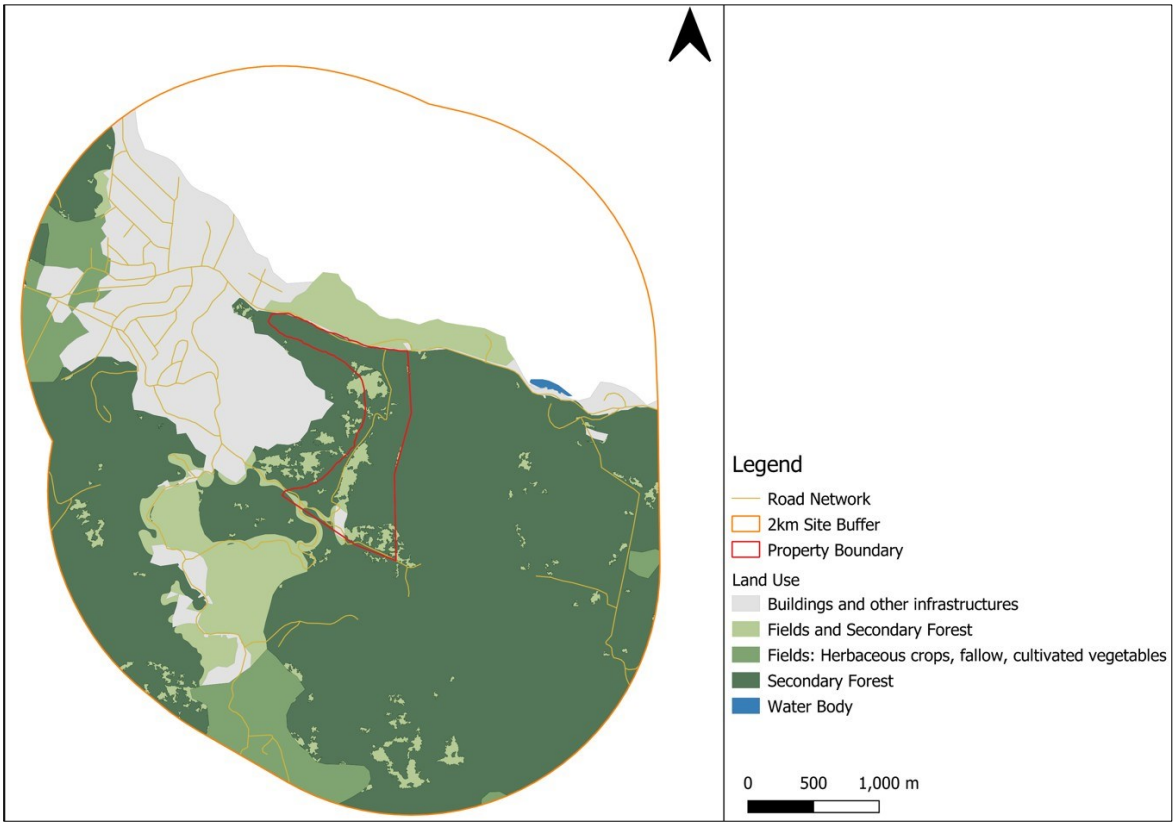


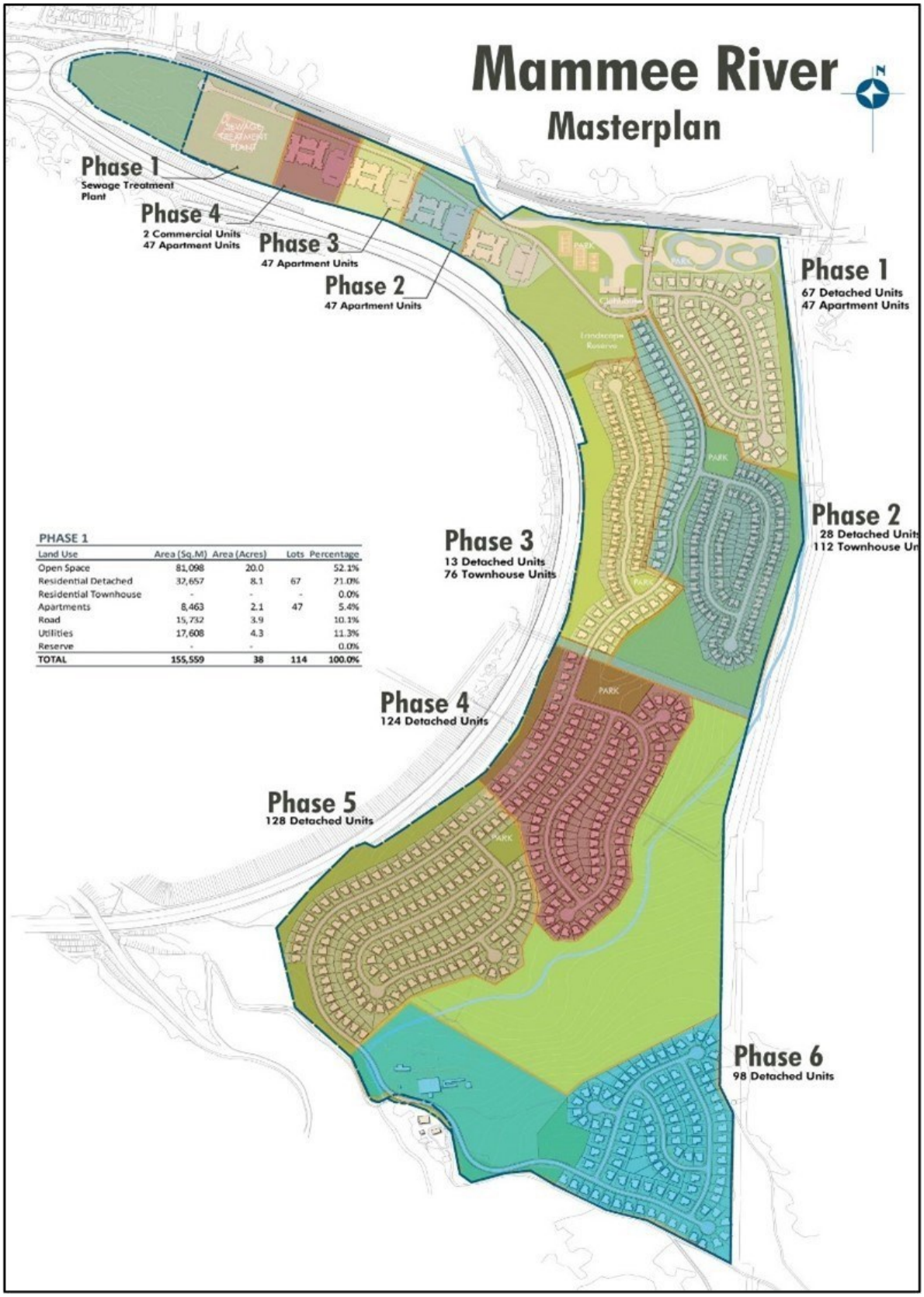
Figure 4-51: Land Use Map of Mammee Bay (Forestry Department,2013)

The development proposes a total of 834 detached town homes and apartments, with roads, commercial

space and utilities that will be built on 167 acres of land. (See Figure Figure 4-52 for Mammee River on following page)

The Roaring River Great House and the Water Wheel Ruins heritage monuments located onsite will be preserved and repurposed. The great house will be renovated and used as a possible restaurant or clubhouse facility. The guidance of the JNHT will be sought for the renovation of this protected heritage site. The waterwheel, though not protected and in ruins, will be refurbished and left as a monument accessible to the viewing public.

The tributary running along the western boundary will be re-directed to flow closer towards the eastern boundary and join the other tributary to improve flood management. A detention pond will be constructed to the north-eastern boundary to regulate the flow leading downstream (offsite) because of this re-training.



PHASE 1

Land Use	Area (Sq.M)	Area (Acres)	Lots	Percentage
Open Space	81,098	20.0		52.1%
Residential Detached	32,657	8.1	67	21.0%
Residential Townhouse	-	-	-	0.0%
Apartments	8,463	2.1	47	5.4%
Road	15,732	3.9		10.1%
Utilities	17,608	4.3		11.3%
Reserve	-	-		0.0%
TOTAL	155,559	38	114	100.0%

Figure 4-52: Draft Masterplan of Mammee River Housing Development

The Government of Jamaica through its local development order has enacted legislative documents that guides development at the parish level. This document is the Town and Planning Development Order that was recommended from the Town and Country Planning Act for Jamaica.

The Town and Planning (St. Ann Parish) Confirmed Development Order (2000) provides the developmental framework for St. Ann. The local planning authority has several stipulations for application considerations for housing development which include:

(I) Housing development should be confined to the growth centres selected in the settlement strategy of the National Physical Plan 1978-1998 and any subsequent revisions and no permission will be given for any large scale linear or housing development outside of these areas.

(II) Housing development will be allowed in urban areas which are in accordance with land use zoning, densities and other criteria which are in the local area plans developed for these towns.

(III) Applications for housing development will not be considered if there is an existing deficiency in the provision of water supplies or sewerage services. It would only be facilitated if this deficiency can be resolved within a reasonable time period

(IV) No housing development is to be built on any land that is subjected to flooding, erosion, subsidence and other natural hazards.

(V) Development on the seaward side of the coastal main road should be arranged that there is no continuous wall of buildings blocking the view of the sea.

(VI) In single and multifamily housing developments, space should be allocated for recreational and landscaping purposes, exclusive of driveways, parking areas and accessways.

(VII) In large housing developments, developers should do a mix of development and provide adequate commercial facilities for residence.

(VIII) The density of housing developments should be controlled. New buildings especially in the areas of infill should not be significantly higher than their surroundings and appropriate densities for new residences should be built in a way that protects the surrounding amenities as well as that of the proposed occupiers.

4.4.7. Regional Assessment

This project site is located within the Steer Town community which is found within the St. Ann's Bay Local Planning Area (SDC, 2012). Steer Town is bordered by Chalky Hill community to the South and the St. Ann's Bay community to the west. The project site is accessible from the Edward Seaga Highway (also known as the Jamaica North South Highway) which is adjacent to the western boundary of the site. Mammee Bay resort facilities are along the northern boundary of the project site, along the class A road linking St. Ann's Bay to Ocho Rios.

The project site is located on the outskirts of St. Ann's Bay, a key urban centre within St. Ann. The surrounding project area has commercial developments with many hotels, small businesses, 'cook shops', restaurants and bars, car marts, gas stations etc. East of the site are attractions of significant national importance such as the Dunn's

River Falls Park and the Mystic Mountain.

The property is recognized due to its proximity to Roaring River, which is the source of the Laughing Waters (falls). These falls were famously featured in the Dr. No, the James Bond film. The site is also significant because of the Jamaica Public Service (JPS) hydroelectric power that the Roaring River generates. The Roaring River Great House is of great historical significance, as it was declared a heritage site by the National Heritage Trust. The Wag Water Wheel, also of historical significance, provides a landmark attraction to the site.

Steer Town is the nearest settlement to the project located just east of the project site. It comprises twelve districts including Mammee Bay South, Greenwich Park and Roaring River, which are discussed further in the study. Steer Town started as an informal settlement, but was later regularised with defined lot boundaries, realigned roads, and water piped from the Bogue facilities of the National Water Commission (NWC) facilities.

These districts are however wide ranging in income levels. As evidenced in the windshield survey, sections of Mammee Bay, and most of Greenwich Park for example, would be classified as middle to high income residential communities with luxury town homes, mansions and Air BnB rentals.

4.4.7.1. Population and Household Demographics

The population within the sphere of influence of 2km is 11,639 persons within 3,603 households. Of that grouping the gender ratio is almost equal with 49.4% males and 50.6% females. Heads of households are almost equally split between male and females.

In these communities in St. Ann, the population is youthful, with 46.9% of the population aged 24 years old or younger, and the 15–19-year-old age groups representing 12.3% of the residents in the community. The elderly population who are ages 60 years and older, represented 9.9% of the population (Social Development Commission 2012).

The community survey results showed that 52% of the participating households were headed by females, while 48% were headed by males, with an average household size of four persons. Most of these heads of households were employed at the time of the study.

In fact, as reflected in Figure 4-53 below, of the 206 respondents, 23% of those surveyed were engaged in commercial/retail activities, 19% were employed in tourism related activities and 6% were engaged in farming activities. Majority of the respondents (52%) however, had other sources of income including construction, taxi operation, those who received money through remittances, and retirees/pensioners.

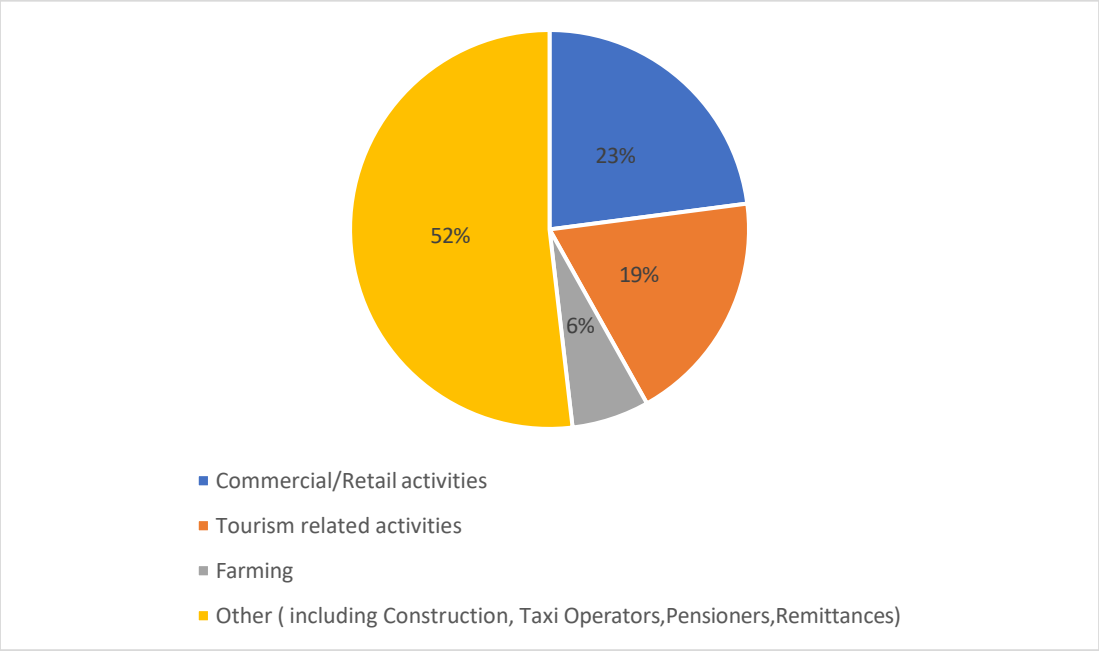


Figure 4-53: Income source in represented communities in St. Ann

4.4.7.2. Education

Regarding education within these St. Ann communities, 47% of the population attained secondary education while 36% attained primary education. A small percentage (7%) of the population attained other tertiary education, 6% of the population attained pre-primary education, 3% of the population attained university education and 1% did not attend school. Other tertiary education refers to all formal post-secondary education, including public and private universities, colleges, technical training institutes and vocational schools. Consistent with national data, the population within most rural communities in Jamaica do not for the most part attend tertiary institutions. This may be due to high tuition fees or lack of financial resources available. Data detailed in the Figure 4-54 below suggests that male students exceeded their female counterparts at the primary level. However, they were exceeded at the secondary level and tertiary level by their female counterparts.

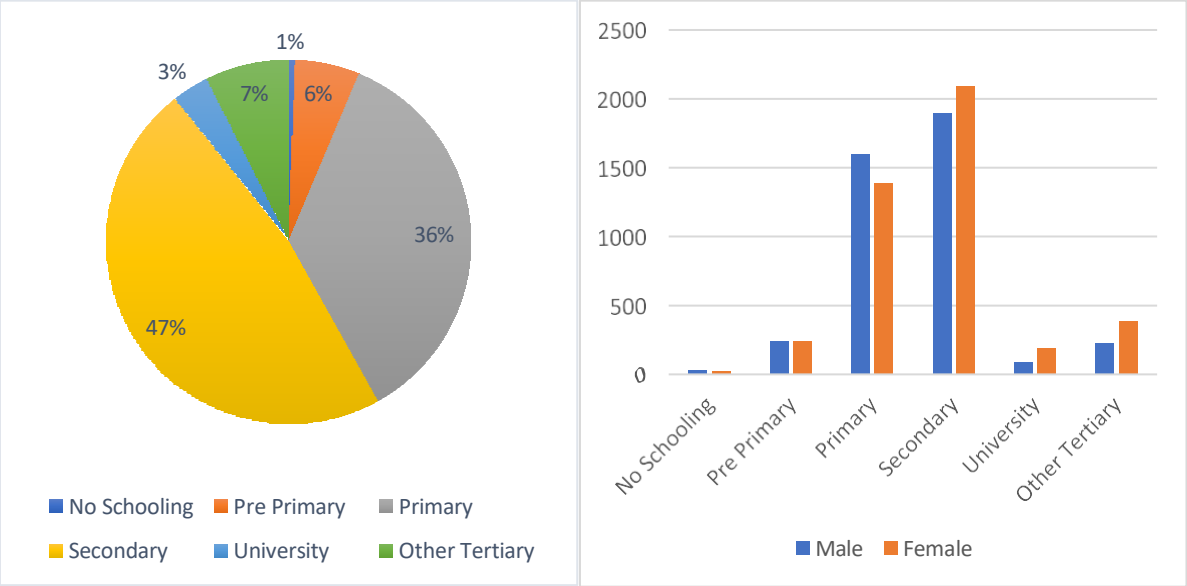


Figure 4-54: Population by highest level of educational attainment in communities in St. Ann and Educational level of population disaggregated by sex (Source: Statistical Institute of Jamaica)

Based on the community survey conducted, it showed that level of education attained for heads of households was primarily secondary education, with tertiary education being the second highest, 60% and 20% respectively.

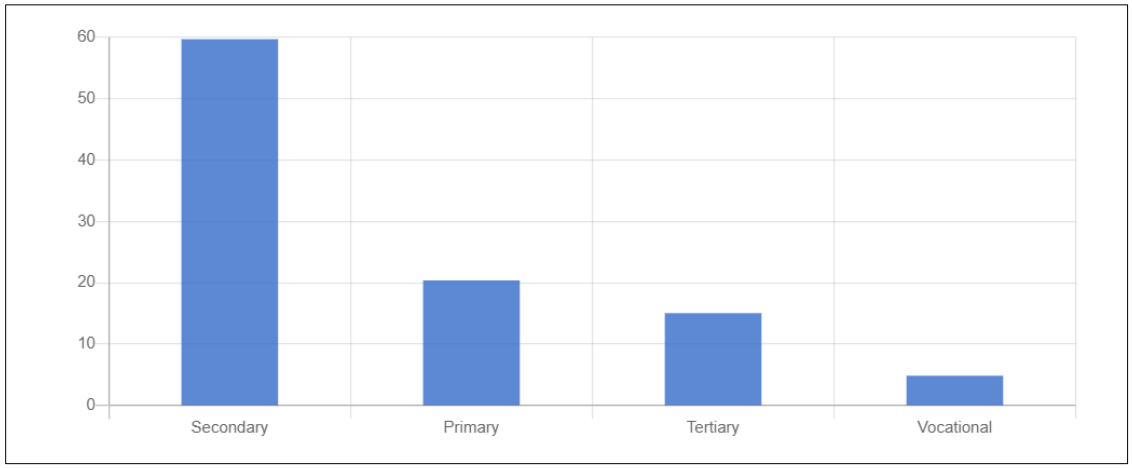


Figure 4-55: Level of education by head of household

4.4.7.3. Community characteristics

In the study area there are 2,727 housing units representing 6% of the units for the entire parish. Of the housing units, 96% can be described as separate house detached, 2% are attached housing units, which includes apartments and shared dwellings. Another 2% are described as part of a commercial building or improvised units. An improvised unit is a standalone temporary shelter or building made typically out of waste materials that are ordinarily deemed unfit for habitation and being utilized as a residence, often by one (1) household.

As detailed in the figure below, of the total housing units, 48% are made from blocks, 33% are made from board, 8% are made from concrete, 6% are made from block and board combinations, and 5% are made from concrete and blocks.

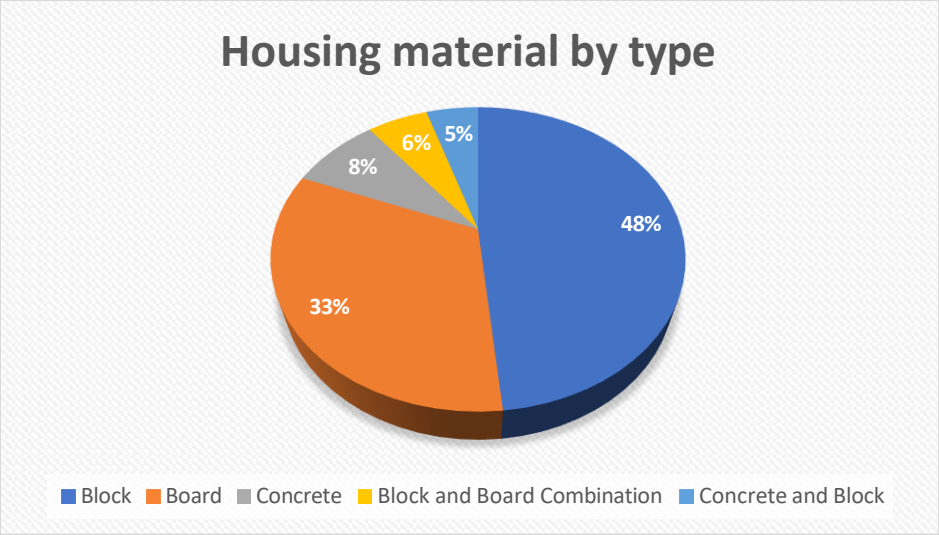


Figure 4-56: Housing material in the project area

Based on site visits conducted below, Figure 8 represents a sample of housing stock from the communities represented in the study which are Steer Town, Mammee Bay, Greenwich Park and Chalky Hill.

Figure 4-57: Sample of housing stock in the represented communities in St. Ann

4.4.7.4. Housing and Property Ownership

Based on data produced by the Social Development Commission, as reflected in the figure below, 77% of the population within the parish of St Ann that reside in the communities of Steer Town, Greenwich Park and Mammee Bay own their homes. The remaining 10% live for free in family homes, 10% rented and

another 3% either leased their houses, or had another type of living arrangement, which may include squatting. There was no data available for Chalky Hill community.

