LLANDOVERY DEVELOPMENT
ENVIRONMENTAL IMPACT ASSESSMENT

SAGICOR JAMAICA LIMITED (FORMERLY LIFE OF JAMAICA)
JAMAICA

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ENVIRONMENTAL IMPACT ASSESSMENT

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TECHNOLOGICAL AND ENVIRONMENTAL MANAGEMENT NETWORK LIMITED
20 WEST KINGS HOUSE ROAD
KINGSTON 10
JAMAICA

TEL: (876) 920-6012
TEMN@CWJAMAICA.COM
WWW.TEMNETWORK.COM

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EXECUTIVE SUMMARY

Sagicor Jamaica Limited (formerly Life of Jamaica) proposes to develop a beachfront property in Llandovery in the Parish of St. Ann. This development is now subject to a feasibility study which includes an Environmental Impact Assessment (EIA) which is a requirement of the National Environment and Planning Agency (NEPA) in exercising their powers under the NRCA Act 1991. Technological and Environmental Management Network (TEMN) Limited has been engaged by Life of Jamaica, through Reliance Consulting Group Limited to carry out the EIA, and this report presents the findings thereof.

The Environmental Impact Assessment was carried out by a multidisciplinary team, and utilised skills in biological assessments, hydrogeology, environmental chemistry, socioeconomics, oceanography, and project management. A comprehensive evaluation of the study area was carried out and the environmental character of the area determined. This was related to the development plans and the potential impacts identified. Recommendations are made which are aimed at ensuring compliance with relevant environmental statutes, and ensuring the preservation or restoration of the ecological balance through the mitigation of anticipated impacts

The site is located within the district of Llandovery (Latitude N 18°29'57.3", and Longitude W077°38'27.9"), St. Ann which is situated on Jamaica's north-west coast. St. Ann otherwise called the "Garden Parish" is located at latitude 18°12'N, longitude 77°28'W. It is bordered by Clarendon, St. Catherine, St. Mary and Trelawny. Its coast washed by the Caribbean Sea, St. Ann covers an area of 1,212.6km, making it the largest parish. The population was an estimated 168,726 in 2001. There are two distinct tourist areas in the parish - Ocho Rios and Runaway Bay. Ocho Rios ranks with Montego Bay and Negril as the three most popular tourist destinations in the island. However, it leads in cruise ship arrivals. The industry is a major employer and supports other businesses in the resort areas and parish.

The development proposes to have 300 habitable units on 4.087 hectares of beachfront property inclusive of studios, apartments and townhouses. Along with an administration building and a club house with spa, commissary, kitchen, dining, sports bar, kiddies pool and adult swimming pool with swim up bar, on the beach front side.

There are also plans for development of a boardwalk and viewing deck alongside a natural stand of mangroves. Road ways will be made of asphalted concrete while parking spaces (278) will be made of turf block (to minimise surface drainage). National Work Agency (NWA) requested a 9.14m building set back from front boundary adjacent to the Highway while NEPA requested 31.25m building set back from the high water mark on sea frontage except for the beach swim up bar. Buildings will be 2 and 3 storey high built of 6" concrete blocks and reinforced concrete floors. Most rooms will have two-wall exposure with large windows for maximum cross ventilation. Mini Split air conditioning units will be used only when necessary as ceiling fans will be installed in most rooms. Sewage treatment will be via Chromoglass® package plant and Constructive Wetlands with adjoining Retention Tanks for recycling irrigation to landscape areas.

Pre-construction activities would include bushing to allow for surveyor to establish levels and the establishment of site office inclusive of temporary on site pit latrine. Construction method and works would be conventional i.e. Strip or raft foundation.

Duration of construction phase should not exceed 6 months for road and sewage. The construction of the Beach Cottages should not exceed 12 months. Both activities could go on simultaneously.

Water and electricity will be supplied in the usual manner. Solid waste disposal will be carried out by the National Solid Waste Management Agency (NSWMA). Storm water flows will be captured and dispersed to the main drain using storm water pipes of the required size.

IMPACT ASSESSMENT

The Environmental Impact Assessment was carried out by a multidisciplinary team, and utilised skills in biological assessments, hydrogeology, environmental chemistry, socioeconomics, oceanography and project management. A comprehensive evaluation of the study area was carried out and the environmental character of the area determined. This was related to the development plans and the potential impacts identified. Recommendations are made which are aimed at ensuring compliance with relevant environmental statutes, and ensuring the preservation or restoration of the ecological balance through the mitigation of anticipated impacts.

Environmental Chemistry Impacts

Present Impacts

TSS and turbidity results were consistent with the fact that no obvious sources of pollution were observed in the immediate vicinity. However physical evidence photographed, point to moments of high flow, which may contain considerable amount of silt and rubble.

Phosphate levels were close to, but just within the draft marine standard. Nitrate levels however exceeded the standard suggesting impact from land-based sources external to the development site.

The absence of faecal coliform indicates no direct impact from sewage or livestock waste on coastal water quality at the time of sampling.