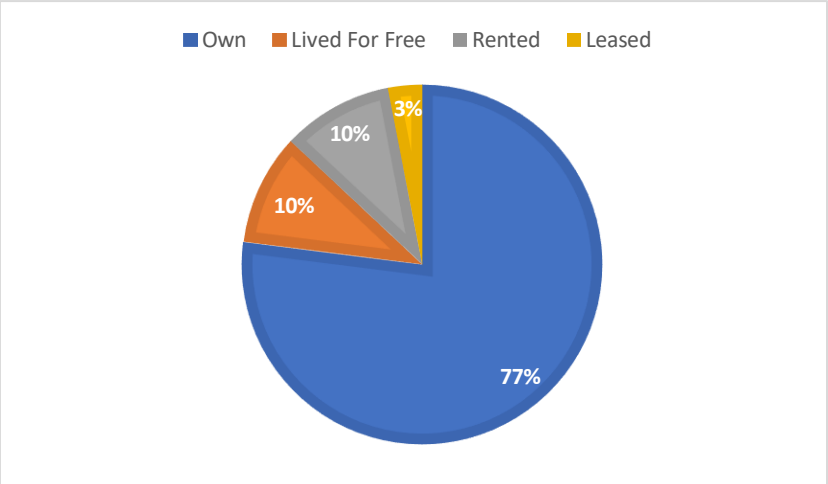
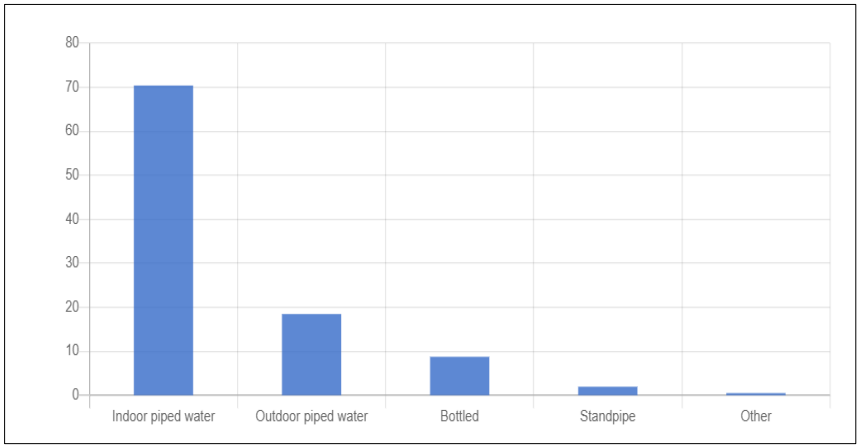


Figure 4-58: Housing Tenure in represented communities

4.5. Description of Existing Infrastructure

4.5.1. Water

Most of the households within the communities in the project area are serviced by the National Water Commission. Of the parish population, 63% had water piped into their yard while 54% had these resources piped into their dwellings. Based on the community survey conducted however as reflected in the figure below, 70% of the surveyed population receive indoor piped water, while 18% received piped water from outdoors, 9% used bottled water, and 2% received water from the standpipe. One percent of the population secured water from other sources, including water supplied from trucks, and one respondent indicated that they were connected through an illegal water connection.



Water source by household in the project area

Regarding the water supply service, 30% of the respondents viewed it as adequate, while another 45% of the population viewed it as inadequate and *sometimes* adequate. In the 2022 survey this perception was linked to the belief that the water supplied was unfit for human consumption and felt the quality declined even further whenever it rained.

As it relates to water storage, most of these respondents store water, using bottles which are used during water lock offs. Majority of the respondents in the 2022 survey indicate that these lock offs occur less than once a month, but more frequently than once a year.

4.5.2. Sewage Disposal

According to the Social Development Commission's Community Profile of 2012 for the Steer Town community, 55% of the households had water closets (toilets) that were not connected to the main sewer system, while 11% of households shared toilet facilities with other families.

The community survey indicated, however, that in the corresponding figure below, of the 206 respondents, most households have their own water closets which are linked to an on-site disposal system/household pit and 18% were linked to a central sewer network, while others were connected to a septic tank.

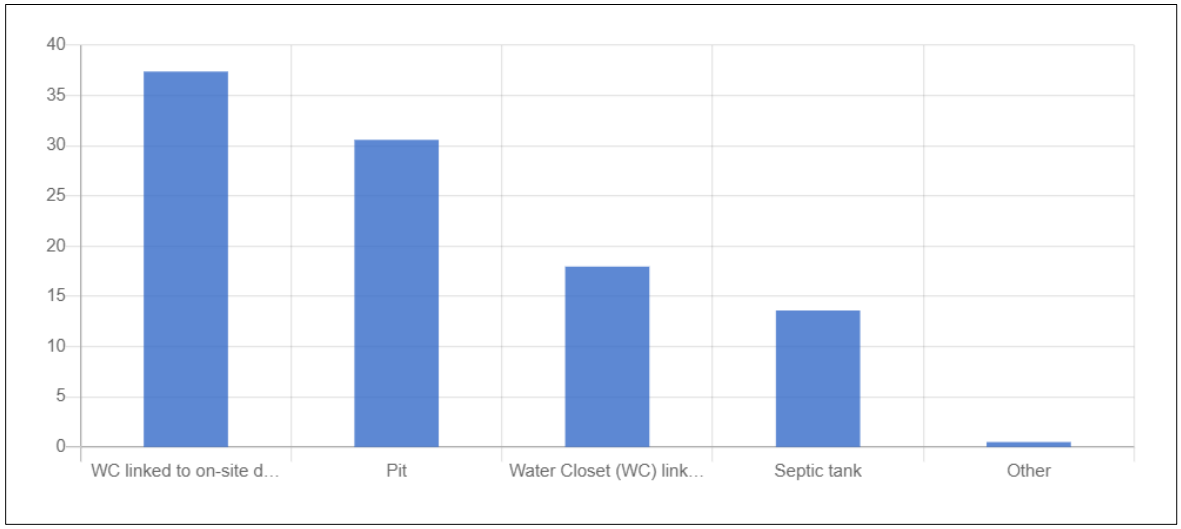


Figure 4-59: Sewerage connection type by household

4.5.3. Garbage Disposal (Solid Waste)

Data from the 2012 SDC Community profile revealed that 67% of households in the communities in St. Ann disposed of their garbage through regular garbage collection (trucks), while 19% of the population used the community receptacles. The community survey reflected similar results, as reflected in the corresponding figure below, where 81% of the households surveyed disposed of their garbage through regular garbage collection, while 17% disposed of their waste via incineration (burning), and another 2% used a community skip.

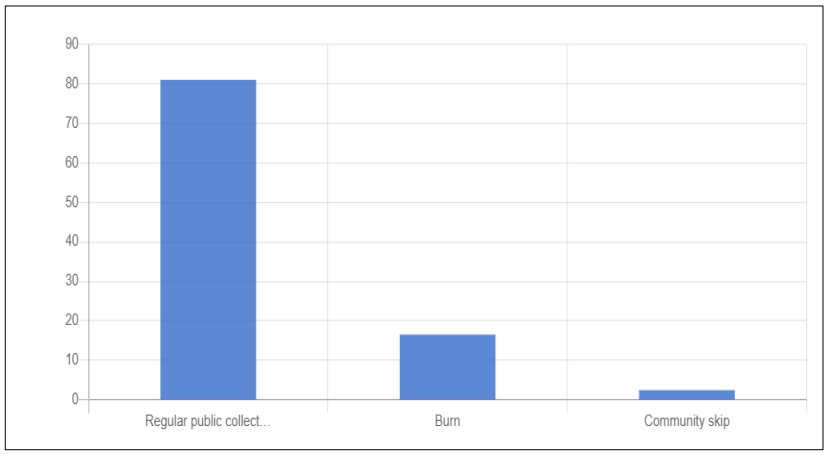


Figure 4-60: Methods of garbage disposal as per household

4.5.4. Transportation

Most (52%) of the population, in St. Ann use route taxis as their main source of transportation. (STATIN 2011)

Based on the community survey of 206 respondents, as reflected in the figure below, 73% of them use public transportation meaning licensed public passenger vehicles, i.e. minibuses and route taxis, while another 23% of them use motor vehicles, 1% of the population use motorbikes, bicycles and another 3% walk.

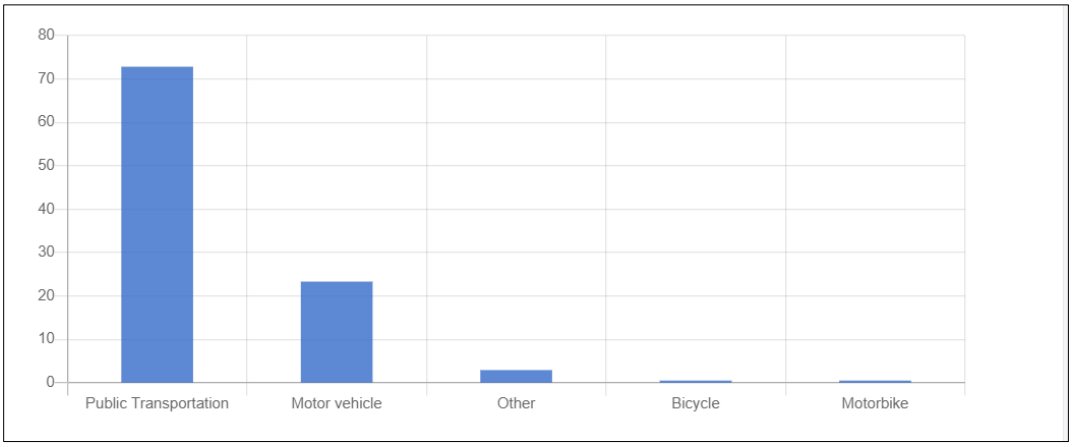


Figure 4-61: Mode of transportation used in the project area

4.5.5. Electricity

Majority (97%) of the population in the project area received lighting from electricity supplied by the Jamaica Public Service Company (Social Development Commission, 2012). Of these households, 91% prepared food using Liquid Petroleum Gas.

4.5.6. Telecommunications

4.5.6.1. Internet Access

In the parish of St. Ann, 10,866 heads of ouseholds, both male and female, have access to internet (STATIN, 2011). The community survey showed that 90% of the respondents had access to the internet in their households. They did not however have public internet access.

4.5.6.2. Phones

Most of the households in the project area have access to phone service (SDC 2012). In the community survey all the respondents indicated that they had a phone and 89% of them had a smart cell phone which could access internet service.

4.5.7. Road and Drainage Network

The proposed project is bordered by two highways, namely the Highway 2000 North-South (Edward Seaga Highway) and the St. Ann's Bay to Ocho Rios section of the North Coast Highway. Both roads are in excellent condition. However, farther west of this development the road surfaces within the nearby hilly communities of Steer Town, Mammee Bay, Greenwich Park, and Chalky Hill could be improved. No evidence of flooding was identified.

4.5.8. Community Services and Facilities

Within the 2 km boundary of the study area, there exists several facilities that serve the communities of Chalky Hill, Greenwich Park, Mammee Bay East and Steer Town. These facilities include churches, recreational facilities, community centres, schools, health care institutions, police and fire stations.

There are other social services that are outside of the study area that serve these targeted communities and that includes the St Ann's Bay Police Station, the St. Ann's Bay Fire Station and the St Ann's Bay Hospital.

St Ann's Bay is a Type B hospital with a total bed capacity of two hundred and twenty beds (220) with an average occupancy of 87%. The type B categorisation means that this hospital specialises in internal medicine, general surgery, obstetrics and gynaecology.

A complete listing of these facilities and services are detailed in the table below.

Health Care Institutions	Churches	Recreational Areas	Schools	Community Centres	Police Station	Fire Station
St. Ann's Bay Health Centre	Steer Town New Testament Church of God	The World-Famous Dunn's River Falls and Park	Steer Town Primary and Junior High	Steer Town Community Centre	St Ann's Bay Police Station	St Ann's Bay Fire Station
Elite Diagnostic Medical Imaging Centre	Kingdom Hall of Jehovah's Witnesses	Pearly Beach	Bright Beginners Kindergarten			
Lifeline Medical Centre	Methodist Church	Dolphin Cove Ocho Rios	Chalky Hill Infant School			
St Ann's Bay Hospital	Pentecostal Tabernacle Steer	Old Fort Bay Beach				

	Town United Pentecostal Church					
Steer Town Health Centre		Scotchie's Drax Hall				
		Kaya Herb House				
		Mammee Bay Jerk Centre				
		Stumpy's Café and Juice Bar				

5. Public Participation

5.1. Perception of the Proposed Development

This section details the perspectives captured from the community survey of households and in person consultations with businesses operating within the 2 km sphere of influence of the Proposed Housing and Subdivision Project in Mammee River, St. Ann. It also details the level of awareness among the business places about the project. It is 120inimizin into two sections, with the former in Section A, and the latter in Section B.

5.1.1. Findings from the community survey

Based on the community survey, 51% of the respondents highly approved of the proposed project, most of whom were not concerned about how this project would impact the Roaring River Great House and the Wag Water Wheel, because they are physically far away from the site, and will not be affected (Figure 5-1 and Figure 5-2).

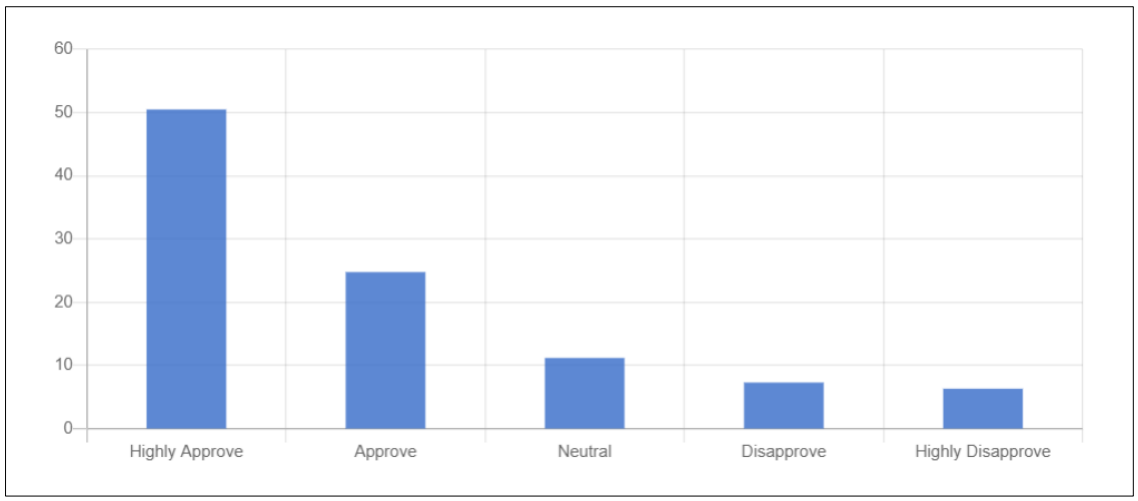


Figure 5-1 Approval rating of the proposed project

In fact, 73% of the respondents perceived this development as very necessary.

In their opinion, as reflected in the figure below, 43% believed that it will create significant development in the community (i.e., modernise the community, lead to community upliftment), 24% believed that it would provide more opportunities for employment, 14% believed that it will address the long-standing housing issue and improve the housing infrastructure, 3% believed that it will improve the natural environment. However, 16% did not respond to this question.

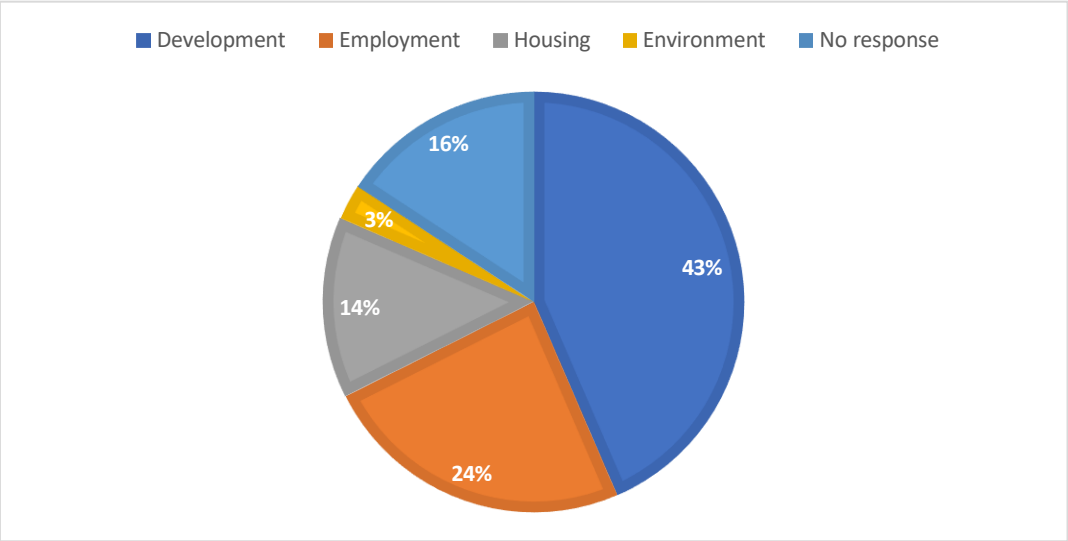


Figure 5-2 Reasons why proposed project is perceived as necessary

In fact, 63% of the respondents could not think of a better use of the space for the development as reflected in the figure below.

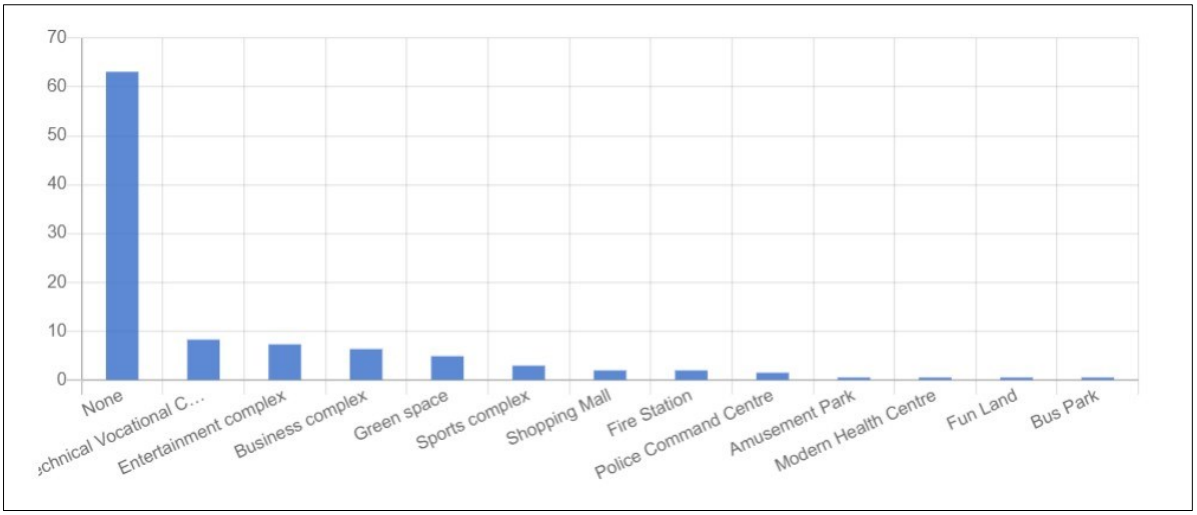


Figure 5-3 Perspectives on alternative use of the space for the development

Regarding environmental concerns that the community would have about the project being implemented, 71% of those surveyed, indicated that they had no major issues. However, they identified some concerns which included: (i) 10% of the respondents indicated that the project may lead to increased traffic congestion in the community; (ii) 5% indicated that it will reduce the water supply; (iii) another 5% indicated that it will negatively impact the plant and animal life in the area; (iv) 3% indicated that the development will destroy the Wag Water Wheel and the Roaring River Great House; and (v) 2% believe that the project will become a noise nuisance.

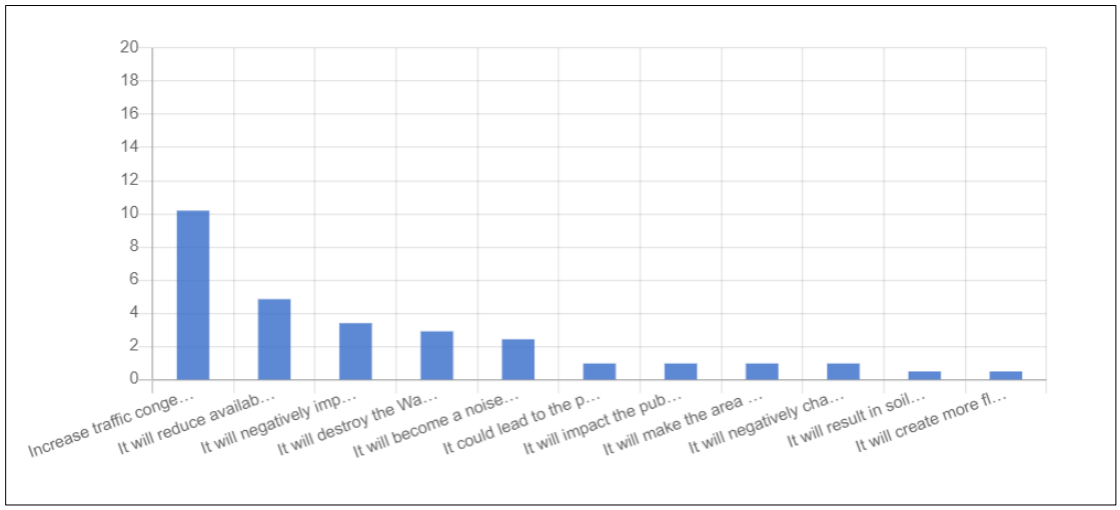


Figure 5-4 Environmental concerns from the proposed project

However, despite these concerns, 79% of the respondents indicated that the project should proceed as designed. Those who disagreed indicated that the new development will:

(i) increase traffic congestion in the area;

(ii) block family access to drinking water supplied by the Roaring River;

(iii) block access of some community members to farm the lands and use the river.

Figure 5-5 Sample of businesses engaged in the project area

5.1.2. Findings from consultations with businesses in the project area

The ESL project team engaged several businesses in the 2km radius of the project area to assess their project awareness and gain their insights on the potential impacts of the proposed housing division on the project area. A zoom consultation was conducted with a representative from the Urban Development Corporation, the manager of the Dunn's River Falls and Park. On the 6th of October surveys were administered orally to fifteen representatives from Boots Gas Station and Business Complex in Drax Hall, Sandals Dunn River, Mammee Bay Wholesale, Mammee Bay Jerk Centre, Total Gas Station Drax Hall, Village Stop and Shop (Steer Town), W& W Hardware, Walmac Hardware, Jay & Cas Minimart, Stumpy's Café and Juice Bar, Kaya Herb House, Scotchie's Drax Hall, Lifeline Medical Centre and N&S Groceries Mammee Bay.

Their insights revealed that:

1) Most (80%) of the businesses interviewed were not aware of the project, while 20% of the respondents were aware of it, as reflected in the corresponding figure below.

Figure 5-6 Assessment of awareness of proposed project from businesses in the project area

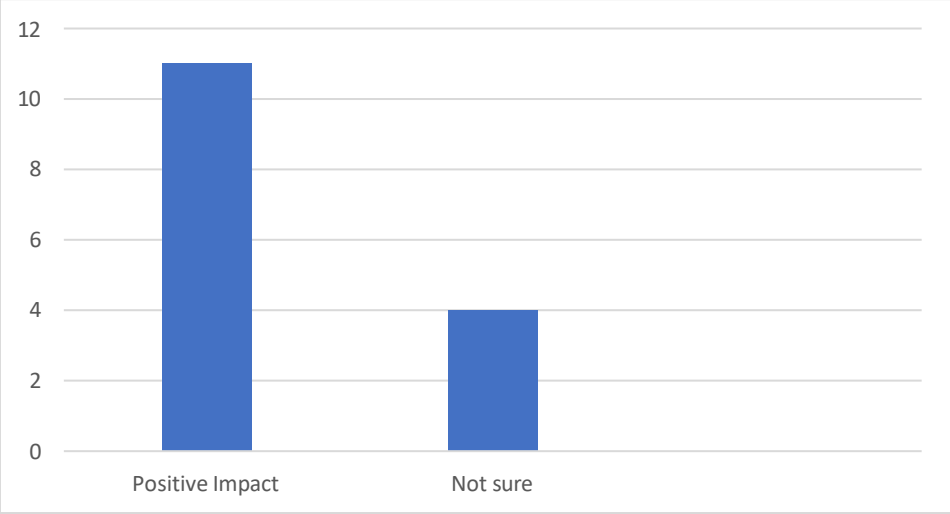


Figure 5-7 Local businesses' perception of the impact of the proposed project in the area

Businesses who expressed positive feedback about the impact of the proposed project on their business provided reasons that included:

- Increased opportunities for employment and better quality of life
- More opportunities for local businesses to economically benefit in the project area such as the Kaya Herb House, Boots Ibex Gas Station and Business Complex, Mammee Bay Jerk Centre,

Scotchies' Jerk Centre,

- Proposed project addresses the urgent problem of housing
- The project is good if it does not affect the local watershed

Respondents who indicated that they were not sure about the type of impact they foresaw happening from the project on their business stated that: (i) if the community benefitted from the project, then they would support it; and (ii) they are physically too far away from the project for the project to have any consequence on their business.

2) Although most respondents viewed the proposed project positively, 26% of the respondents, viewed the project negatively, some respondents indicated that the presence of the project in the area would lead to more traffic congestion and noise. They stated, however, that this would be a short term 'headache' for a long-term gain.

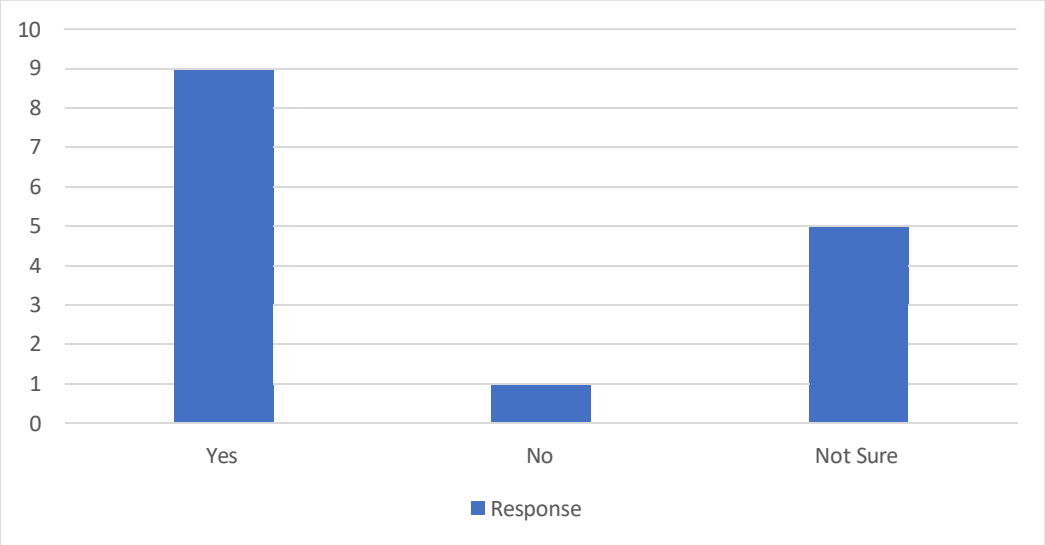


Figure 5-8 Local businesses' perception of the impact of the proposed project in the area

Most (60%) respondents from the local business community view this project as necessary. This is because: (i) This project may lead to more job opportunities in housekeeping, landscaping, and security; (ii) houses are necessary; (iii) people are always in need of accommodation. Only one respondent viewed this project as unnecessary. This respondent indicated that they would have preferred that the proposed project would be for youth empowerment/development which would discourage them from engaging in antisocial behaviour. Crime and violence are a significant problem in the Steer Town community which is the nearest community within the project area. On the other hand, very few respondents (33%) indicated that they were not sure if the project was necessary.

3) As reflected in the corresponding figure below, 53% of the respondents from the local business community surveyed, reported that the space reserved for the proposed project is the best use of space. Housing development is a serious issue in St. Ann and so the proposed development will address this long- standing issue. A significant number (40%) of the respondents from these businesses indicated that there could have been other uses for the space. Suggestions for alternative uses include:

- A shopping mall that could eliminate the commute to Ocho Rios.
- A road expansion of the highway. Any development without the expansion of the nearby road is impractical
- No development in the project area
- A National Housing Trust (NHT) funded housing development that would allow low income working Jamaicans an opportunity to own homes. It is believed that this would reduce the squatting issue in St. Ann, which is a significant issue.
- A technical vocational centre that could 'uplift the youth' and benefit the residents from surrounding communities. It is believed that equipping the youth with skills will encourage the youth to refrain from engaging in antisocial behaviour.
- A police station for Steer Town would be useful.
- Business complex, modern health clinic and technical vocational centre
- Businesses that provide employment for workers with trade skills (welding, carpentry etc.)

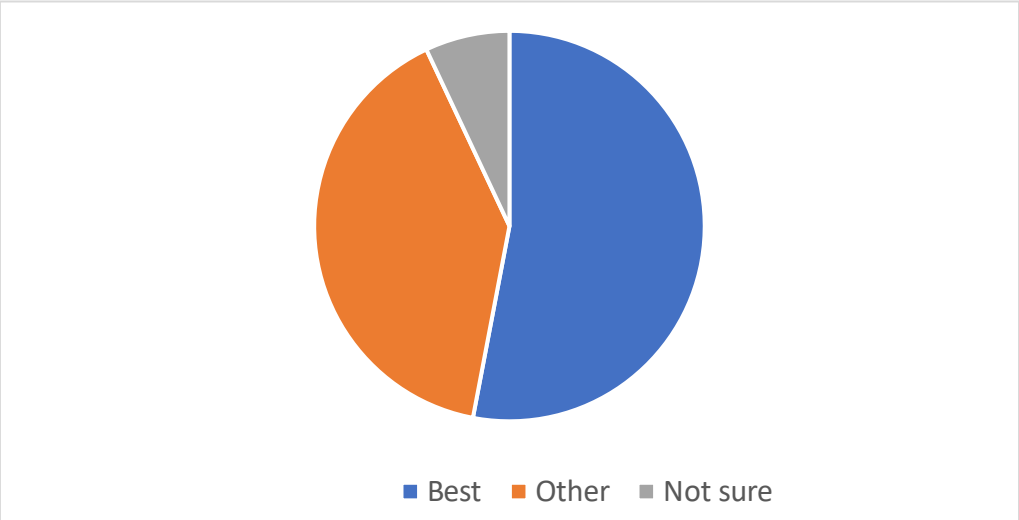


Figure 5-9 Assessment of optimal or 'best' use of physical space for proposed project according to local businesses

5.1.3. Findings from consultation with the Urban Development Corporation

A representative from the Urban Development Corporation (UDC) which currently owns and manages the nearby Dunn's River Falls and Park was engaged in an online (Zoom) interview. The UDC was also a previous owner of the Roaring River Great House and Wag Water Wheel properties on the project site. The following reflects the findings from this consultation.

The UDC was largely in support of the proposed development because it addressed a long-standing housing issue in St. Ann. They also indicated that if the development considers the environment, then the UDC would have no problem with it.

The UDC indicated that other businesses in the project area would approve of this development because of

the potential revenue that could be generated in the area.

However, the representative was concerned about the affordability of this project and whether National Housing Trust contributors would be able to afford it. Other concerns they expressed were: a) whether the property would be properly drained to eliminate the potential of sedimentation accumulating on nearby beaches and reefs; b) the extent to which the proposed project would affect the water table of the Dunn's River Falls and Park; c) the representative was also concerned about the possibility of erosion and declining water availability for the attraction, which they indicated could become a national issue. Furthermore, apart from environmental issues, they were concerns about: a) waste management in the area and b) the possibility of traffic issues and the degree to which it would impact the tourist buses traversing from that attraction to other attractions in the surrounding area back to the Falmouth or Montego Bay ports.

NB. As previous owners of the property the UDC has information related to soil, erosion and other environmental issues which could be useful to the ESL project team. They also expressed interest in collaboration with the project team because they have also interest in the project site as they own the adjoining lands.

5.1.4. Environmental Concerns based on the community survey

This section details the perception of the 206 respondents in the community survey as it pertains to their exposure to environmental hazards such as droughts, earthquakes, storm surge, flash flooding, tropical storms/hurricanes.

Regarding their exposure to flooding, 99% of the respondents indicated that they do not experience flooding in the community.

However, when asked to select all the likely hazards as it relates to their exposure to storm surges, earthquakes, flash flooding and drought within their communities the following responses were given. Of the 206 respondents, 145 respondents listed hurricanes and tropical storms as the most likely hazards to affect the community, while 119 respondents listed storm surge as the most likely. This is followed by drought, which 89 respondents viewed as a common hazard, 15 indicated flash flooding and another 10 indicated earthquakes as a common occurrence.

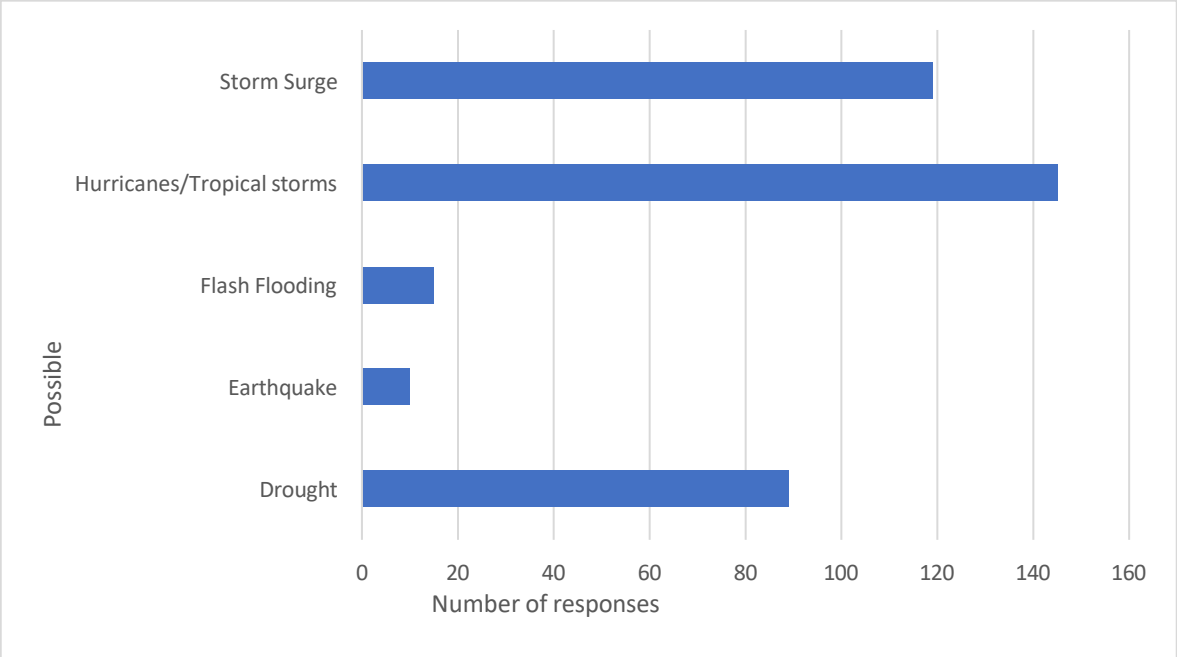


Figure 5-10 Responses about potential hazards in St. Ann communities

5.1.5. Cultural Assets

The Roaring River Great House and the Wag Water Wheel are important cultural and historical assets found in the project area, with the former designated with protected status by the Jamaica National Heritage Trust. The nearby Roaring River is an important asset in the area, and this section details the perception of the community about this asset as informed by the survey.

Based on the community survey conducted, 54% of the respondents indicated that they use the Roaring River. However, when asked about this river usage, of the 206 respondents, only 111 persons responded. Of that population as reflected in the figure below, 39% of those surveyed use this river for recreational purposes i.e., swimming, 6% use it for laundry purposes, and 3.4% use it for drinking water, 1.46% use the water to irrigate agricultural crops. 4.86 % of the respondents used it for other activities such as fishing for crayfish.

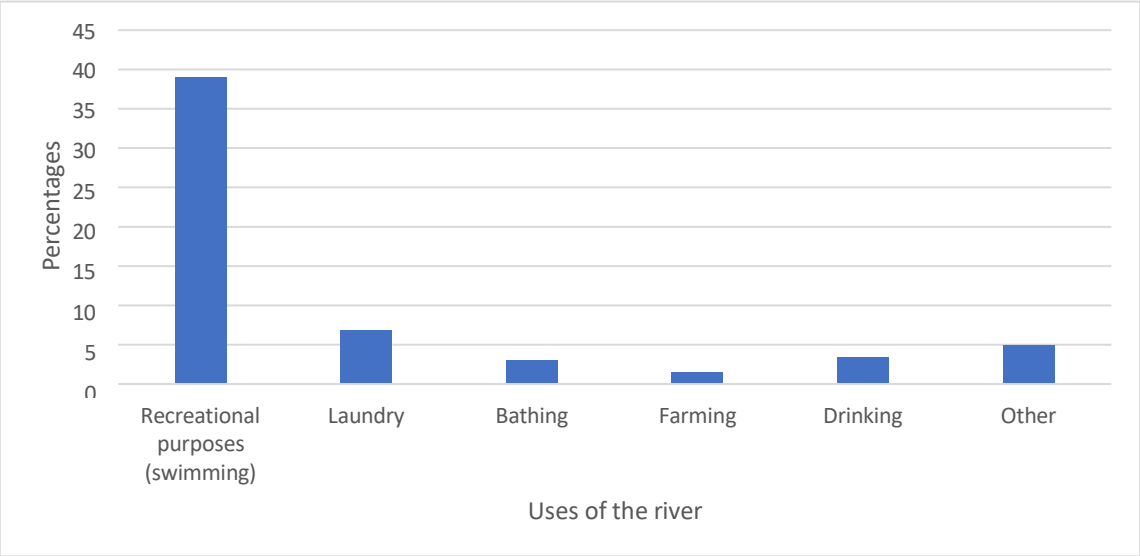


Figure 5-11 Assessment of river use in the community

5.2. Summary

The perception of the residents and businesses in the project area about their current situation and existing infrastructure is essential in understanding the potential social impacts associated with the proposed development. This data was collected over a three-month period from electronic field surveys and in person interviews with businesspersons in the 2-kilometre boundary of the project area. The electronic survey was administered by a group of data collectors using the Kobo Toolbox field data collection online platform.

The survey covered the communities of Steer Town, Chalky Hill, Mammee Bay and Greenwich Park via the convenient sampling technique. Two hundred and six (206) individuals, representing 6% of the total population of households in the area, were surveyed. Survey interviews were conducted with respondents from ages ranging from eighteen (18) years to over sixty-five years (65) of age. Most of the respondents surveyed were those in the thirty-five (35) to forty-four (44) age group who lived in the area for over twenty-six years.

Most of the respondents were employed full-time in commercial/retail activities, tourism related activities, and farming. Home ownership was high at 77% among the respondents.

The section on the provision and access to utilities in the area received mixed results among those surveyed. Most (97%) of these communities in St. Ann received electricity from the Jamaica Public Service Company (JPS) and a similar percentage used gas stoves.

However, the perception of potable water quality in the project area remains a major concern. Although 70% of the respondents had access to indoor piped water, a significant number of respondents were unsure if it was adequate. They believed that the water supplied was oftentimes dirty and was unfit for human consumption.

Regarding garbage disposal, most (81%) respondents surveyed did not consider it a major issue, indicating that their garbage is collected regularly.

As it relates to perception about the proposed development, 73% of the respondents approved of it. They believe that this project will: (i)provide more job opportunities; (ii) address the housing shortage in the

project area; (iii) create much needed development in the community (i.e., modernise the community, lead to community upliftment); and (iv) improve the natural environment. They were largely unconcerned about the impact the proposed development would have on the Roaring River Great House and Wag Water Wheel historical assets, because they were physically very far away from the site and would not be affected.

A small percentage of the respondents, however, were concerned about the environmental impact associated with the proposed project. These issues included:

- Possibility of increased traffic congestion in the community
- Reduction in the water supply
- Negatively impacting the plant and animal life in the area
- Possibility that the development will destroy the Wag Water Wheel and the Roaring River Great House
- Possibility of the project becoming a noise nuisance.

Generally, residents and businesspersons who were engaged during this assessment were largely in agreement with the proposed project, as they perceive numerous benefits because of this development in Mammee River.

6. Impact Identification & Analysis

This section identifies the potential impacts that have been considered for the pre-construction, construction and operational phases. Physical, Biological/Ecological and Social attributes are assessed in Sections 6.1 to 6.4. Cumulative impacts have been considered in Section 6.5, as this development expands the existing tourism facilities and infrastructure in Mammee Bay and should also take account of other known proposed developments within the sphere of influence of the proposed project.

It is important to note that the hydrological assessment and the geotechnical investigations were completed before the finalization of the site plans and the impact identified in this Chapter were based on the previously completed reports. This Chapter will be updated in accordance with the recent site plan and layout provided by CHEC in the final draft of the EIA Report.

In order to assess potential impacts, the sensitive receptors have been identified to inform the analysis. The box below outlines these receptors. It should be noted that the potential impacts are not exhaustive but includes those that are most likely.

Box 1: The potential receptors considered in the impact analysis

- People (workers, residents, visitors)
- Nearby tourism properties
- Downstream Beaches
- Drainage system
- Other businesses
- Communities, housing development
- Footpaths and roads
- Important archaeological/heritage sites
- Schools, and other public buildings
- Water sources – Roaring River
- Protected, rare, endangered, or economically important species
- Heritage assets including Taíno sites and Mammee Bay Great House

6.1. Pre-Construction and Construction Phase

This section outlines the potential impacts associated pre-construction and construction activities. Activities include site clearance, excavation, levelling of the proposed site, internal road construction and the laying of utility lines (power, water, wastewater, telecommunications), construction of houses, and erection of supporting project components such as the sewage treatment plant, a site office, and a batching plant.

6.1.1. Potential Physical Impacts

6.1.1.1. Hydrology and Drainage

Disruption of surface water and changes in hydrologic regime is possible with the pre-construction and construction activities of this proposed development. This can be as a result of improper storage of construction material or refuse, along with the removal of exiting natural drains without appropriate alternatives. It has the potential to increase runoff which may cause flooding onsite or downstream.

6.1.1.2. Water Quality

If the planned pre-construction and construction activities are not managed properly, these activities can result in increased sediment run-off to the nearby water systems and other drainage channels that empty along the coastline. Land clearance and improper storage of fine earth material near to drains and or stream are activities that can potentially negatively impact the quality of the water in the river, channels and along the coastline.

Additionally, improperly treated or disposed of sewage and improperly stored and used chemicals can also potentially contaminate adjacent surface water.

6.1.1.3. Air Quality

Construction activities can potentially result in a rise in air emissions in and around the construction site.

The following construction activities can contribute to air quality deterioration due to increased particulate matter:

- Transportation, storage, and handling of construction material (e.g., fine earth material)
- Clearing and excavation of the land
- Improper storage and transportation of cleared/excavated earth materials
- Increased traffic and construction vehicles in the area
- Improperly maintained vehicles
- Fugitive dust from unpaved roadways
- Use of diesel generators

The impact to air quality is expected to be predominant in the pre-construction and construction phases of the development. Currently, the land is heavily vegetated and the client should use this to their advantage by minimising phase clearing to minimize potential impacts to the air quality.

6.1.1.4. Noise

Due to the large amount of mechanical equipment, transport vehicles and physical activities associated with the construction of the residential units, apartment complexes, sewage treatment plant and other supporting amenities, there is a potential for elevated noise within the sphere of influence.

It is anticipated that the highest noise levels will be experienced during the pre-construction and construction phases. However, during the operation phase of the development, residents may be impacted by vehicular noise from busy throughfares found along the northern and western boundaries of the property.

6.1.1.5. Solid Waste

During construction, non-hazardous solid waste may be generated from activities such as site clearance (debris), packaging for construction materials (pallets, cardboard, plastics etc.) and generally from workers on site. To a lesser degree, construction activities may also generate hazardous waste e.g., concrete additives, paint, and varnish containing organic solvents. The proper disposal of these materials must be adhered to.

Receptors likely to be impacted include surface water features on property and possible receiving water bodies. The construction workforce and local ecology within the sphere of influence may also be impacted. Importantly, the coastal water is a receiving body for all the drainage features running off or through the site. This coastal water serves as both a marine ecological asset and is used for recreation and a source of persons livelihood.

6.1.2. Natural Hazards

Hazards such as hurricanes, tropical storms and earthquakes can occur during the pre-construction and construction phase. There is potentially a higher risk from hurricanes and storms to the site than earthquakes based on the desk review. Natural hazards mentioned can potentially result in loss of assets, injury to persons, disruption to pre-construction and construction stage activities and loss of life if not managed. This can potentially have a major negative impact but can be mitigated through having emergency response procedures on site for contractors to follow and a disaster risk management plan in place.

6.1.3. Potential Biological Impacts

The ecological environment on site is anticipated to be disturbed from land clearing and other activities during the pre-construction and construction period. Despite this, the site is very vegetated with some endemic species identified mainly within the forested areas. Although the larger portion of the site will undergo mass vegetation and habitat loss, larger trees should be tagged and integrated into the development to retain their ecological functioning. This loss/displacement of flora will in turn affect the fauna across the site however, retaining the forest areas in its current state should provide a nearby habitat for the species that are displaced.

6.1.4. Potential Social Impacts

This residential development proposed for Mammee Bay has the potential to create a variety of impacts in all project phases. These potential impacts can be both positive or negative depending on the receptors involved and other parameters such as magnitude and duration. It is anticipated that this project will potentially have a significant positive impact on areas such as the economy, employment, foreign exchange earnings among others.

6.1.4.1. Employment

This development will potentially result in the direct and indirect employment of workers to support the pre-construction and construction phases of the project. Direct employment is projected at approximately 1200 tradesmen and labourers during the pre-construction and construction phase. Direct employment of approximately 800 employees is anticipated during the operational phase. This employment is a positive one but is expected to be short-term and will decrease as construction is completed.

Indirect employment will also likely result in the support of other businesses such as taxi's that will transport workers to and from the site and the trucking services that may be employed, to name a few.

6.1.4.2. Worker Health and Safety

Based on the planned pre-construction and construction activities site health and safety implications can potentially impact both the workers that will both work and reside on the site. Accidents, falls, bruises, and potential loss of life can occur from operating machinery and excavating. It is important that investments are made with respect to the necessary personal protective equipment to prevent these potential issues, which can be irreversible if there is loss of life.

6.1.4.3. Community Health and Safety

The planned pre-construction and construction activities can also negatively impact the health and safety of nearby community residents that traverse the area. Accidents, falls, bruises, and potential loss of life are all likely is the construction site is not properly managed and restricted access and signage are not implemented. Mitigation measures would be important investments to prevent these potential hazards which can be irreversible in the case of potential loss of life.

6.1.4.4. Heritage

There are Taíno sites that are expected to be found during construction along with the foundation ruins of the Mammee Bay Great House that were not located due to the thick undergrowth. These can potentially be destroyed during the site clearing, excavation and construction processes. This potential loss is likely to a significant archeological and permanent loss during the pre-construction and construction phases of this project. Mitigation measures need to be implemented to prevent this potential irreversible loss.

6.1.4.5. Small-scale Commercial Business

A micro-economy is likely to be developed supplying refreshments, lunches etc. to workers on site. This is a potential positive impact on the community as the workers contribute to the thriving of small-scale businesses in the immediate project area. In addition to the establishment of new shops and small-scale businesses, existing businesses such as local hardware stores will also likely receive an increased benefit from purchases to support the pre-construction and construction phases of the project.

6.2. Occupation & Operation Phases

6.2.1. Potential Physical Impacts

6.2.1.1. Hydrology and Drainage

For the post-development assessment, the major parameters affecting the runoff would be the percentage of the area that would become impervious as a result of the development. The proposed areas affecting the imperviousness of the area include the roadways, parking areas, the buildings and depression ponds. The simulated peak runoff is summarized in Table 6-1.

Table 6-1 Post-development peak runoff/flows

Structures		Peak Runoff (m^3/s) in Return Period (RP)				
		5- Year RP	10- Year RP	25- Year RP	50-Year RP	100- Year RP
Bridge		8.5	15.0	26.4	36.4	48.6
Channel	Upper	1.8	3.3	6.1	8.9	12.7
	Lower	5.7	10.3	19.3	28.1	40.2
Culvert		1.2	2.2	4.4	6.4	6.4

Table 6-2 illustrates the differences in pre- and post-development peak flows. Based on the estimated runoff, the bridge will experience the greatest increase as a result of the development, while there will be no change in the runoff at the culvert. Table 6-3 shows that the 10-year return period increase in peak flow at the bridge will be at least 15.0 cubic meters per second (cumecs). Similarly, the 10-year return period increase in peak runoff at the Upper Channel will be at least 3.3 cumecs. This means that there is a 1% chance that in any given year, the proposed development will increase flows at bridge by at least 15.0 cumecs and within the upper channel a 1% chance that the increase will be 2.2 cumecs.

Table 6-2 Differences in pre- and post-development peak flows

RETURN PERIOD	UNITS	POST-DEV OUTLET	PRE-DEV OUTLET	DIFFERENCE	PERCENT DIFFERENCE
Bridge					
5	Peak Runoff (m^3/s)	5.8	5.4	0.4	7.4%
10	Peak Runoff (m^3/s)	15.0	9.7	5.3	54.6%
25	Peak Runoff (m^3/s)	26.4	17.7	8.7	49.1%
50	Peak Runoff (m^3/s)	36.4	25.0	11.4	45.6%
100	Peak Runoff (m^3/s)	48.6	33.3	15.3	45.9%
Upper Channel					
5	Peak Runoff (m^3/s)	1.8	1.5	0.3	20.0%
10	Peak Runoff (m^3/s)	3.3	2.2	1.1	50.0%
25	Peak Runoff (m^3/s)	6.1	5.2	0.9	17.3%
50	Peak Runoff (m^3/s)	8.9	7.5	1.4	18.6%
100	Peak Runoff (m^3/s)	12.7	10.5	2.2	20.9%
Lower Channel					
5	Peak Runoff (m^3/s)	5.7	4.8	0.9	18.8%
10	Peak Runoff (m^3/s)	10.3	8.7	1.6	18.4%
25	Peak Runoff (m^3/s)	19.3	16.4	2.9	17.7%
50	Peak Runoff (m^3/s)	28.1	23.7	4.4	18.6%
100	Peak Runoff (m^3/s)	40.2	33.1	7.1	21.4%
Culvert					
5	Peak Runoff (m^3/s)	1.2	1.2	-	0%
10	Peak Runoff (m^3/s)	2.2	2.2	-	0%

RETURN PERIOD	UNITS	POST-DEV OUTLET	PRE-DEV OUTLET	DIFFERENCE	PERCENT DIFFERENCE
25	Peak Runoff (m^3/s)	4.4	4.4	-	0%
50	Peak Runoff (m^3/s)	6.4	6.4	-	0%
100	Peak Runoff (m^3/s)	6.4	6.4	-	0%

The required dimensions for the drainage structures are also presented in Table 6-3. The drainage requirements are based on the design discharges and the slope of the pipe or channel. Details of the required drainage structures and capacities is presented in Appendix H. The drainage plan in Figure 3-22 illustrates the proposed drainage for the site.

Table 6-3 Post-development proposed structures for large off-site watersheds. BC = Box Culvert; PC = Pipe Culvert

Structures		Design Discharge (m^3/s)			Required Structure Size
		10- Year Return Period	25- Year Return Period	100- Year Return Period	
Bridge		-	-	48.6	7m x 3.0m BC (without mitigation) 1200mm PC (with mitigation)
Channel	Upper	3.3	6.1	-	1.0mW x 0.6mH (25yr) 0.8mW x 0.6mH (10yr)
	Lower	10.3	19.3	-	1.5mW x 0.9mH (25yr) 1.0mW x 0.9mH (10yr)
Culvert		2.2	4.4	-	Match channel width and height

5.1.1.1.1 Detention Ponds

To counter the potential impact on the beach and nearshore area, a detention pond is proposed north of the subdivision as indicated in Figure 6-1 the detention pond consists of an area of up to 150m x 40m – a base area of 6,000m^2. This pond will be designed in its entirety as a soakaway with an estimated infiltration rate between 0.001m/s and 0.01m/s, and a percolation rate ranging between 6m^3/s – 60m^3/s. A small detention pond is also recommended to prevent runoff from impacting the residential areas.

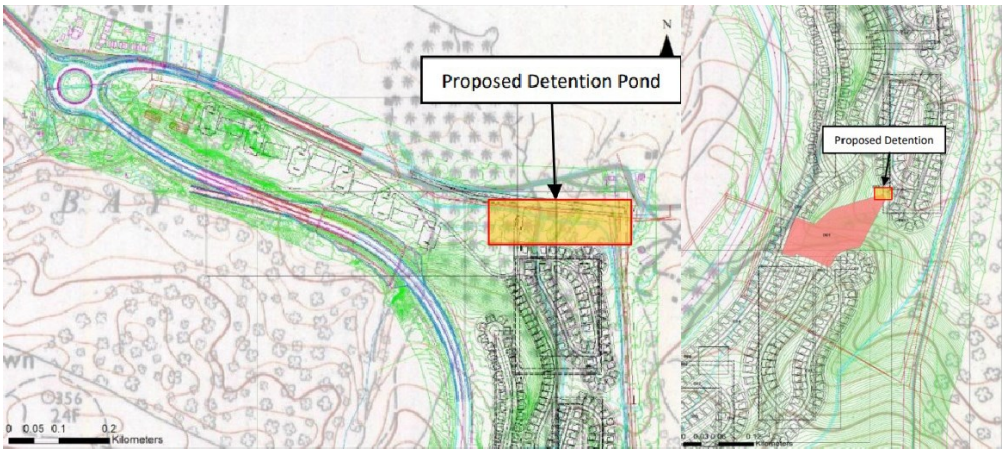


Figure 6-1 Proposed location of detention ponds

6.2.1.2. Natural Hazards and Climate Change

The operational phase of the development will mean that the houses are sold to private homeowners. It is also likely that a community association is formed with the private homeowners and so the hazard exposure and risk namely, storms, hurricanes and earthquakes will impact these private homeowners. The exposure and risks which are more likely to have a negative impact on homeowners are storms and hurricanes, more so than earthquakes. Additionally, climate change projections, can increase the risk of storms and hurricanes. With climate change, intensified hurricanes and tropical storms in the area pose a negative risk to the development. These can potentially result in damages and losses to buildings and infrastructure. The design of the structures would be most critical in the minimization of negative impacts from these natural hazards. The design, as a result, should be informed by hydrological and drainage assessments as well as geotechnical investigation and building codes, which will allow for the integration of the most safe and sustainable design in the infrastructure and houses constructed.

6.2.2. Potential Ecological Impacts

During the occupation and operational phase, the impact of human activities will likely continue, although on a smaller scale. If homeowners have access to the undisturbed vegetation along the eastern side of the property flora and fauna habiting this space can be affected. Other activities like burning and improper disposal of solid waste should be avoided to further reduce the impact of humans on the environment.

Given the proposed installation of a sewage treatment plant in which any overflow of sewage will directly lead to drainage pipes that directly outflows to the sea, there are concerns regarding the impact this may have on the existing marine environment. The high nutrient nature of sewage outflow in marine environments can result in the proliferation of macroalgae and encrusting aggressive invertebrates in affected areas. As such, it is highly recommended that a baseline marine assessment be conducted to understand the current benthic conditions prior to construction and operation of the sewage treatment plant.

6.2.3. Potential Social Impacts

The development will also spawn direct and indirect employment throughout the surrounding communities and within the tourism corridor in St. Ann as a whole. The influx of middle to high income permanent and short-term vacation rental residents will encourage new businesses and services to be established to

service their needs. This represents a significant positive, both direct and indirect, long-term impact. The land values in the area may rise, and the cost of living may increase in the area. There may be a lag between the population growth and the expansion of social services (i.e. health, police, fire etc.) to meet the needs of the increased population. These services may experience strain during this lag period. However, overall, the development will result in an improvement of infrastructure and resources in the area (water and electricity) along with improved property values. These are significant positive, direct, long-term impacts to the community.

6.3. Cumulative Impacts

Cumulative impacts, as it pertains to air, noise and water associated with the project identified include: -

- With the expected growth in the proposed project development area, the potential arises for increased traffic along the Highway 2000, in the Mammee Bay area and possibly in the Steer Town/ Chalky Hill communities. This may result in increased noise nuisance and particulate matter production in the area as more people will have to get to and from the proposed development site.
- Coastal areas in Jamaica have been regarded as being deteriorated over the years with developments along the coast or nearby to the coast. The Mammee Bay area receives water from several rivers/ tributaries/ culverts that may pass through the proposed project location. There is evidence along the beaches and coastal area of possible nutrient impacts. If sewage and stormwater run-offs are not managed properly, the proposed develop can combine with pre-existing impacts to increase the impacts of surface and sewage in-flows into the marine environment.
- With the expected development there will be a reduction in the amount of undisturbed secondary forest, however, the development has included in its plans areas that will remain in their more natural state for walking trails and bird watching opportunities, along with manicured green spaces, which will increase accessibility of the residents to natural and green spaces, which will have log term benefits to their well-being and general health. See Figure 6-2.

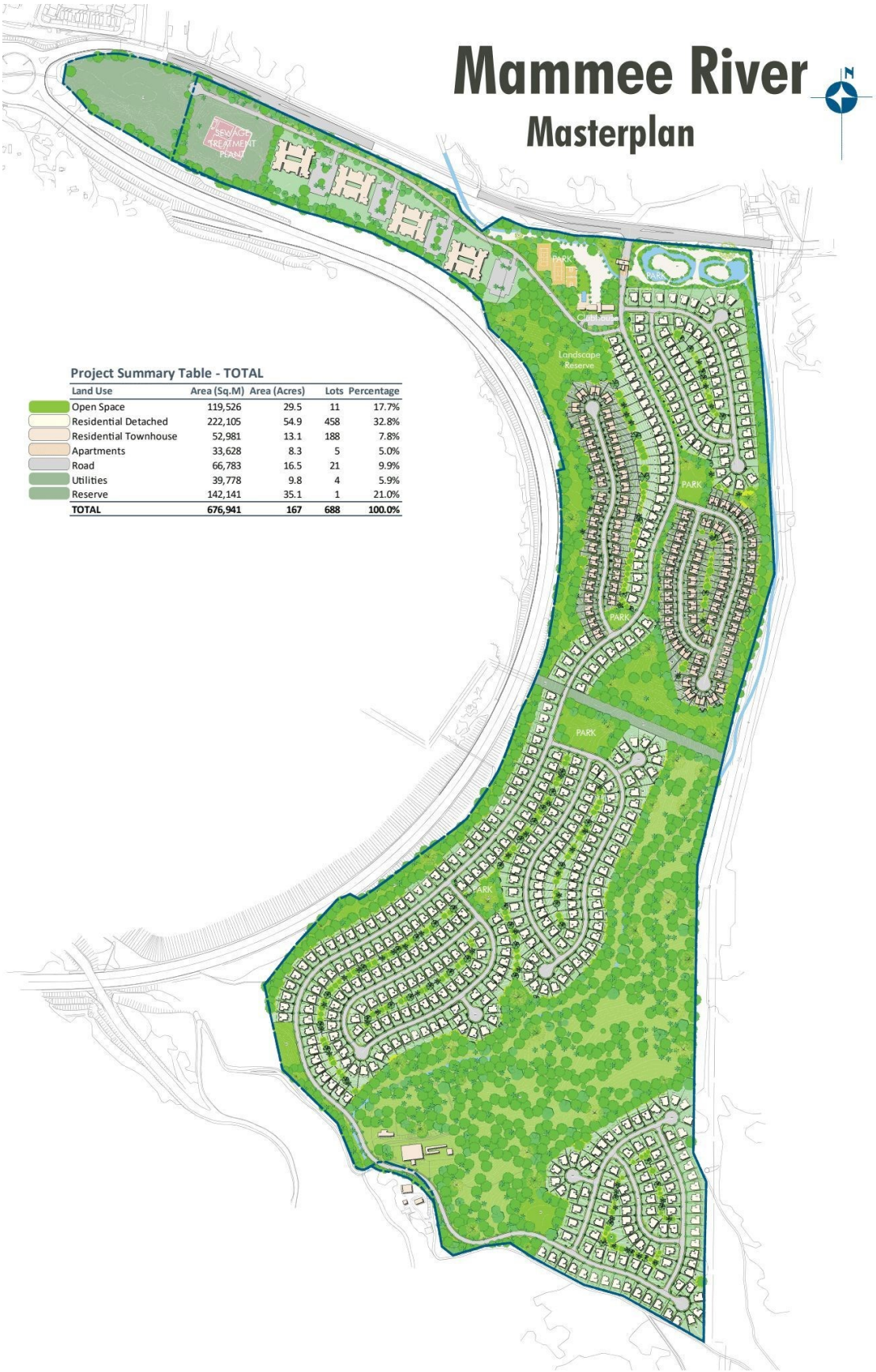


Figure 6-2 Green/Open Spaces

7. Risk Assessment

The section below outlines the risk matrix and mitigation measures for various aspects of the proposed Project. The legends for the components of the risk assessment are outlined in Table 7-1 to Table 7-4 below.

Table 7-1 Assessment of Probability

LEVEL	DESCRIPTION	EXAMPLE
5	Almost Certain	Is expected to occur in most circumstances, e.g., once per week
4	Likely	Expected to occur in most circumstances, e.g., once per month
3	Possible	Will probably occur in most circumstances, e.g., once per year
2	Unlikely	Could occur at some time, e.g., once every 10 years
1	Rare	May occur only in exceptional circumstances, e.g., once per 100 years

Table 7-2 Assessment of Impacts

LEVEL	PERSONNEL INJURY/ILLNESS	EXAMPLE DOWN TIME	EXAMPLE ENVIRONMENTAL EFFECTS
Catastrophic 5	Death	>1 month	Long-term environmental damage (project lifetime)
Critical 4	Severe injury or severe occupational illness > 2-week hospitalisation	1 month – 1 week	Medium-term environmental damage (5-15 years)
Significant 3	Major injury or major occupational illness < 2-week hospitalisation	3 days – week	Short-term environmental damage (0 – 5 years)
Marginal 2	Minor injury or occupational illness, no hosptialisation, day case	1 day – 3 days	Brief (< 3 months)
Negligible 1	First aid, no injury or illness	< day	Minor environmental damage

Table 7-3 Risk Scoring Matrix

Impact	**Catastrophic**	5	5	10	15	20	25
	Critical	4	4	8	12	16	20
	Significant	3	3	6	9	12	15
	Marginal	2	2	4	6	8	10
	Negligible	1	1	2	3	4	5
			1	2	3	4	5
			Rare	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
			Probability				

Table 7-4 Risk Response

SCORE	RISK	RESPONSE
≥ 20	Extreme	Urgent action required
11-20	High	Action required at the earliest possible moment
6-10	Medium	Action required
≤ 5	Low	Continue managing routine practices
0	Controlled Risk	Operation may continue with new controls in place

7.1. Control Measures

The image below presents the hierarchy of control measures that should be considered to reduce the likelihood and severity of risks or any impact that may arise from the proposed development. Controls should be selected from as high up on the list as reasonably practical to maximise effectiveness. In many cases a combination of controls may be necessary to reduce the hazard. Table 7-5 presents the risks and considerations for the proposed project.

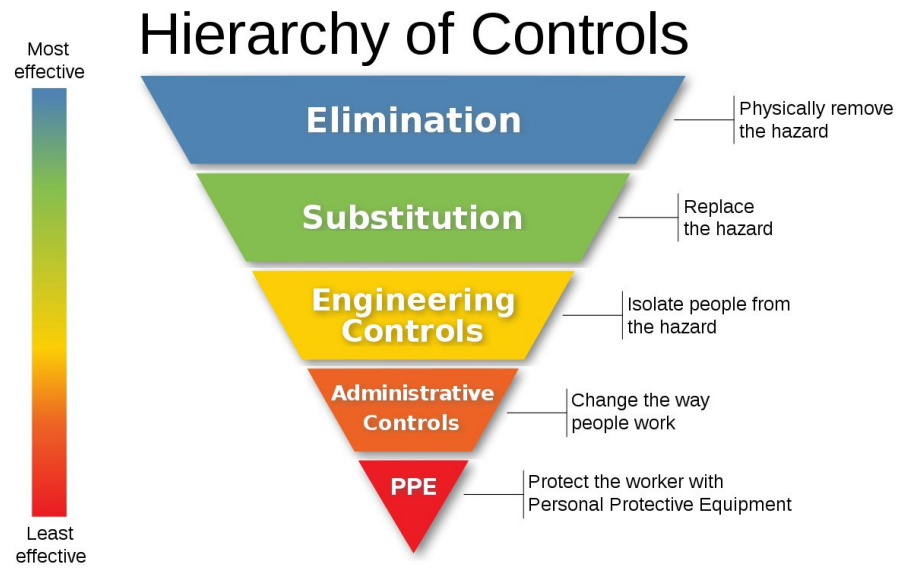


Figure 7-1 Hierarchy of Controls

- ELIMINATE: Eliminate the hazard by removal from the workplace
- SUBSTITUTE: Replace the activity, process, or substance with a less hazardous one
- ISOLATE/ENGINEERING SOLUTIONS: Isolate the hazard from employees, e.g., proper storage of chemicals, firearms, mechanical aids
- ADMINISTRATION CONTROLS: Implement safe workplace practices, procedures, and policies; provide training, adequate supervision
- PERSONAL PROTECTIVE EQUIPMENT (PPE): Provide suitable PPE to cover and protect employees The best method of controlling risk is to eliminate the hazard – it is not always possible to do this immediately.

Table 7-5 Project Risk, Mitigation, & Control Measures

RISKS/CONSIDERATIONS	LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	POSSIBLE MITIGATION/CONTROL MEASURES
OCCUPATIONAL HEALTH AND SAFETY					
OPERATIONAL AND WORKPLACE HAZARDS	• Slips, trips and falls resulting in sprains, strains and fractures • Ergonomic hazards from manual handling, lifting weights, or repetitive movements. • Accidents involving sharp and moving objects in the workplace • Over-exposure to noise, vibration, and extreme or adverse weather conditions.	Likely	Significant	High	• Implement an Occupational Health, Safety and Environment Management Plan (OHSEMP)and incident management system (Heath Safety and Environmental (HSE) monitor) • Practice good housekeeping, e.g. implements procedures for handling spillages of different kinds • Ensure good lighting in all areas • Use appropriate PPE • Install proper signage and demarcation of storage and waste collection areas • Organize appropriate and frequent training and sensitization • Ensure that all staff members/ contractors are trained to operate machinery and the wearing and/or use of PPEs.
MACHINERY AND VEHICLE HAZARDS	• Accidents may occur in the use of machines and vehicles including vehicle collisions • Vehicle and machinery roll-overs; • uncontrolled movement resulting in personal injury (e.g., crushing by moving vehicles); • damage or loss of asset; • injury, entrapment, or death due to faulty or unguarded equipment and machinery (e.g., moving parts and pinch points on machinery and vehicles); • entrapment due to unplanned starting, activation, or engagement of equipment (e.g., rollers); or • injury during inspection or repair of vehicles (e.g., vehicle lift not secured while personnel working underneath).	Likely	Critical	High	• Where applicable, ensure that equipment with moving parts are fitted with safety guards or interlocks • Power off or power down and lock equipment prior to maintenance, repair, or cleaning activities • Ensure proper training and sensitisation for personnel is completed and signed-off before persons are allowed to operate, repair or clean machinery • Restrict access to areas with heavy machinery in operation and ensure proper signage is present at strategic locations within range of the heavy machinery. • Provide PPE such as high visibility jackets to ensure workers are seen • Develop and implement a maintenance and inspection programme for the equipment in keeping with best practices and the manufacturer's guidelines.

RISKS/CONSIDERATIONS	LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	POSSIBLE MITIGATION/CONTROL MEASURES
	• Fatal accidents associated with crushing by vehicles or equipment • Injuries associated with manual, hand-related operations • Injuries associated with overhead lifting equipment and supply vehicles, Exposure to noise produced by the machines while in operation				• Ensure all staff received the proper training on the use, care and storage of PPE (Personal Protective Equipment) before equipping all personnel with said protective gear.
COLLAPSING TRENCHES	• Injuries and fatalities caused by collapsing trenches with workers inside. • Buildings under construction or demolition during decommissioning can have sudden unexpected collapses which can cause severe injury or death.	Possible	Critical	High	• Consider the types of support best suited for trenches and structures. • Ensure trench is completely secure. • Regularly inspect trenches before and during work shifts. • Proper signage and cording off for unsafe areas.
INJURIES AND FATALITIES FROM WORKING AT HEIGHTS	• Contractors/workers may suffer severe and possibly fatal injuries if they fall from any height e.g., falling from a ladder. • Contractors/workers may suffer severe and possibly fatal injuries from equipment falling from persons working from heights.	Possible	Catastrophic	High	• Ensure proper training and sensitization to use ladders and other scaffolding appropriately • Agree to a safe system of work prior to start and ensure that safety harnesses are worn while work is being conducted at heights. • Access and inspect equipment (ladders, scaffolding) before use and store safely after use • Use appropriate PPE and have appropriate signage in areas of high risk of injuries • Ensure that at least two persons work in the same area at any given time once possible.
NOISE NUISANCE AND VIBRATIONS	• Vibration from machinery may affect the whole body and can cause chronic backache, hip and knee pain and can additionally lead to spinal, gastro-intestinal, and urinary tract problems. • Noise and vibration from hand-held equipment (such as chainsaws, brush cutters, or trimmers) can cause hand/arm problems or hearing loss.	Possible	Marginal	Medium	• Consider implementing a green belt to leverage natural topography and vegetation of the proposed site to reduce noise impact. • Ensure workers use appropriate PPE • Consider equipment with a low noise rating. Where this is not possible, noise dampeners should be used to attenuate noise. This equipment should be placed in areas downwind of sensitive receptors.

RISKS/CONSIDERATIONS	LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	POSSIBLE MITIGATION/CONTROL MEASURES
					• Limit, where possible, the hours of operation for mechanical equipment that produces high levels of noise and vibration. • Ensure, where possible, that noise sources are in less sensitive areas (away from sensitive receptors) to take advantage of distancing and shielding. • Develop and implement a Noise Management Plan with Grievance Mechanism
ELECTRICAL SHOCKS	• Contractors/workers may suffer shock, burns or fatal injuries from faulty electrical equipment or installation, or improper handling of equipment.	Possible	Catastrophic	High	• Implement an Occupational Health, Safety and Environment Management Plan (OHSEMP) and incident management system (HSE monitor). Ensure that a lockout/tagout system is in this plan and used in areas where applicable. • Discuss electrical safety before tasks to ensure relevant machinery, circuits etc. are isolated and powered off throughout the task. • Conduct proper training and sensitization sessions. • Use appropriate PPE • Schedule frequent maintenance and inspection of electrical installations and equipment.
INJURIES AND FATALITIES WORKING IN CONFINED SPACES	• Risk of asphyxiation; explosions due to gas, dust, or fumes (e.g., residual petroleum fumes); and entrapment or enclosure within confined spaces such as stacks, tanks, manholes, etc. • Serious injury or fatality can result from inadequate preparation when entering a confined space or in attempting a rescue from a confined space.	Possible	Catastrophic	Low	• Design specifications should consider eliminating confined spaces to the greatest extent possible. Where necessary, confined spaces should be designed to accommodate most of the workforce including adjustments for tools and PPE (consult ISO and EN standards). Adjoining areas should have ample room for emergency and rescue operations. • A risk assessment and plan should be completed prior to controlled entry to confined spaces, including ensuring process or feedlines are disconnected, atmospheric testing conducted, etc. The plan should include facilitating ventilation until target safe conditions are met. • Restrict entry to confined spaces, subject to permitted supervision by properly trained personnel. • Ensure appropriate PPE and training in same is provided prior to worker entering confined space

RISKS/CONSIDERATIONS	LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	POSSIBLE MITIGATION/CONTROL MEASURES
INJURIES AND FATALITIES FROM HEAT EXPOSURE	• Working with heat-related processes associated with the development may result in injuries (fatal or non-fatal). • Exposure to extremes of weather, including sustained exposure to the sun can be harmful. Typical problems include hypothermia dehydration, UV damage to skin or eyes, and heat exhaustion cases	Likely	Critical	High	• Shorten exposure time and use frequent rest breaks. • Provide cool (air-conditioned) rest-areas. • Remind workers to keep hydrated. • Ensure workers are aware of the risks of heat stress associated with their work and ensure they understand the symptoms to look out for. • Design work timetables around the weather with the most strenuous work scheduled for cooler times of the day. • Increase air circulation by using fans, air conditioning and ventilation to lower temperatures; and physical structures that reduce exposure to radiant heat or create shade. • Monitor the health of workers by checking on those who are most at risk to heat stress due to the nature of their job or because of an illness, condition or medication. • Provide frequent rest breaks on the hottest days, provide hourly breaks with access to cool areas in the shade, or in an air-conditioned building or vehicle. • Outside workers should wear light, loose-fitting clothing, sunglasses and sunscreen. Be aware that protective equipment may increase risk of heat stress and provide more rest breaks for these employees.
INJURIES AND FATALITIES FROM FIRE AND EXPLOSION	• Fire and explosions can result from operations, during product handling (onsite and off-site), combustion of chemicals or stored oil • Staff or visitors who are trapped could suffer fatal injury from smoke inhalation	Possible	Catastrophic	High	• Include in management plans and operating procedures comprehensive strategies for the prevention, detection, and suppression of fires within the perimeters of the proposed Project site and adjacent properties, including: ○ Description of primary detection methods, tools, and protocols ▪ Ability to communicate with field staff, contractors, and communities ○ Measures for reducing fuel loading ○ Means to access and contain fires within proposed Project site ○ Proper placement of appropriate fire suppression equipment ○ Training of staff, contractors, and communities in fire prevention and suppression actions

RISKS/CONSIDERATIONS	LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	POSSIBLE MITIGATION/CONTROL MEASURES
AIRBORNE FIBERS AND MATERIALS	• Invisible fibers, dust, and toxic mixture of gases can damage lungs and lead to or aggravate diseases/ conditions such as asthma, chronic obstructive pulmonary disease and silicosis.	Likely	Critical	High	• Implement an Occupational Health, Safety and Environment Management Plan (OHSEMP) and incident management system (HSE monitor) • Implement Grievance Mechanism ▪ Usage of appropriate PPE, e.g., N95/FFP masks • Implement dust reduction mechanisms or Dusk Mitigation Plan that includes wetting and covering bare soil, applying dust-retarding products, spreading gravel or mulch to contain fine particles, creating wind breaks, phasing site clearing, and enforcing low speed limits on unpaved roads • Implement a green belt or vegetation buffers around the proposed Project site • Prohibit open burning of waste • Ensure proper use of PPE provided
INJURIES AND FATALITIES FROM CHEMICAL HAZARDS/ SPILLS	• Injuries (fatal and non-fatal) may result from: ○ Dermal contact ○ Inhalation • Ingestion	Likely	Catastrophic	High	• Maintain updated Safety Data Sheets (SDSs) • Use appropriate PPE (gloves, clothing, eye, face and respiratory protection) • Ensure incompatible materials are stored separately • Keep storage containers in a dry, cool, well-ventilated area preferably with secondary containment ▪ Use appropriate firefighting equipment, e.g., dry chemical fire extinguisher, fire extinguisher for Class A, B or C fires, sand, etc. • Implement proper, regular training and sensitization on storage, handling and first aid ▪ Where possible, have stations designated for eye washing and emergency showering. • Implement Hazardous Waste Management Plan

RISKS/CONSIDERATIONS	LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	POSSIBLE MITIGATION/CONTROL MEASURES
INJURIES AND FATALITIES FROM CORROSIVE SPILLAGE	• Leakage/leeching or spillage from storage or handling of acid/caustic soda may cay cause dangerous corrosion that could harm the environment or workers/visitors	Possible	Critical	Medium	• Implement an Occupational Health, Safety and Environment Management Plan (OHSEMP) and incident management system (HSE monitor) • Implement strict standard operating procedures (SOPs) incl. safety data sheets (SDSs) for all materials • Schedule proper training and sensitization • Organise proper storage of corrosive materials in suitable labelled containers away from incompatible materials in a cool, dry, well-ventilated area • Ensure corrosive containers are kept closed except when materials are being used • Inspect containers regularly for damage or leaks • Keep minimal quantities
BIOLOGICAL HAZARDS	• Contact with venomous animals, such as stinging insects, spiders, scorpions, snakes and disease vectors (e.g., mosquitoes, ticks). • Microorganisms can develop in wastewater	Possible	Significant	Medium	• Wear appropriate clothing and PPE • Inspect any clothing, shoes, or equipment (including PPE) before use • Remove or reduce tall grasses, debris, and rubble from around the outdoor work areas • Control water accumulation ▪ • Use insect repellent • Ensure availability of onsite first-aid equipment and trained personnel, as well as procedures for emergency evacuation • Use observation and sighting records so workers know areas where there are dangerous animals • Ensure that sewage is properly treated and disposed of

RISKS/CONSIDERATIONS	LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	POSSIBLE MITIGATION/CONTROL MEASURES
PHYSICAL					
AIR EMISSIONS/ POLLUTION	• Increase in particulate matter in the proposed project area and surrounding environs.	Possible	Significant	Low	• Avoid open burning for land clearing and weed control. • Ensure that all material (especially fine earth materials) used on and removed from the site are transported, stored and handled properly. • Ensure that all vehicles are properly maintained. • Where unpaved surfaces are used, the speed of vehicles should be reduced to minimise the generation of fugitive dust. • Wet areas where the generation of airborne dust is likely. Burning of solid waste or plant material should not be encouraged or practiced, and if necessary, should be done in a controlled environment under conditions which will prevent the release of any air pollutants. • Develop a preventative maintenance schedule for all equipment on site. • Consider inventory of critical items and equipment parts to ensure speedy remediation of any equipment failures.
WATER QUALITY POLLUTION	• Vegetation clearance, increase in paved areas, improper storage/disposal of construction materials, improper sewage treatment/disposal and removal/blockage of existing and natural drains may cause: ○ Increased sediment laden run-off to surface and groundwater ○ Disruption of natural stormwater runoff ○ Onsite and downstream flooding ○ Contamination of water with • pathogens/spread of waterborne diseases	Likely	Significant	High	• Paving or grassing of exposed grounds as soon as possible; where possible, unused areas should be left vegetated • Excavated material should not be stored along drains, gullies, swales or in the path of natural drainage. • Stockpiles should have a berm and should be covered. • Natural drainage should not be blocked without suitably engineered alternatives • Use sediment traps/turbidity barriers where necessary to avoid sedimentation of the nearby waters

RISKS/CONSIDERATIONS	• LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	• POSSIBLE MITIGATION/CONTROL MEASURES
PHYSICAL	• Proposed project may generate significant quantities of nonhazardous solid waste, with limited hazardous wastes such as fuel oil, tires, pesticides, which can create issues if not properly handled	Almost Certain	Significant	High	• Establish a Waste Management Plan that considers prevention, reduction, reuse, recovery, recycling, removal, and disposal of wastes. • Prohibit burning of packaging, plastics or other solid waste. • Consider procuring fuels, oils and chemicals in bulk quantities to reduce the volume of waste containers • Institute good housekeeping and operating practices including inventory control to reduce the amount of waste resulting from packaging materials etc. • Conduct periodic inspections of storage tanks and components to check for corrosion and structural integrity. These should also be subject to structural integrity tests. • Place skips and bins strategically within the proposed construction site • Design and cover adequately skips and bins to prevent entry by pests and to minimise odour • Contract services of a licensed contractor approved for the approval of hazardous waste disposal such as tires and used oil • A record of the transaction should be kept of file for auditing purposes • Empty skips and bins regularly to prevent overfilling • Ensure that hazardous wastes are separated from non- hazardous wastes • Ensure that solid waste is disposed of at an approved disposal site • The client should refer to NEPA for assistance for the proper classification system and subsequent disposal practices for hazardous waste. If one is not provided, the client can utilise the International Finance Corporations for Environmental and Health and Safety Guidelines for classification or section 40 CFR-part 261 of the Federal

RISKS/CONSIDERATIONS	• LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	• POSSIBLE MITIGATION/CONTROL MEASURES
					Hazardous Waste regulations of the USEPA. (https://www.ifc.org/content/dam/ifc/doc/2023/ifc-general-ehs-guidelines.pdf or https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-261) •
SOIL DEGRADATION	• Physical and chemical degradation of soils may result from unsuitable management techniques, such as use of inappropriate machinery or earthworks associated with site preparation and infrastructure development	Possible	Significant	Medium	• Develop and implement a soil monitoring and management plan that includes soil and terrain mapping and erosion risk identification • Minimise the use of inorganic pesticides and fertilizers for ongoing landscaping by implementing a pest and disease early warning system, by using biological pest and disease control methods, and by implementing control measures before outbreaks require large-scale control. • Implement buffer zones and/or setbacks from water—including "no treatment" areas along water sources, rivers, streams, ponds, and other surface water bodies—to act as a filter for potential nutrient runoff from the land

RISKS/CONSIDERATIONS	• LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	• POSSIBLE MITIGATION/CONTROL MEASURES
SEDIMENTATION FROM DRAINAGE & SURFACE RUNOFF	• Sediments from areas without vegetation during rainfall periods can result in flooding, infrastructural damage and siltation of surface water and groundwater receptors	Likely	Significant	High	• Establish buffer zones near to ponds, gullies or other water ways using trees, grass, etc. to reduce sediments getting into these systems • Design and implement appropriate drainage improvements that form part of the proposed Project design as they should mitigate against flooding • Separate stormwater from process and sanitary wastewater streams to reduce the volume of wastewater to be treated prior to discharge • Minimise runoff from areas with potential sources of contamination, e.g., limit area of impermeable surfaces ▪ Reduce peak discharge rates, e.g., using vegetated swales or retention ponds • Manage stormwater, if possible, as a resource (for meeting water needs on site) • Install and maintain oil water separators and grease traps around fuel storage and containment areas, refueling facilities, parking areas
SEVERE WEATHER HALTING PROJECT ACTIVITIES	• The proposed project site is not located in an area that is prone to severe weather. However, severe weather may impact supply chains and workforce availability.	Possible	Critical	High	• Develop and implement an Emergency Preparedness and Response Plan (EPRP) • Implement standard operating procedures (SOPs) implemented to minimize the potential loss of life, injury, and damage to the environment /property in the event of extreme weather • Monitor daily the possibility of inclement weather, which could affect the proposed Project site • Monitor Meteorological Service Jamaica weather alert system to ensure that it is operational and monitored during operating hours • Ensure shutdown and start-up are done within established procedures if a forced shutdown of all operations is required resulting from severe weather

RISKS/CONSIDERATIONS	• LIKELY IMPACTS	PROBABILITY	IMPACT	RISK LEVEL	• POSSIBLE MITIGATION/CONTROL MEASURES
CREATION OF INFORMAL AND UNPLANNED SETTLEMENT	• The proposed project may attract workers from outside of the sphere of influence. This could result in the establishment of informal and unplanned settlements near the Project site. • Increased risk of vehicular or machinery injuries on roads and access routes around the community	Possible	Marginal	Medium	• Give priority to the employment of persons who reside in the immediate sphere of influence
ECOLOGY					
LAND CLEARANCE DURING CONSTRUCTION	• Disturbance/loss of foraging habitats and/or modification of commuting routes (including disturbance from lighting) for local fauna. • Damage or disturbance to habitat for protected species including bird species, some of which are endemic, resident and migratory and endemic reptiles.	Almost Certain	Significant	High	• Retain, if present, larger trees with a DBH >25cm if present • Conduct sensitization/awareness sessions on ecology for local workforce. • Prepare an environmental management and monitoring plan (EMMP) before the start of construction. • Conduct (where possible) vegetation clearance and construction activities outside of the March to September breeding season for birds
	• Damage or disturbance to nesting birds, nests or their young by construction activities				• Phase construction activities to control erosion and existing vegetation should be maintained/preserved where possible and the minimum amount of land should be disturbed • Implement the use of sediment traps, where necessary • Undertake works as much as possible in the dry season ▪ Wet the construction site and materials during construction
OPERATIONS					
POWER OUTAGE	• The proposed project site may experience a power outage (with or without severe weather)	Likely	Varies -	Low	• Ensure proposed Project site is equipped with emergency lighting and back-up power sized to allow security on site

8. Impact Mitigation

IMPACT CHATACTERISTIC	
Probability	
Rank	**Definition**
Unlikely	Impact which is unlikely to occur
Likely	Impact which may occur
Very Likely	Impact which is almost certain to occur
Direction of Impact	
Positive	Impacts of the project on the environment and vice versa are likely to be good
Negative	Impacts of the project on the environment and vice versa are likely to be bad
Magnitude	
Low	• Little or negligible action and/or control are useful, but not required in the short-term • Exceeding of threshold value in case of operating problems (abnormal conditions) and low effect and low probability of occurrence and/or high probability of detection • Minimal effect • Limited probability of occurrence • "Aspect" controlled under normal circumstances • High knowledge of "aspect"
Moderate	• Action and/or control are required in the near future • Exceeding of threshold values in case of operating problems (abnormal conditions) and above • Average high probability of occurrence and/or low probability of detection • Financial threat • Effect likely to increase under planned activities • Rising concern of shareholders • Emergency situation would cause a large environmental impact • Complaint likely to be received • "Aspect" not fully controlled under normal conditions
High	• Immediate action and/or controls necessary • "Aspect" is currently not controlled under normal operations • Could break legal or policy documents • In breach of legislation
Duration	
Short Term	Occurring infrequently or during one project phase
Medium Term	Occurring frequently during a few project phases
Long Term	Occurring frequently during most or all project phases
Persistent	Occurring for a significant period after completion of construction and demobilization or on a permanent basis due to operation of revetment structures
Permanence	
Reversible	Effects which are reversible and diminish when activities cease or over time
Irreversible	Effects which are not reversible and do not diminish even if the activity ceases to occur, and do not diminish with time

Table 8-1 Impacts and Mitigation Options

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
A.	**Pre-Construction Phase**				
BIOLOGICAL	Ecosystem	Habitat Loss	Loss of flora and fauna habitats in areas cleared and topsoil prior to construction including endemic species	• Tag endemic trees that are in close proximity to areas that will be cleared to ensure they are preserved. • Put in place a plant nursery in the area slated for Block F that is properly managed by the landscape architect to preserve endemic plant species that are within the footprint	Probability: Likely Magnitude: Major Direction: Negative Duration: Persistent Extent: Direct Permanence: Irreversible
		Edge Effect	Edges of fragmented land becomes exposed to a new microclimate which may cause stress to flora and fauna that are not adapted to the new conditions	Preserve important species in these areas in the plant nursery established	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Long term Extent: Direct Permanence: Irreversible
		Food scarcity	Reduction in food sources	Replanting similar trees to those that were removed	Probability: Likely Magnitude: Major Direction: Negative Duration: Long term Extent: Direct Permanence: Irreversible
	Landscape	Slope instability	Increased potential for land slippage and soil erosion due to vegetation removal	Clear land in stages/phases that are currently being worked on	Probability: Likely Magnitude: Major Direction: Negative Duration: Long term Extent: Direct Permanence: Irreversible

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
HEALTH & PHYSICAL	Water Quality	Site clearing and Improper disposal of materials removed from the site	Site clearance, improper storage of construction materials, improper sewage treatment/disposal may cause increased sediment laden run-off to freshwaters and marine waters, and contamination of water sources with pathogens and nutrients which may affect the appearance and usability of the water for recreational and "potable (freshwater systems)" use.	Excavated materials should not be placed in or along drains, riverbanks, or in the path of natural drainage. • An Environmental Management and Monitoring Plan (which should also include Solid Waste and Sewage Management) should be developed and implemented. Periodic monitoring should be instituted to ensure that the plans highlighted are fully implemented and fit for purpose. • Use sediment traps/turbidity barriers where necessary to prevent sedimentation of water bodies on site.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short term (However duration is dependent on the quantity and quality of sewage and period of disposal) Extent: Direct Permanence: Reversible
		Improper sewage management		• Provide proper lavatory access to workers. • Ensure adequate space is allocated in project site design for additional sewage processing capacity if needed in the future since system may be operating near maximum capacity.	
		Improper storage of materials to be used during Construction Phase		• Stockpiled should be covered properly and placed on a berm where applicable. • Materials to be used during construction phase should not be stored near on in drains, riverbanks, or in the path of natural drainage	
	Air Quality	Site Clearing	Increased air pollutants and fugitive particle matter which may have adverse health impacts on employees, residents living or owning businesses, animals and properties in the surrounding areas	• Phase land clearance activities. • Ensure that the appropriate PPEs are worn where there is a high possibility of fugitive dust. • Wet areas where applicable to reduce the generation of fugitive dust.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short term Extent: Direct Permanence: Reversible
		Vehicle Emissions		Develop and implement an Environmental Management and Monitoring Plan which should include a Vehicle Maintenance and Traffic Plan.	
		Burning of vegetation		• Develop and implement an onsite Waste Management Plan to reduce the likelihood of team members resorting to burning methods to get rid of unwanted material. Ensure the site is monitored periodically to ensure compliance with the practices highlighted in this plan.	

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
		Fugitive dust from unpaved roads used for site access		• Wet site when necessary to reduce fugitive dust. • Install dust screens/vegetative barriers around the site.	
		Improper storage and transportation of fine earth material to be used in construction phase		Cover fine earth material with appropriately sized covers during transportation. If these materials are to be stored long-term on site (stockpiles that will remain on site for more than a week), appropriately sized covers should be considered also.	
	Noise	Site Clearing Activities	Prolonged exposure to noise levels above recommended limits without the appropriate PPE can result in adverse health impacts.	• Conduct noise generating activities during regular working hours to minimize noise nuisance at night-time. • Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area. • Erect noise barriers as needed. • Implement soft-start procedures where possible when using construction equipment. • Ensure an Environmental Management and Monitoring Plan is developed and implemented which should include an Equipment Maintenance Plan, Vehicle Management Plan and Traffic Plan. • Ensure a Safety Management and Monitoring Plan is developed and implemented which should include appropriate signage. Staff should be equipped and trained in the use of required personal protective equipment (PPE). • Phase clearance activities.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Dependent on the intensity of the noise and exposure time Permanence: Typically reversible, however, this is dependent on the extent of damage for the health and safety category. Extent: Direct
		Increased Vehicular Traffic inclusive of Heavy Equipment Operation			

CULTURAL	HERITAGE	Degradation of Historical Buildings	Loss and damage through land clearance and demolition activities to the: -
			• Roaring River Estate:
			  • Great House
			  • Ancillary Building 1 – north-west of Great House
			  • Ancillary Building 2- west of Great House through land clearance and demolition
				• Clear around the sites where these buildings are located and appropriately label them to prevent damages/ destruction during land clearing activities.
				• Protection for the Great House to avoid damage to building because it is of cultural significance.
				• The Ancillary buildings are not of cultural significance, and don't require additional protection.
					Probability: Likely
					Magnitude: Major
					Direction: Negative
					Duration: Long Term
					Permanence: Irreversible
					Extent: Direct

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
		Degradation of Historical Sites	Loss and damage through land clearance and demolition to the: • Roaring River Taíno site • Mammee Bay Estate Aqueduct Ruins • Mammee Bay Estate Ruins	These sites are of cultural significance therefore: • A watching brief should be in place if and when land clearance of the Taíno site is conducted. Artefacts identified from land clearance should be collected and stored. A simple monument and/or an information plaque should be erected or mounted to recognize the site of the indigenous people. • The Aqueduct Ruins should be duly recorded, and a storyboard or information plaque be erected to record its presence. Further mitigation such as preservation is optional. • The Mammee Bay Estate ruins were not physically located by the archaeologist and may already be destroyed. However, when land clearance is being conducted in this area, a watching brief should be in force. If and when the feature is identified it should be recorded, and a storyboard or information plaque to record its presence. Further preservation is optional.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct
SOCIAL		Employment	• Possibility of short-term employment opportunities for workers on the development site • Possibility of long-term opportunities to operate as gardeners, maids, plumbers when the development is up and running	None	Probability: Likely Magnitude: Major Direction: Positive Duration: Long Term Permanence: Irreversible Extent: Direct
NATURAL HAZARDS		Flooding	Removal/ blockage of natural drains	Natural drainage areas should not be blocked unless a suitable engineered alternative has been developed and implemented. All drains on-site should be maintained. Signage should be placed on site and sensitization should be done to ensure that these areas are kept free of debris. Monitoring should be done (from what is on site to the exit point of the drain) to ensure that drains are free from debris.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct

		Earthquakes and Seismic Risk	• Possible:
			  ○ Damage to assets
			  ○ Diisrupting Pre-Construction activities
			  ○ Injury to persons
			  ○ Loss of life
				• Ensure design follows the code for earthquake design.	Probability: Likely
					Magnitude: Minor
					Direction: Negative
					Duration: Short Term
					Permanence: Irreversible
					Extent: Direct & Indirect

		Hurricanes	• Possible:
			  ○ loss of assets
			  ○ injury to persons
			  ○ loss of life
				• Ensure warning system is developed for contacting all on-site personnel when strong weather alerts are issued
				• Develop and Emergency Response Plan
					Probability: Likely
					Magnitude: Major
					Direction: Negative
					Duration: Long Term
					Permanence: Irreversible
					Extent: Direct

CATEGORY	ISSUE		POSSIBLE IMPACT	MITIGATION	OTHER
B.	**Construction Phase**				
BIOLOGICAL	Biodiversity	Habitat degradation	• Changes in species composition (increase in abundance of weed species; erosion of genetic diversity; exposure of interior and area-sensitive species of plants and animals) • Habitat fragmentation particularly in forested area as it is anticipated that the expanse of available habitat will be reduced and/or divided into segments by construction of roads and the housing scheme • Increased incidence of fire due primarily to the increase penetration of wind, reduced humidity, higher temperatures and the accumulation of drying wood from dying or dead trees at fragmented edges	• Retain as many of the important species identified, including those native to the area and encourage the use of these species when replanting • Try to limit the creation of small size fragmented areas by grouping intended small fragments into large fragments • Ensure areas are cleared as soon as possible to reduce the possibility of the accumulation of drying or dead trees	Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct
		Species composition	• Increased vulnerability of the fragmented areas to invasion by alien and native species as well as diseases • Introduction of exotic species and ornamental plants • Noise from construction can disturb auditory signals communicated by animals	• Identify and removing invasive species during construction monitoring. • Encourage the use of plants native to site • Operate within standard noise levels	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
			• Plant growth and health can be significantly affected by dust, grime, chemical spills and some gaseous emissions. Leaching from storage areas can disturb the pH balance in the soil and result in further plant loss	• Manage dust emissions on the property such as wetting areas prone to high levels of fugitive dust, using appropriate covering for fine earth storage areas (when needed), using dust barriers where foliage may be maintained etc. • Ensure storage areas (especially for chemicals) are inspected frequently to identify any breaches or spills for immediate action. Where possible, construct berms around storage areas. • Ensure vehicles are properly maintained to reduce the likelihood of oily emissions (can form grime on surfaces of plants).	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
HEALTH & PHYSICAL	Occupational Health & Safety	Injuries	Potential increased incidence of construction works injured onsite (e.g., falling from heights, fugitive dust affecting respiratory health)	• Establish an onsite emergency medical response team. • Provide and enforce wearing of appropriate PPE gear. • Have frequent sensitisation on sessions with employees (especially with new batches of workers) on safety requirements and practices. • Conduct audits of work site to ensure compliance is adhered to. • Incidents should be logged so that they can be reviewed and safety measures can be updated accordingly. • Ensure that proper signage is placed in areas where proper PPE is	Probability: Likely Magnitude: Minor Direction: Negative Duration: Short Term Permanence: Reversible- Irreversible Extent: Direct
		Hygiene & Sanitation	Illness resulting from improper food handling practices and subsequent pressure on the Public Health Management Systems	• Developers should build temporary housing units on worksites with proper hygiene and sanitation infrastructure. • Ensure canteen facilities, where applicable, have the appropriate approval from the MoHW.	Probability: Likely Magnitude: Major Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
	Water Quality	Site clearing and Improper disposal of materials removed from the site	Site clearance, improper storage of construction materials, improper sewage treatment/disposal may cause increased sediment laden run-off to freshwaters and marine waters, and contamination of water sources with pathogens and nutrients which may affect the appearance and usability of the water for recreational and "potable (freshwater systems)" use.	• Excavated materials should not be placed in or along drains, riverbanks, or in the path of natural drainage. • An Environmental Management and Monitoring Plan (which should also include Solid Waste and Sewage Management) should be developed and implemented. Periodic monitoring should be instituted to ensure that the plans highlighted are fully implemented and fit for purpose. • Use sediment traps/turbidity barriers where necessary to prevent sedimentation of water bodies on site.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short term (However duration is dependent on the quantity and quality of sewage and period of disposal) Extent: Direct Permanence: Reversible
		Improper sewage management		Provide proper lavatory access to workers	
		Improper storage of materials to be used during Construction Phase		• Stockpiles should be covered properly and placed on a berm where applicable. • Materials to be used during construction phase should not be stored near on in drains, riverbanks, or in the path of natural drainage	
	Air Quality	Site Clearing	Increased air pollutants and fugitive particle matter which may have adverse health impacts on employees, residents living or owning businesses, animals and properties in the surrounding areas	• Phase land clearance activities. • Ensure that the appropriate PPEs are worn where there is a high possibility of fugitive dust. • Wet areas where applicable to reduce the generation of fugitive dust.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short term Extent: Direct Permanence: Reversible
		Erection and Use of Batching Plant and Block Factory		• Ensure that the appropriate PPEs are worn • Wet areas where applicable to reduce the generation of fugitive dust. • Stockpiles should be covered properly and placed on a berm where applicable. • Tipper trucks when transporting should be covered and material unloaded into enclosed areas where possible. • Preventive maintenance should be done on all equipment used on a predefined schedule.	
		Vehicle Emissions		Develop and implement an Environmental Management and Monitoring Plan which should include a Vehicle Maintenance and Traffic Plan.	

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
		Burning of vegetation		• Develop and implement an onsite Waste Management Plan to reduce the likelihood of team members resorting to burning methods to get rid of unwanted material. Ensure the site is monitored periodically to ensure compliance with the practices highlighted in this plan.	
		Fugitive dust from unpaved roads used for site access		• Wet site when necessary to reduce fugitive dust. • Install dust screens/vegetative barriers around the site.	
		Improper storage and transportation of fine earth material to be used in construction phase		• Cover fine earth material with appropriately sized covers during transportation. If these materials are to be stored long-term on site (stockpiles that will remain on site for more than a week), appropriately sized covers should be considered also	
	Noise	Site Clearing Activities	Prolonged exposure to noise levels above recommended limits without the appropriate PPE can result in adverse health impacts.	• Conduct noise generating activities during regular working hours to minimize noise nuisance at night-time. • Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area. • Erect noise barriers as needed. • Implement soft-start procedures where possible when using construction equipment. • Ensure an Environmental Management and Monitoring Plan is developed and implemented which should include an Equipment Maintenance Plan, Vehicle Management Plan and Traffic Plan. • Ensure a Safety Management and Monitoring Plan is developed and implemented which should include appropriate signage. Staff should be equipped and trained in the use of required personal protective equipment (PPE). • .Phase clearance activities.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Dependent on the intensity of the noise and exposure time Permanence: Typically reversible, however, this is dependent on the extent of damage for the health and safety category. Extent: Direct
		Increased Vehicular Traffic			
		Heavy Equipment Operating			

CATEGORY		ISSUE	POSSIBLE IMPACT	• MITIGATION	OTHER
HERITAGE	Cultural	Degradation of Historical Sites	• Loss and damage to Roaring River Taíno side through foundation preparation	This site is of cultural significance therefore: • The watching brief should continue through from the pre-construction phase if and when the foundations are being dug in this area Artefacts identified from such excavation should be collected and stored, and salvage archaeology conducted. Subsequently, a monument and/or information plaque should be erected or mounted to recognize the site of the indigenous people.	Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct
PHYSICAL	Water Quality	Increased sediment runoff	Soil erosion can lead to blocked drains from sedimentation and water pollution	• Sediment traps, filter fabric fencing, vegetated filter strips, grassed swales • Maintenance of paving cover of all internal roads	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
	Soil & Water Quality	Chemical Spills	Soil contamination from chemical spills can possibly result in soil and water contamination.	• Ensure storage areas (especially for chemicals) are inspected frequently to identify any breaches or spills for immediate action. Where possible, construct berms around storage areas. • Ensure vehicles are properly maintained to reduce oil leaks.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
	Human Safety	Structural safety	Collapsed building structures/ structural integrity of buildings	Ensure all buildings are constructed according to the national building code and are sited in appropriate areas (as per recommendations in in the geotechnical report)	Probability: Unlikely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Reversible Extent: Direct

CATEGORY	ISSUE		POSSIBLE IMPACT	• MITIGATION	OTHER
NATURAL HAZARDS	Landscape	Flooding	Risk of flooding due to project design	Comply with setbacks from gully courses as recommended from the geotechnical investigation and with the regulator	Probability: Unlikely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Reversible Extent: Direct
		Earthquakes and Seismic Risk	Risk of Damage to assets; Disrupting Construction activities; Injury to persons; Loss of life	• Ensure design follows the code for earthquake design. • Ensure a disaster risk management plan is in place and that all who are constructing the building are aware of best practice to avoid injury and damage to assets.	Probability: Likely Magnitude: Minor Direction: Negative Duration: Short Term Permanence: Irreversible Extent: Direct & Indirect

	Human Safety	Hurricanes	• Possible:
			  ○ loss of assets
			  ○ injury to persons
			• loss of life
				• Ensure warning system is developed for contacting all on-site personnel when strong weather alerts are issued
				• Develop and Emergency Response Plan
				• Site inspection after storm to ensure worker and structural safety
					Probability: Likely
					Magnitude: Major
					Direction: Negative
					Duration: Long Term Permanence: Irreversible Extent: Direct

CATEGORY	ISSUE		○ POSSIBLE IMPACT	• MITIGATION	OTHER
HUMAN/SOCIAL/CULTURAL	Social	Employment	Creation of direct and indirect jobs	The developers via government intervention liaise with the Social Development Commission to announce upcoming development and job prospects so locals have opportunities to be a part of the formal application process	Probability: Very likely Magnitude: Major Direction: Positive Duration: Long Term Permanence: Irreversible Extent: Direct
			Increased incidence of employment description and preference for foreign workers		Probability: Unlikely Magnitude: Minor Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
	Social	Personal security	Possibility of increased crime and petty theft incidents due to the influx of "outsiders" in host communities resulting in some residents in surrounding communities feeling unsafe	• Build temporary sites for workers away from the communities and destroy them afterwards, thus eliminating opportunistic squatter settlements. • Ensure security protocols are established and included in the Safety Management and Monitoring Plan	Probability: Likely Magnitude: Medium Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
		Transportation &Traffic	Traffic flow and delays at intersection of site access road and the main road (based on increased traffic loading and increase in heavy machinery) will lead to increased congestion in the area	• Improve parochial roads and use those for the time being and use those for the time being. • Developers should also coordinate with local transport authorities to ensure that road closures or delays due to increased traffic are communicated in a timely manner to other road users where possible.	Probability: Likely Magnitude: Major Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct

CATEGORY	ISSUE		POSSIBLE IMPACT	MITIGATION	OTHER
C.	**Occupation Phase**				
BIOLOGICAL	Biodiversity	Species Loss	Buildings and other infrastructure may act as physical barriers to the passive movement of spores and seeds across the landscape and can affect population levels.	Establish plant nursery to include currently existing endemic and native species across the site. This should be located in Block F and be managed by the landscape architect initially then the client. It can be populated by seedlings found on the property.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct
			Restricted movement of animals, some of which act as pollinators for many plants		Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct
			Unintentional or intentional death of animals due to increased human and vehicular interaction	Establish connective greenways across the property to connect fragmented areas	Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct
			Further introduction of fruit trees and ornamental plants by residents	Encourage use of ecologically important plant species that are already growing on the site to act as hedges, plants on lots and in parks and open areas	Probability: Very likely Magnitude: Minor Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
HEALTH & PHYSICAL	Air Quality	Increased Vehicular Traffic	Increased air pollutants and fugitive particulate matter which may result in adverse health impacts on employees, residents, and properties in surrounding areas.	• Develop and implement an Environmental Management and Monitoring Plan which should include a Vehicle Maintenance and Traffic Plan. • If possible look into having the access into the site on a less traversed road to minimisei cumulative impacts associated with increased traffic in an area. Establish speed limits and install speed bumps within the housing development. Pave or grass all exposed areas to reduce fugitive emissions.	Probability: Likely Magnitude: Moderate Duration: Duration of Project Permanence: Non-Permanent Spatial Extent: Project Area Specific

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
HEALTH & PHYSICAL		Site Clearing		Pave or grass all exposed areas to reduce fugitive emissions, where possible areas that can be left vegetated, should be left vegetated.	
		Burning of vegetation and/or construction domestic waste		Develop and implement an onsite Waste Management Plan to reduce the likelihood of team members resorting to burning methods to get rid of unwanted material. Ensure the site is monitored periodically to ensure compliance with the practises highlighted in this plan.	
		Fugitive dust from unpaved road used for site access		• Wet site when necessary to reduce fugitive dust. • Install dust screens/vegetative barriers around the site.	
		Improper transportation and storage of material with fine particles to be used in construction phase		Cover fine earth material transported and stored on site.	
		Repairs, maintenance or expansion activities		Same as in construction phase.	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Extent: Direct Permanence: Generally reversible, however dependent on the extent of the damage on the ear.
	Noise	Heavy equipment operating	Prolonged exposure to noise levels above recommended limits without the appropriate PPE can result in adverse health impacts	Same as in construction phase.	
		Site Clearance		Same as in construction phase	
		Increased vehicular traffic		Same as in construction phase	

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
HEALTH & PHYSICAL	Water Quality	Pollution of waterways from improperly treated sewage and WWTP Management	Site clearance, improper storage/disposal of construction materials, improper sewage treatment/disposal may cause increased sediment laden run-off to freshwaters and marine waters and contamination of water sources with pathogens and other detrimental constituents which may affect the appearance and usability of the water for recreational and "potable" use.	• Provide proper lavatory access to workers • An Environmental Management and Monitoring Plan should be developed and implemented to have a Sewage Management Plan. • All wastewater treatment plant operators should be properly trained to ensure that all activities for the proper operations of the treatment plant such as daily checks, desludging and monitoring of the operations of the disinfection system. • It is a possibility that the treated effluent may be used for irrigation purposes, however, effluent that is not reused will be disinfected using UV technology, then discharged into an earthen drain (which leads straight to the sea), a holding pond (that has adequate capacity) may be necessary. This will reduce the negative impacts to the environment when the WWTP is not working properly. It will also enable the client to make the necessary adjustments to the plant without discharging improperly treated effluent into the environment. • Additional/alternative disinfection should be considered such as the use of chlorine tablets to further enhance the disinfection process and to prevent recontamination of the treated effluent.	
		Site Clearance		• Excavated material should not be placed in drains, riverbanks, or in the path of natural drainage. An Environmental Management and Monitoring Plan should be developed and implemented to have a Solid Waste Plan. Periodic monitoring should be instituted to ensure that the plans highlighted are fully implemented. • Use sediment traps/turbidity barriers where necessary to prevent sedimentation of water bodies on site.	
		Improper storage of materials		• Stockpiles should be covered properly. • Material to be used during construction phase should not be stored near drains, riverbanks, or in the path of natural drainage	

CATEGORY	ISSUE		POSSIBLE IMPACT	MITIGATION	OTHER
				• Inspection of storage areas should be done to identify any breaches (leaks, spills, improper covering etc.) and rectify as soon as possible.	
		Removal/blockage of natural drains		• Natural drainage areas should not be blocked unless a suitable engineered alternative has been developed and implemented. • Inspection of drainage areas should be done to identify any breaches and rectify as soon as possible.	
NATURAL HAZARDS	Landscape	Flooding	Risk of flooding due to project design	• Comply with setbacks from gully courses as recommended from the geotechnical investigation and with the regulator	Probability: Unlikely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Reversible Extent: Direct

	Human Safety	Hurricanes	• Possible:
			  ○ loss of assets
			  ○ injury to persons
			  ○ loss of life
				• Ensure warning system is developed for contacting all on-site personnel when strong weather alerts are issued
				• Develop and Emergency Response Plan and share appropriate measures with residents that have moved in on how to respond, communicate and report issues before and during a hazard event, such as hurricanes and earthquakes.
				• Site inspection after storm to ensure worker and structural safety
				• Ensure structure design and execution meet national building code standards
					Probability: Likely
					Magnitude: Major
					Direction: Negative
					Duration: Long Term
					Permanence: Irreversible
					Extent: Direct

CATEGORY	ISSUE		POSSIBLE IMPACT	MITIGATION	OTHER
D.	**Operation Phase**				
HUMAN/SOCIAL/CULTURAL	Culture	Cultural misconceptions	Harm to domestic animals near the project site	• Residents encouraged to place their animals in enclosures	Probability: Unlikely Magnitude: Minor Direction: Negative Duration: Short Term Permanence: Irreversible Extent: Direct
	Social	Personal security	Possibility of increased crime and petty theft incidence due to the influx of "outsiders" in host communities resulting in some residents in surrounding communities feeling unsafe	• Build temporary sites for workers away from the communities and destroy them afterwards, thus eliminating opportunistic squatter settlements. • Establish good relationships with local law enforcement and private security to reduce crime in the area. • Ensure perimeter is properly fenced and maintained.	Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct Residual Impact: Low
	Social	Social Services	An increase in the population into the community could lead to an increased demand for social services (i.e schools, health care facilities, community centres)	• Sensitise government agencies during the public consultation phase of the EIA process of the projected population increase and consult where possible on the priority infrastructure needs the new population will generate so that sufficient holistic development planning can be conducted for the region. • The developer has committed to creating a daycare space within the community center.. • The developer is to build a relationship with the local community development committee to have a townhall meeting inviting the new residents in the area to sensitise them about all of the existing services available for their use.	Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Reversible Extent: Direct

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
	Social	Employment	Loss of temporary employment opportunities	None	Probability: Likely Magnitude: Major Direction: Negative Duration: Short Term Permanence: Irreversible Extent: Direct
HEALTH & PHYSICAL	Water Quality	Pollution of waterways from improperly treated sewage	Improper storage/disposal of solid waste materials, improper sewage treatment/disposal may cause increased sediment laden run-off to freshwaters and marine waters and contamination of water sources with pathogens which may reduce the usability of the water bodies.	Same as Occupation phase	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Long Term Permanence: Irreversible Extent: Direct
		Repairs, maintenance, or expansion activities		Same as Occupation phase	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
	Air Quality	Increased vehicular traffic	Possible increase in air pollutants and fugitive particulate matter which may impact residents and properties in surrounding areas.	Same as in Occupation phase	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Long-term Permanence: Reversible Extent: Direct
		Repairs, maintenance, or expansion activities		Same as in Occupation Phase	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short-term Permanence: Reversible Extent: Direct

CATEGORY	ISSUE		POSSIBLE IMPACT	MITIGATION	OTHER
	Noise Pollution	Increased vehicular traffic	Possible increase in ambient noise levels	Develop and implement traffic management plan (to include speed bumps and signage) where speeds throughout the community are managed. Possibly look into having access into the site on less traversed road to minimise cumulative impacts associated with increased traffic in the area. Erect permanent noise barriers along the property adjacent to the north south highway and maintain a green noise buffer zone with the second growth forest already established in the area, supplemented by species from the nursery (e.g. terminalia cattapa, cecropia peltata an delonix regia which already exist on the property)	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
		Repairs, maintenance, or expansion activities		Same as occupational phase	Probability: Likely Magnitude: Moderate Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
	Illness	Hygiene & Sanitation	Illness resulting from improper food handling practises and subsequent pressure on the Public Health Management Systems	• Ensure all onsite food facilities have the appropriate approval from the MoHW.	Probability: Likely Magnitude: Major Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct
NATURAL HAZARD	Flooding	Increased post-development run-off	If not curtailed within the site by drainage designed solutions, there may be issues related to flooding such as damage to infrastructure as well as increased sedimentation in surface water sources	• Ensure drains are adequate for 50-year and 100-year events. Ensure drains ae maintained and cleaned regularly.	Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Reversible Extent: Direct

CATEGORY	ISSUE		POSSIBLE IMPACT	MITIGATION	OTHER

	Human Safety	Hurricanes and Earthquakes	• Possible:
			  ○ loss of assets
			  ○ Damage to buildings and infrastructure
			  ○ injury to persons
			  ○ loss of life
				• Ensure structures meet national building code standards
				• Ensure infrastructure is being maintained. If there is an event, the condition of the infrastructure does have an effect on how it will respond to an event.
				• Ensure that a disaster risk management plan is in place for infrastructure.
				• Encourage home owner/community associations to have a disaster management plan for the development.
					Probability: Likely
					Magnitude: Major
					Direction: Negative
					Duration: Long Term
					Permanence: Irreversible
					Extent: Direct

PHYSICAL	Solid waste	Improper waste disposal	Increased generation of solid waste near the worksites.	• Develop and implement a solid waste management plan	Probability: Likely Magnitude: Major Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct

CATEGORY	ISSUE		POSSIBLE IMPACT	MITIGATION	OTHER
E.	**Decommissioning Phase**				
HUMAN/SOCIAL/CULTURAL	Social	Employment	Boost in short-term employment	None	Probability: Likely Magnitude: Minor Direction: Positive Duration: Short Term Permanence: Reversible Extent: Direct
		Site Operations	Removal of batching plant and other temporary structures	Site office inclusive of batching plant should be decommissioned as outlined in the Decommissioning Plan. All construction refuse should be removed, and area landscaped if applicable.	Probability: Likely Magnitude: Major Direction: Negative Duration: Long Term Permanence: Reversible Extent: Direct
NATURAL HAZARD	Flooding	Increased post-development run-off	Possible blockage of drains by site clearance activities during decommissioning phase.	• Inspection of drains during and after decommissioning phase ensure that they are free from debris.	Probability: Likely Magnitude: Major Direction: Negative Duration: Short Term Permanence: Reversible Extent: Direct

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER

HEALTH & PHYSICAL	Water and Air Quality	Site Clearing and improper disposal of materials removed from the site	Site clearance and improper disposal of sewage, construction materials may cause increased sediment laden run-off to freshwater and marine waters, as well as contamination of water sources with pathogens and nutrients which may affect the appearance and usability of the water for recreational and "potable (freshwater systems)" use.	• Follow all measures outlined in:
				  ○ Environmental Management and Monitoring Plan
				  ○ Solid Waste and Sewage Management Plan
				  ○ Safety Management and Monitoring Plan
				  ○ Vehicle Maintenance Plan
				  ○ Traffic Plan
				• Advanced notification two weeks to relevant local authorities (e.g., NSWMA) For the disposal and removal of any refuse. All solid waste and debris on site and in the marine environment will be removed and disposed of by licenced contracted municipal waste operators at an approved disposal site. Ensure that unwanted material is not burnt on site.
				• Final notification to relevant local authorities (NEPA, St. Ann Municipal Corporation) of completion of construction and change in status of the site to that of an operational development.
				• Notification to property neighbours and the immediate surrounding residential and business communities should occur one week before decommissioning activities commence.
				• Security personnel will be present at all times, as it would be during normal construction phase until the decommissioning has been completed.
				• Signage will be clearly posted at the entrance of the facility alerting the public that the facility is "Closed," and the area is "Restricted."
				• Vehicular and pedestrian access will be restricted to only personnel necessary to carry out the activities associated	

		Increased vehicular traffic			

CATEGORY		ISSUE	POSSIBLE IMPACT	MITIGATION	OTHER
		Heavy Equipment Operating		with decommissioning activities. Flag persons will continue to remain at the entrance to regulate any heavy equipment entering or exiting the site as during the construction period. • All access will be via the posted security personnel and recorded in the security log. • All equipment and material utilized during construction will be removed from the site. • Temporary administrative office structures and worker housing solutions will be transported off the property • Portable toilets and hand wash facility leased would expire and returned to the operator • All material stockpiles will be utilized in the construction process and any remainder removed from the site (Any fine earth materials should be covered while transported offsite).	

9. Energy Use and Conservation

Electricity will be the main form of energy used at the Mammee River Development. The total expected three phase load draw after diversification is 525kVa. This will mainly be supplied by JPS, however the bungalows will have the option to have solar panels installed. In addition, street lighting (83 poles) within the development will be solar powered. See Figure 9-1 below.

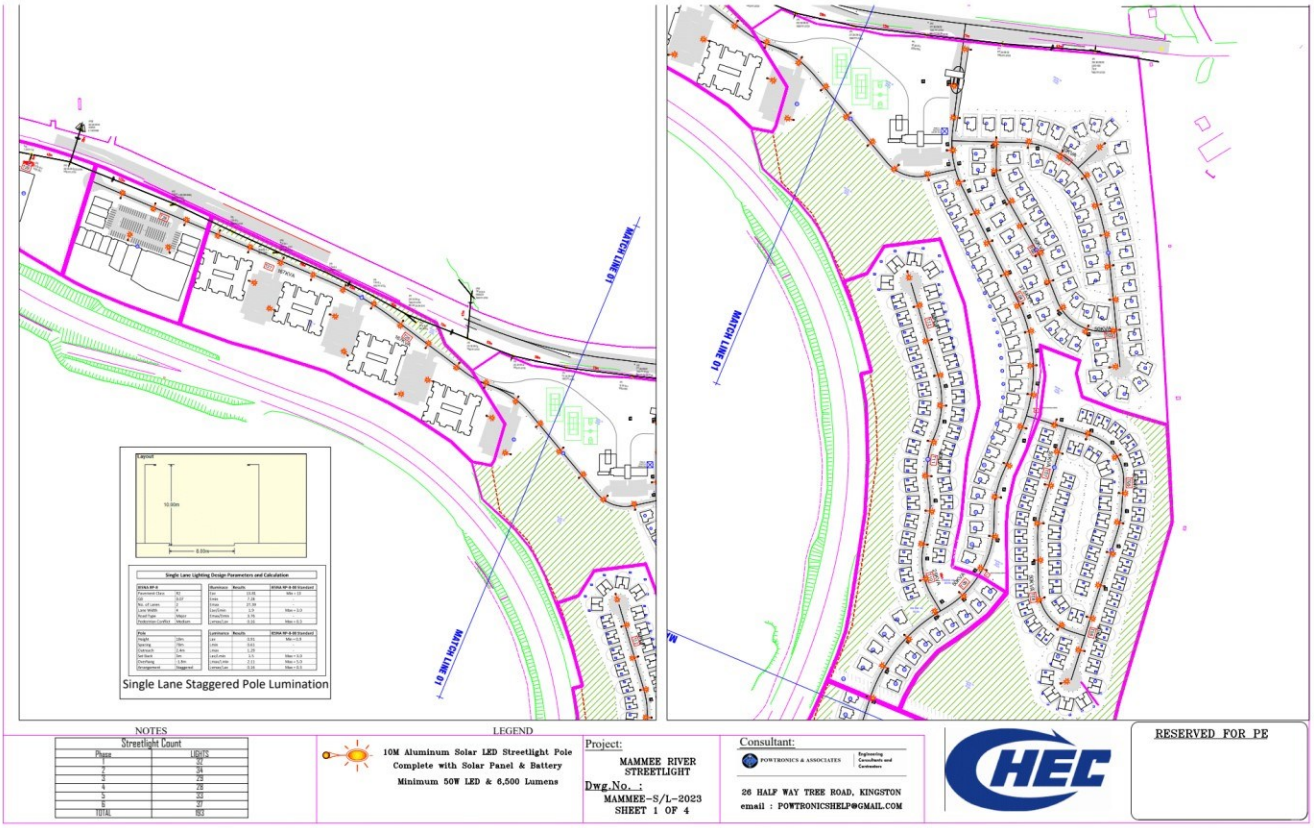


Figure 9-1 Sample of solar power street lighting system grid

The development also intends to utilize treated effluent for irrigation purposes and has incorporated a MABR sewage treatment system which uses 90% less energy for aeration than a standard system.

Energy efficiency could be a key feature of this development. The development should build on its energy and water conservation efforts by focusing on additional activities to incorporate best practices in energy consumption, energy management and minimising their carbon footprint including:

- Cooling and heating system design and management
- Architectural design to reduce energy demand
- Maximizing the use of alternative energy e.g. solar power
- Utilizing vegetation and landscaping to reduce heating and induce cooling
- Integrated building controls
- Lighting control
- Efficient energy distribution

10. Analysis of Alternatives

10.1. No-Action Alternative

This option would entail the land remain without any development and the land would remain as secondary forest. This would remove the possibility for additional housing solutions in an area that could attract affluent residents to the area, which could stimulate further downstream development and growth. This no-action alternative would entail a great opportunity cost lost in the foregone employment to the area, both during and after construction, additional clientele for the existing businesses in the area, as well as the new businesses that would be fostered to support 4,000 new residents. The loss of this development scheme would also prevent knowledge transfer, skills upgrading, overall economic upliftment, improvement in infrastructure on the site and overall property values increasing in the area.

This development is also significant to the preservation of the island's historic cultural heritage with the Roaring River Great House being preserved and brought back into operation as a restaurant for a new generation of Jamaicans to utilize, along with any Taíno and other historical artefacts that may be unearthed during the excavation activities. Additional sites like the Mammee Bay Estate Ruins and Aqueducts may be uncovered and additional historical sites marked and preserved for generations to come. Without this development these sites may remain unnoted, buried and allowed to further fall into disrepair.

10.2. The Proposed Development in Another Location

Other locations were considered in conjunction with the proposed Mammee Bay location for implementation of this project. However, the Mammee Bay property offered the following advantages over other locations considered:

- Land was zoned for the type of development desired
- The available land and its location was desirable based on its accessibility, road networks and proximity to a JPS power station, an NWC potable water treatment facility, neighboring towns and recreational areas.
- Land was previously permitted for use as a resort hotel development
- Beach and waterfront location was ideal with beautiful white sand beach and marine environment
- Size of property allowed for inclusion of a tertiary level sewage treatment system with capability to treat to a level satisfactory for use as irrigation water
- The sewage system in Steer Town, the closest community, would not have the capacity to support a similar sized development in another location
- Issues relevant to solid waste management were easily satisfied due to the development of the area and availability of resources

No other location was able to offer the comprehensive package of available land, size, natural resources and access. As a result, no location that was more suitable or amenable than the Mammee Bay site identified in the Ocho Rios area.

10.3. Recommended Alternative

The recommended alternative is the "Proposed Alternative". Once the proposed recommendations are implemented, the project meets or exceeds all local regulatory requirements.

11. Environmental Monitoring & Management Plans

The sections below highlight the proposed environmental monitoring and management plans for various aspects of the proposed development. The roles and responsibilities for various members who have one or more duties for executing and ensuring that management plans are implemented and followed are highlighted in the table below.

Table 11-1 Identification of Roles and Responsibilities

POSITION	ROLE/ RESPONSIBILITY
CHEC or Project Developer	Implementing Entity. Responsible for monitoring the contractor to ensure that monitoring is being undertaken and mitigation measures are being enforced. CHEC should ensure that an EHS Manager, or suitable alternative, is employed to oversee the specific requirements of this plan.
Contractor	Outside entity/ person employed to execute a task. The contractor may be required to implement mitigation measures and prepare monitoring reports.
NEPA, Enforcement Branch /ODPEM	Monitoring reports are submitted to the relevant agency to be reviewed based on stipulated timelines.
Operations Manager	Generally responsible for reviewing and approving recommendations from the EHS Manager and the coordination of response. Operations Manager also provide support to the EHS Manager
Facility Manager	Generally responsible for the upkeep of the facilities and maintenance of equipment/ machinery and to implement mitigative measures as recommended by the EHS Manager.
Environmental Health and Safety (EHS) Manager	The overall implementation responsibility of the Operations Environmental Monitoring Plan lies with the EHS Manager. In addition, the EHS Manager is responsible for the review of all monitoring reports and ensuring that any corrective actions needed are put in place. The EHS is also responsible for ensuring that the staff conducting the sampling are adequately trained and that the staff/ contractors receive a site-specific induction course.
Environmental Specialist (internal or external) and Environmental Monitor	The Environmental Specialist will be responsible for: • Conduction of the Air Quality and Noise Assessments • Conduction of the Wastewater and surface/ marine water quality assessments • Conducting inspections and audits • Analysis of the results • Identifying any correction measures needed • Generating a report for review.

11.1. Air Quality Management

11.1.1. Monitoring Standards

The relevant NEPA and international standards (where local standards do not exist) standards should be used for the environmental monitoring of this Project during the construction phase. The table below outlines the relevant local and international standards monitored data for comparison.

Table 11-2 Ambient Air Quality Standards (NEPA)

Ambient Air Quality	Average Timing	NRCA (NEPA) Standard (Max Concentration in µgm^3)
PM_{10}	Annual	50
	24 hours	150
$PM_{2.5}$	Annual	12
	24 hours	35

Through monitoring of the ambient air quality, the development will ensure that they comply with all emission limits in the NEPA standards and the USEPA ambient air quality standards.

11.1.2. Monitoring Equipment and Stations

11.1.2.1. Particulate Matter

Samples for particulate matter should be collected using calibrated pumps approved for air quality monitoring by the relevant agency and guidelines. The pumps should be placed as specified in the NRCA Ambient Air Quality Guidelines. The data obtained from the analyses of the filter should be expressed as the exposure levels of particulate matter (PM_{10} and $PM_{2.5}$) using a Time Weighted Average (TWA). The results at the end of the sampling period will be compared to the NEPA standards and/ or the USEPA National Ambient Air Quality Standards.

11.1.2.2. Stations

Monitoring stations should be established as per the requirements of the regulatory agency. Sampling sites that may be recommended may take into consideration the closest sensitive human receptors and the direction of the prevailing winds. The location of these monitoring stations will be outlined in the regulator's permit to operate the facility. PM_{10} will be required to be monitored during the construction phase of the project.

11.1.3. Monitoring Frequency

This will involve continuous monitoring for a 24-hour period along the length of the proposed site. Monitoring should be carried out as specified by the regulatory agency until construction is completed.

11.1.4. Management and Mitigation Measures

Measures which should be implemented to ensure compliance with the relevant standards includes:

- Reducing engine idling during on- and off-loading activities should be encouraged.
- Minimising the generation of fugitive dust by:
    - Ensuring all unpaved areas are paved or grassed.

- Reduce the speed limit of vehicles used in the development.
- Wash dusty paved surfaces when necessary.
- Wet unpaved areas frequently.
- Ensure dust screens are used for any activities which will generate fugitive dust.

11.1.5. Roles and Responsibilities

All members within the chain of command for the proposed Project are identified in Table 11-1along with their roles and responsibilities. Regulatory oversight is performed by NEPA. The positions listed are an example and any suitable alternative to carry out the functions listed can and should be employed.

The EHS Manager is responsible for the Environmental Health & Safety Plan (EHSP) and is supported by a team of technical professionals (Environmental Monitors/ Specialists) who carry out specific environmental programs to include sampling needed for each monitoring programme. The EHS Manager is also responsible for periodically updating this EHSP.

11.1.6. Key Performance Indicators

The table below identifies the KPIs.

Table 11-3 Air Quality - Key Performance Indicators

NO.	KEY PERFORMANCE INDICATORS	MONITORING AND MEASURING METHODS	RESPONSIBILITY
1	Equipment maintenance log and schedule	Review and inspection of documentation	Contractor or EHS Team
2	Notices to stakeholders	Review and inspection of documentation	EHS Manager
3	Air quality parameters within NEPA standards	Results certificates	Contractor or EHS Team
4	Log of wetting frequency	Review and inspection of documentation	Contractor or EHS Team
5	Use of personal equipment gear	Review and inspection of documentation	Contractor or EHS Team

11.1.7. Data Analysis and Reporting

All samples collected during the monitoring exercise should be analysed using verified/validated analytical methods at an Environmental Health Unit (EHU) approved laboratory and an internationally accredited laboratory. The Certificate of Analysis (CoA) obtained from the laboratory should contain at least the following information:

1. Sample identification/information and description
2. Sample collection date and time
3. Sample submitting information (temperature and condition of sample, time and date of submission)
4. Analysis date
5. Test results with units of measurement
6. Test methods
7. Notes regarding anomalous tests results

8. Applicable standard
9. QA/QC documentation
10. Signature of authorized persons

he data obtained from the certificate of analysis will be analysed, taking into consideration statutory requirements and operational standards as well public health and safety. These reports will be prepared by the environmental specialist (internal/ external) and submitted to the EHS Manager who will then review and take necessary actions and report to the relevant regulatory agencies (according to the reporting frequency in their License). The structure of the report should include but not be limited to the following:

- Introduction
- Project Background
- Sampling locations (including GPS locations) and description.
- Approach/Methods
- Results
- Discussion
- Recommendations based on findings.

11.2. Noise Management

The NRCA (NEPA) Standards are presented in the table below. The relevant NEPA permit will stipulate the frequency that monitoring should take place during the construction and operation phases. Noise level readings, wind direction and any unusual local noise sources will be recorded. Measurements will be taken using approved and calibrated sound level meters. The frequency spectrum of the noise should be measured.

The results at the end of the sampling period should be compared with NEPA standards. Through monitoring of the noise, CHEC should ensure that they comply with the requirements of their environmental permit.

Table 11-4 Noise Standards

NRCA (NEPA) Standard		
	Day (7am – 10pm)	Night (10pm – 7am)
Residential	55dBA	50dBA
Commercial	65dBA	60dBA
Industrial	75dBA	70dBA

11.2.1. Monitoring Equipment and Stations

Ambient noise measurements will be conducted at stations specified by the regulatory agency. A calibrated sound level meter will be used to measure noise. The model of the equipment will be clearly stated, and the meter will be calibrated before each survey.

Monitors should be placed, and noise level readings should be done as specified by the regulatory agency. In general, the noise level limit is represented by the background or ambient noise levels that would be present in the absence of the project or noise source(s) under investigation. In addition, before and after

the survey, the instrument will be checked with a calibrator, which should be factory calibrated.

11.2.2. Monitoring Frequency

The noise level readings will be taken as specified by the regulators.

11.2.3. Management and Mitigation Measures

In addition to the monitoring procedures, a member of the CHEC (EHS team) or a contractor will ensure the following noise reduction options are implemented where necessary.

- Workers must be properly protected from noise above 90dBA using the appropriate protective gear (according to US OSHA Permissible Noise Exposure Limits). The exposure limit for occupational noise exposure recommended by the National Institute for Occupational Safety (NIOSH) is 85dBA for an 8 Hour shift.
- The noise leaving the compound should not exceed that as specified in the Environmental Permit.
- Utilise noise mitigation measures (including the construction of bunds, metal sheet walls) in order to limit noise levels at sensitive receptors.
- Ensure that construction works are only undertaken in defined working hours (weekdays 8h00 – 17h00 and weekends 8h00 – 13h00). In the event that noisy activities are undertaken outside of the specified working hours, all noise receptors will be informed of such activities in advance.
- Assess and manage all noise complaints.
- Undertake noise monitoring at locations with persistent noise complaints.
- Vehicle speeds should be limited to 20km/h on unpaved surfaces.

11.2.4. Key Performance Indicators

The following KPIs have been selected in order to evaluate the effectiveness of the noise monitoring system.

Table 11-5 Noise – Key Performance Indicators

NO.	KEY PERFORMANCE INDICATORS	MONITORING AND MEASURING METHODS	RESPONSIBILITY
1	Equipment maintenance log and schedule	Review and inspection of documentation	EHS Team or Contractor
2	Notices to stakeholders	Review and inspection of documentation	EHS Manager
3	Noise parameters within NEPA standards	Results certificates	EHS Team or Contractor
4	Log of complaints	Review and inspection of documentation	EHS Team or Contractor
5	Use of personal equipment gear	Review and inspection of documentation	EHS Team

11.2.5. Roles and Responsibilities

All members within the chain of command for the proposed Project are identified in Table 11-1along with their roles and responsibilities. Regulatory oversight is performed by NEPA. The positions listed are an example and any suitable alternative to carry out the functions listed can and should be employed.

The EHS Manager is responsible for the Environmental Health & Safety Plan (EHSP) and is supported by a team of technical professionals (Environmental Monitors/ Specialists) who carry out specific environmental programs to include sampling needed for each monitoring programme. The EHS Manager is also responsible for periodically updating this EHSP.

11.2.6. Data Analysis and Reporting

The results from the sampling exercise will be compared to NEPA noise pollution standards and included in the environmental monitoring report prepared and submitted to NEPA. If there are any exceedances, this will be reported immediately to the EHS Manager to allow management strategies to be changed according to the results.

11.3. Water Quality Management

11.3.1. Monitoring Standards

Monitoring of water quality for the proposed project will consider environmental and public health during all phases of the project. The parameters to be monitored during each applicable phase to ensure protection of the aquatic environment will be stipulated by NEPA in the relevant license (if granted) and the sampling protocol used will meet at a minimum, the Ministry of Health & Wellness (MoHW) Environmental Health Laboratory Sampling and Field Measurements Protocol and standards for ambient water quality stipulated by NEPA will be used to assess the water quality.

11.3.2. Monitoring Equipment, Stations and Frequency

Monitoring will be carried out by a contractor or the EHS Team according to the frequency that is stipulated in the NEPA Permit.

11.3.3. Management and Mitigation Measures

Once parameters are determined to be non-compliant with the regulatory stipulations or process requirements, corrective actions should be taken to bring the parameters back into compliance. Investigations into the cause(s) of the non-compliance should be done as soon as possible once results are obtained to ensure swift and adequate corrective measures are implemented.

11.3.4. Key Performance Indicators

The following KPI's have been selected to evaluate the effectiveness of the water quality management program.

:

Table 11-6 Water Quality - Key Performance Indicators

NO.	KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	RESPONSIBILITY
1	Sediment traps	Site Inspection	Contractor or EHS Team
2	Logs indicating when work was halted	Review and inspection of documentation	Operations Manager on recommendations from EHS Team
3	Water Quality Results from a certified lab.	Review and inspection of documentation- certificate results	Contractor or EHS Team

11.3.5. Data Analysis and Reporting

All samples collected during the monitoring exercise will be analysed using verified/validated analytical methods at an EHU approved laboratory. The Certificate of Analysis (CoA) obtained from the laboratory should contain at least the following information:

1. Sample identification/information and description
2. Sample collection date and time
3. Sample submission information (temperature and condition of sample, time and date of submission)
4. Analysis date
5. Test results with units of measurement
6. Test methods
7. Notes regarding anomalous tests results
8. Applicable standard
9. QA/QC documentation
10. Signature of authorized persons

The data obtained from the certificate of analysis will be analysed, taking into consideration statutory requirements and operational standards as well public health and safety. These reports will be prepared by the environmental specialists/monitor or contractor and submitted to the EHS Manager who will then review and take necessary actions and report to the relevant regulatory agencies (according to the reporting frequency in their License).

11.3.6. Roles and Responsibilities

All members within the chain of command for the proposed Project are identified in Table 11-1along with their roles and responsibilities. Regulatory oversight is performed by NEPA. The positions listed are an example and any suitable alternative to carry out the functions listed can and should be employed.

The EHS Manager is responsible for the Environmental Health & Safety Plan (EHSP) and is supported by a team of technical professionals (Environmental Monitors/ Specialists) who carry out specific environmental programs to include sampling needed for each monitoring programme. The EHS Manager is also responsible for periodically updating this EHSP.

It is the responsibility of the EHS Manager to ensure that the management and mitigation measures for water quality are clearly understood by all workers and that they are carried out and relevant monitoring reports are prepared. The EHS team is responsible for monitoring the contractor to ensure that monitoring is being undertaken and mitigation measures are being enforced.

11.3.7. Data Analysis and Reporting

If there are any violations, this will be reported immediately to the EHS Manager to allow for management strategies to be changed according to the results.

11.4. Solid Waste Management

Solid (Non-Hazardous) Waste

The National Solid Waste Management Act, 2001, defines solid waste as to include 'medical and hazardous waste and a) refuse or sludge from a waste treatment facility, water supply plant, air pollution control facility and garbage; b) solid, semi-solid or contained gaseous or liquid matter resulting from industrial or commercial, mining or agricultural operations or domestic activities; and c) any contained substance or object which is or in intended to be, or required to be, disposed of'.

Hazardous Material/Waste

Under regulation 2 of the Natural Resources Conservation (Permits and Licences) Regulations, 1996 hazardous waste is defined as 'any substance which by reason its chemical activity, toxicity and explosivity, corrosivity or other characteristics, causes or is likely cause, danger to health or the environment, whether of itself or on contact with other waste.

11.4.1. Monitoring Frequency

Monitoring of waste should be done as recommended by the regulatory authority. If not specified, it is recommended that weekly monitoring be done.

11.4.2. Management and Mitigation Measures

The EHS Team or Contractor will ensure that the following mitigation measures are followed during all phases of the project to reduce the possible negative impacts of improper waste disposal and management. During the Operation Phase of the project, CHEC should consider engaging NSWMA for the collection and disposal of solid waste.

11.4.2.1. Hazardous Waste

- Potential hazardous material should be identified prior to the start of construction and stored in properly designated and labelled locations.

- The storage of hazardous materials maintained in larger quantities should be in appropriate containers, clearly labeled, in a labeled, bonded, paved area. For small quantities of said material the client may store materials in appropriate containers with spill-proof drip trays.

- Bonded storage areas should hold 110% of the total volume of the containers within the bonded area as required by NRCA guidelines. Additional guidelines on how to construct bonded areas can be seen in the NRCA Secondary Containment of Hazardous Liquids.[18]

- The client must also have appropriate sorbents on site to assist with the cleanup of any spills.

- All hazardous spills or contaminated water or effluent should be handled using the appropriate safety data sheets (SDS) as a guideline and where necessary under the supervision and advisement of NEPA or

[18]Guidelineshttps://websitearchive2020.nepa.gov.jm/new/services_products/guidelines/docs/NRCA2011Guidelines.pdf

other appropriate regulatory agencies.

• All personnel shall be trained and educated during induction by the EHS team on the classification and safe handling of hazardous substances on site;

• Any hazardous material, such as waste oil and tyres, solvents, contaminated soil or material etc., should be disposed of via approved contractors in locations approved by NEPA. A special permit for removal and transportation is a requirement of NEPA;

• In the event of leaks/spills, they should be cleaned up immediately, NEPA/ODPEM consulted where applicable, and the waste disposed of at an approved dump site;

• No impacted materials from leaks/spills etc. should be diverted to a municipal disposal sites.

• CHEC should limit the storage of hazardous material on site and these materials should not be stored near rivers, streams or drains. It is preferred that these materials are stored offsite, however, if onsite storage is required, this should be temporary (where applicable), in a secured area, according to the appropriate SDS requirements and in as minimal quantities as possible.

• Hazardous materials which may be stored in larger quantities such a fuels, lubricants, solvent and paints shall be stored in properly bunded areas (where applicable) to contain any leaks. Smaller containers of liquid hazardous material should be stored over drip trays to contain leaks.

• Workers handling hazardous waste should be properly equipped with PPE (masks, gloves, hard hat, hard boots, etc.);

• Appropriate spill kits must be readily available and easily accessible

• Burning or burying of any kind of hazardous waste should be prohibited.

• In the absence of any local guidelines, the client may use the guidelines provided by the International Finance Corporation for Environmental Health and Safety Guidelines or the USEPA Guidelines.[19]

Non- Hazardous Waste

• All non-hazardous waste generated should be disposed of using approved methods. Waste should only be collected by NSWMA, or a contractor approved by NEPA or NSWA and transported to an approved landfill.

• Material that can be recycled, such as scrap metal, should be separated and carried to approved collection points.

• Burning or burying of non-hazardous waste should be avoided as best as possible.

• Sufficient and appropriate weather and scavenger-proof bins (with lids to prevent the escape of litter) shall be provided and be accessible at all points where waste is generated.

• The project area should be kept clean and free of litter. No litter from the site shall be allowed to be dispersed to surrounding areas.

• All personnel shall be instructed to dispose of all non-hazardous in a proper manner.

[19] https://www.ifc.org/content/dam/ifc/doc/2023/ifc-general-ehs-guidelines.pdf
https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-261

• All construction materials should be suitably stored and protected so that they do not become damaged and unusable.

• Portable toilets, if used, must only be transported by approved contractors. NEPA permits may be required.

• A schedule for collection of waste must be developed and waste must never be stored in or near to waterways or along roadways.

11.4.3. Key Performance Indicators

The following KPIs have been selected in order to evaluate the effectiveness of the solid waste management system:

Table 11-7 Solid Waste Management – Key Performance Indicators

KEY PERFORMANCE INDICATOR	HOW IT WILL BE MONITORED AND MEASURED	RESPONSIBILITY
No waste deposited in the active roadway, waterways, ponds or pedestrian walkways	Weekly inspections of these areas to ensure no waste is seen.	Contractor, EHS Team
No leakages or spills	Monitor possible spills. Inspection of the site and checking incident logs.	
No leaking containers	Regular inspections of storage containers	
All waste materials removed by appropriate contractors	Receipts maintained for all contractors for removal of sewage and hazardous waste. Maintain disposal logs	
All hazardous waste areas labelled and access restricted	Sufficient signage for bonded area.	
Limited sediment laden run-off during heavy rain	Monitor near/downstream wells and water bodies during operation for significant sediment deposits	
Reuse of waste (construction, organic etc. where possible)	Monitoring of the amount and type of waste being removed from the site.	
Use of approved contractors	Inspection of licenses and documentation. A copy of these documentation should be kept on the contractor's file.	

KPIs will be reviewed occasionally to determine areas for improvement. Specific KPIs will need to be developed for the additional Environmental Management Plans.

11.4.4. Roles and Responsibilities

It is the responsibility of the EHS Team or Contractor to ensure that all mitigation measures are carried out and that monitoring reports are prepared and submitted to the EHS Manager. During Operation, where waste is generated, the EHS Team or Contractor is responsible for monitoring.

11.4.5. Data Analysis and Reporting

If there are any breaches, these will be reported immediately to the EHS Manager to allow for management strategies to be changed according to the results.

11.5. Emergency Response Management

This pertains to all phases of the project but primarily the pre-construction and construction phases when there will be more workers on the project site.

11.5.1. Standards

The inspection and/or audits will be conducted by a member of EHS Team or Contractor based on applicable standard or best practice.

11.5.2. Audit/Inspection Frequency

Audits or inspections should be carried out by a member of the EHS Team or Contractor as stipulated by the relevant standard or best practice. If a frequency is not defined, then it is recommended that said activity be done monthly or weekly depending on the risk associated with the activity/task.

11.5.3. Management and Mitigation Measures

The EHS TEAM or Contractor will ensure that the following measures are put in place for effective emergency response:

- Preparation, implementation and Monitoring of an Emergency Response Management Plan for all phases of the project.
- In the event of fire there should be sufficient, available and well-maintained firefighting equipment.
- If the fire is too large, the Jamaica Fire Brigade shall be called to extinguish it.
- In the event of pending heavy rainfall, all equipment should be removed so that it is not damaged.
- Workers should not be allowed to work during periods of heavy rainfall or lightning events.
- First Aid Kits should be readily available at the Construction Site Office and persons trained in first aid should be present at all times on site.
- Proper Signage and alerts systems in place. Alert systems should be maintained and tested frequently.
- Conducting the relevant drills on an approved frequency for natural and/or man-made emergencies

11.5.4. Key Performance Indicators

Table 11-8 Emergency Management - Key Performance Indicators

KEY PERFORMANCE INDICATOR	HOW IT WILL BE MONITORED AND MEASURED	RESPONSIBILITY
Maintenance log	Review and inspection of documentation	EHS Team or Contractor
Drill schedule	Conducting of Drills	
Incident Log	Review and inspection of documentation	

11.5.5. Roles and Responsibilities

It is the responsibility of the EHS Team or the Contractor to ensure that the emergency response measures are clearly understood by all workers and that all management and mitigation measures are carried out and that the necessary audit/inspection reports are prepared and submitted to the EHS Manager.

11.5.6. Data Analysis and Reporting

If there are any violations, this will be reported to the EHS Manager to allow for management strategies to

be changed according to the results.

11.6. Worker Health and Safety Management

This section relates to both workers' health and safety as well as to the health and safety concerns of the general surrounding communities.

11.6.1. Monitoring/Inspection Frequency

Inspections or Monitoring activities will be carried out by a member of the EHS Team or Contractor as determined by any applicable standard or best practice.

11.6.2. Management and Mitigation Measures

The EHS Team or Contractor will ensure that any mitigation measures are followed during the relevant phase of the project so as to reduce the potential negative impacts of workers and surrounding areas. Some activities which should be implemented to ensure worker's health and safety includes:

- CHEC must have a health and safety policy that is known and understood by all workers. It must also be visible to the workers on site.
- Safety signs should be clearly demarcated in the relevant areas and barriers erected to prevent possible incidents.
- Workers should be properly equipped with health and safety equipment and trained in the proper use of such equipment.
- All workers must be trained in the proper handling and management/disposal of materials which they work with.
- The Contractor and EHS Team shall maintain a register of all EHS-related incidents that have occurred on the project site or off the project site (but is related to the project). EHS incidents that should be recorded include fires, accidents, spills of hazardous materials that contaminate soil or water resources, stop-order notices issued by NEPA, St. Ann Municipal Corporation, or any other relevant agency, noncompliance with this EMP.
- Each EHS-related incident will be investigated by the EHS Team or Contractor and an incident report prepared and submitted to the EHS Manger within five days.
- EHS incident reports will include as a minimum, details of the incident, analyses of the incident (where applicable), immediate actions taken to contain any damage to the environment, personnel or the public, the corrective actions to repair/remediate any damage and preventive actions to prevent/minimize recurrence of incident (where applicable)
- All equipment (inclusive of the batching plant), tanks and machinery shall be maintained in a good state throughout the construction period.
- Equipment service areas should have an impermeable surface.

Effluent from service areas should be properly treated prior to discharge in the environment.

- Emergency medical supplies must be available and easily accessible in the case of an incident.
- In the event that the onsite medical supplies are not adequate, the incident needs to be escalated to

the nearest hospital or medical facility.

• In the event that a worker is improperly exposed to hazardous material, they should be assessed (if possible) by a trained First Aider and taken immediately to a medical facility if medical attention is required.

• 'Work Ahead'/'Detour' signs should be used ahead of potential traffic disruptions;

• Avoid blocking entrances/ exits to the project site or impeding main road/highway traffic.

• Dirt/ debris should not be stored on sidewalks, roadways, near drains, streams or rivers.

• Wherever works are taking place pedestrian and vehicular traffic must not be completely obstructed. The use of flag men will be required when heavy vehicles are moving on and off the site.

- Site security measures should be enacted to minimize non-essential personnel onsite.

11.6.3. Key Performance Indicators

The following KPIs have been selected in order to evaluate the effectiveness of the health and safety management system.

Table 11-9 Worker Health and Safety Management - Key Performance Indicators

KEY PERFORMANCE INDICATOR	HOW IT WILL BE MONITORED AND MEASURED	RESPONSIBILITY
Health and Safety Policy	Review and implement documentation	EHS Team or Contractor
Health and Safety Signs	Inspection of the site	
Training log and schedule	Review training log and associated documentation	
Register of all EHS related incidents	Review and analyses of incident logs and reports	
Equipment maintenance log	Review and inspection of documentation	Operations or Facilities Manager
Emergency Kit	Presence of a fully stocked emergency kit	EHS Team or Contractor
Site security log	Review and inspection of documentation	Operations Manager

11.6.4. Roles and Responsibilities

It is the responsibility of the EHS Team or contractor to ensure that the health and safety management policy is clearly understood by all workers and that all mitigation measures are carried out and that relevant inspections/monitoring reports are prepared and submitted to the EHS Manager. It is the responsibility of the workers to ensure that they understand the health and safety requirements and that they abide by them.

11.6.5. Reporting

If there are any violations, this will be reported immediately to the EHS Manager to allow for management strategies to be changed according to the results.

11.7. Flora and Fauna Management

11.7.1. Monitoring Standards

The works will be monitored by the EHS Team or Contractor based on adherence to the NEPA environmental permit.

11.7.2. Monitoring Frequency

Monitoring will be carried out by the EHS Team or Contractor according to the frequency that is stipulated in the NEPA Permit. It is recommended that this should be done during the land preparation phase and every two weeks thereafter until no longer required by the permit conditions.

11.7.3. Management and Mitigation Measures

The EHS Team/ Contractor will ensure that the following measures are put in place to manage the flora and fauna during the construction phase:

• Clearing of vegetation shall be kept to the minimum required.

• All construction sites should be clearly demarcated.

• No clearing of vegetation, storage of materials or other construction-related activities shall be permitted outside the demarcated construction area.

- Efforts should be made to retain some of the larger trees on site (i.e., with a diameter at breast height greater than 25 cm)
- NEPA should be contacted if there is sighting of any species of concern and this should be fully communicated to all workers. Activities may need to be halted until NEPA has assessed the findings and provided a way forward.
- Where possible, vegetation clearance and construction activities should take place outside of the March to September breeding season for birds. Where construction must proceed during this period, activities that could disturb or destroy nests should be avoided, adapted, rescheduled, or relocated.
- The EHS Team should consider sensitivity/awareness training on local and migrant avifauna to mitigate risks.
- Active nest searching is not recommended as the ability to detect nests is very low while the risk of disturbing or damaging active nests is high.
- If an active nest is encountered during construction activities, all activities should be halted in the nesting area and persons should move away quietly. Appropriate setbacks should be established (species dependent) and a qualified ecologist or NEPA consulted. If the status of the nest cannot be confirmed, or if a nest is found outside of the breeding season, appropriate setback distances should be implemented until such time that the nest status can be confirmed.
- Cleared vegetation should be disposed of in a suitable manner. Burning should not be permitted.
- Proper storage and disposal of construction waste and the management of stockpiles to minimize/avoid sedimentation of waterways and surface water bodies at each site should be practiced.
- A nursery should be established for tree and plant species native to the area to be utilized in future landscaping.

11.7.4. Key Performance Indicators

The following KPIs have been selected in order to evaluate the effectiveness of the fauna and flora protection.

Table 11-10 Flora and Fauna Managment - Key Performance Indicators

KEY PERFORMANCE INDICATOR	HOW IT WILL BE MONITORED AND MEASURED	RESPONSIBILITY
No major losses of priority species	The establishment and implementation of a log to capture all priority species in the area. Review and assess information captured in said log.	EHS Team or Contractor
Signage	Conduct site inspections to ensure that signs are placed and remain placed in the relevant areas.	
Number of Training and Awareness sessions	Review training log and associated documentation	
Nursery established	Establish a log to determine the quantity and type of plants moved from the nursery to the project site.	

11.7.5. Roles and Responsibilities

It is the responsibility of the EHS Team to ensure all workers are made aware of the importance of following this plan and that the relevant monitoring reports are prepared for submission to the EHS Manager.

11.7.6. Data Analysis and Reporting

If there are any violations, this should be reported immediately to the EHS Manager to allow for management strategies to be changed according to the results.

11.8. Heritage Management

11.8.1. Chance Find Programme/ Watching Brief

During construction activities, cultural heritage assemblages may be discovered or identified. The Chance Find Programme is intended to manage impacts to known, probable and unknown cultural sites. Consultations and communication with the legal and regulatory institutions, such as JNHT, should be held and procedures and protocols for assessing any unanticipated cultural heritage sites or materials encountered during the project construction phase should be developed and implemented as outlined below.

11.8.2. Chance/Find Protocols & Procedures

Essentially there are several main protocols involved in the implementation of a Chance Find Procedure. These include:

- The Chance Find Programme includes the following procedures:
    - A local specialist or archaeologist should remain on call and shall provide oversight of the entire Chance Find Programme.
    - The on-call specialist should be used on an as-needed-basis and will monitor the Chance Find Programme.
    - The on-call specialists are only required to conduct field monitoring in the case of unusual or highly sensitive and important chance finds.

- A stop work authority/procedure should be affected in the immediate area for the protection of cultural heritage materials encountered during construction activities.
- Document and assess Chance Finds to determine if additional investigations are required.
- Adhere to any established protocols established in consultation with project management of Implementing Agency, Contractors, cultural heritage specialists, local regulatory bodies (for the design and implementation of additional investigations, if needed).
- Identify the roles and responsibilities of the various stakeholders involved.
- The archaeologist must be present during all ground disturbing works conducted within culturally sensitive areas.
- Ground works in other areas should be monitored by at least one member of the project staff who has previously received cultural heritage training.
- Considering that a chance find can be reported by any member of the project staff, it is important that cultural training be provided to all project staff and subcontractors.

If a Chance Find is encountered, the following steps should be undertaken:

- Issue a stop work order in the vicinity of the find and inform the site supervisor or project manager.
- Install temporary site protection measures such as warning tape of avoidance signs.
- Inform all personnel of the Chance Find if access to any part of the work area is restricted.
- Establish a localized no-go area needed to protect the Chance Find.
- Arrange for the specialists to perform a preliminary evaluation to determine whether the Chance Find is cultural heritage and if so, whether it is an isolate or part of a larger site or feature.
- Leave artefacts in place if possible; if materials are collected, they will be placed in bags and labelled by an archaeologist and transported to the relevant agency. Artefacts should not allowed to be taken by any project personnel as personal possessions.
- Document the find via the use of photography, notes, GPS coordinates and maps as appropriate.
- If the Chance Find proves to be an isolated find or not of cultural heritage, the specialist will authorize the removal of the site protection measures and activity in the area.

If, however, the specialist confirms the Chance Find as a cultural heritage of artefact or site of significance, inform the JNHT and initiate discussions about treatment as follows:

- Prepare and retain archaeological monitoring records including initial reports whether they are later confirmed or not. The record shall include coordinates of all observations to be retained within the project's GIS system;
- Develop and implement treatment plans for confirmed finds using the services of qualified cultural heritage experts;
- If a Chance Find is a verified cultural heritage site, prepare a final Chance Find report once treatment has been completed;
- While investigation is ongoing, co-ordination with onsite personnel is needed so as to keep them informed of the status and schedule of the investigations and inform them of when construction will resume.

In the event that mitigation is required, then expedient rescue excavations should be undertaken by the relevant archaeological specialists unless the chance find is of international importance. If this is the case, then special care should be taken and archaeologists with the appropriate expertise in addressing the find should be appointed.

12. Conclusion

China Harbour Limited (CHEC) proposes to construct a premier housing development complex in Mammee Bay, St. Ann that in our professional opinion, based on the information provided, will have minimal to moderate impact on the surrounding physical environment and a net positive impact on the social environment once mitigation measures have been successfully implemented.

Key positive impacts identified include:

- Direct and indirect economic multiplier effects and rural development
- Increased housing options in local areas
- Modular sewage systems that can serve as an example to other developments across the Caribbean.
- Proposed energy efficient design elements

Potential negative impacts and risks identified, with their corresponding mitigative measures, include:

- Significant impacts during construction
    - Internal migration and possible squatting
    - Possible uptick in crime
    - Loss of biodiversity
    - Air and water quality deterioration
    - Noise pollution
    - Potential flooding
    - Potential damage to historical buildings and sites

- Significant impacts during operations
    - Severe weather damage to structures
    - Wastewater contamination of the soil, fresh and marine water
    - Increase in traffic
    - Increase in runoff

Additional assessments such as a marine environment study to assess the baseline for the area, and additional hydrology and geology assessments based on the final site plan may be required prior to construction. Several risk factors were identified, and commensurate risk control measures were enumerated. The overriding residual risk, with minimal control in the hands of the developer is severe weather halting project activities.

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