Projected Impacts

During Construction potential impacts will be associated with the movement of traffic engaged in the transportation of construction material as well as earth movement. Specific impacts could include:

1. Silt laden run off from the site to the marine environment,
2. Spillage of earth and debris from trucks onto roadways

3. Aeolian dispersion of dust
4. Deposition of earth on roadways from truck wheels
5. Disposal of sewage generated by site workers
6. Disposal of solid waste generated by construction activity

Post Construction Impacts to the environment will be associated with the populating of the area and the conversion of soft surface to hard surface. Specific impacts anticipated include:

1. Increased run off to the marine environment
2. Sewage discharge to the environment
3. Introduction of household solid waste to the area.

Post Construction Impacts to the development will be associated with the location of the development adjacent to a major highway to the south, the marine environment to the north, and a major drain to the east. Specific impacts likely include:

1. Corrosion of metallic fixtures and materials
2. Susceptibility to intrusive noise from traffic
3. Susceptibility to tidal influence and storm water runoff from the nearby hilly region.

ECOLOGICAL IMPACTS

Development of residential development projects with multiple units designed as integrated scheme on single expanse of land such as the Llandovery property brings with it a series of environmental impacts. The following section identifies anticipated environmental impacts resulting from the proposed project based on the information provided and on the surveys conducted in the area. The environmental impacts are summarised, rated and classified as immediate, short-term, long-term or deferred in the Impact Matrix .Environmental impacts of significance during and post construction phases include:

Loss of Land Use:
The portion of the Llandovery property that has been proposed for the condominium development has been partially cleared and has been previously exploited (possibly as agricultural or pasture lands). Construction of condominium units represents a permanent and irreversible commitment of land resources, eliminating all other land use options including agricultural uses or rehabilitation of the area as a nature reserve.

Loss of Habitat and Biodiversity

Loss of Vegetative Cover The clearing of the site in preparation for the construction phase represents an immediate and negative environmental impact to the area. The removal of trees and shrubs would reduce the existing forest cover, resulting in irreversible loss of natural habitat for flora and associated fauna in the area. The construction activities and the presence of the development will impact negatively on the composition of the bird community and lead to loss of species from the area, especially of the forest-based endemic species. The development site is situated in the middle of a stretch of undeveloped coastal area and will result in permanent fragmentation of the existing habitat. This carries with it the possibility of permanently altering the movement patters of terrestrial fauna and/or nesting and feeding patters of the avifauna thereby altering the overall function of the ecosystems in the area (Clevenger & Waltho 2003).

Loss of Avifauna

The proposed development will have negative (disruptive) effects on the bird composition of the area. There will obviously be loss of species from the area, however based on the low numbers of species observed, any loss would be negligible. It is expected that most species would relocate to more suitable habitat.

Impact on the Beach and Wetland areas Wetland areas, common to Jamaica's coastal areas, are among the most biologically productive ecosystems and are defined as "a site where plants and animals have become adapted to temporary or permanent flooding by saline brackish or fresh water" including "permanently or temporary flooded lands with sedge or grass morass, swamp forest or mangroves". Regardless of the size, coastal wetland areas are essential to coastal stability and to reducing coastal erosion by acting as a physical buffer and against wave action and flood waters. Acting as "sinks", wetland areas are capable of absorbing and slowing down flood waters thereby reducing riverbed and coastal erosion. Wetland areas or costal marshes also act as a natural "sediment trap" playing a vital role in protecting coral reefs and seagrass beds from being smothered by silt brought downstream by flood waters.

Wetland areas support a rich indigenous flora, and fauna, with several of the species being endemic. Species of birds, crabs, fish, brackish water shrimp and also commercially important species use wetland areas as breeding and nursery grounds. The Jamaican government (NEPA – Coastal Zone Management &Wetland Policy) has adopted the mangrove and coastal wetlands protection policy and regulation in order to promote the management of coastal wetlands to ensure that the many benefits they provide are sustained. Wetlands are an important part of Jamaica's coastal resources and their preservation is a key component of coastal area management. In addition to the national significance, government has a wider responsibility to conserve wetlands (especially those which are waterfowl habitats) as a signatory to the Ramsar Convention on Wetlands of International Importance.

Wetland destruction resulting from draining and filling activities associated with land reclamation has been shown to result in loss of fishery resources as well as reduced flood control. The draining of wetlands by widening and deepening of wetland compromises the role and the capability of these areas in slowing the run-off of flood waters. The consequences of manipulating coastal wetland areas contributes to increasing freshwater flows to coastal areas contributing to the die-off of nearby coral reefs. Housing developments located on or near drained/filled wetland areas are more vulnerable to the effects of natural disasters including wave action, flash flooding and the occurrence of nuisance species e.g. mosquitoes.

The potential increase in runoff from the construction site would compound the nutrient loading into the reef lagoon which is already heavily impacted by sedimentation and could result in further deterioration of inshore water quality, with negative impacts to the marine life due to loss or degradation of the benthic habitat. Increased use of the beach area by the residents of the condominium could result in trampling of the Turtlegrass beds in the shallow waters which not only serve as a nursery habitat to numerous juvenile fish species but also serve to trap sediments in the lagoon.

Loss or Alteration of Turtle Nesting Grounds Sea turtles: The sandy Llandovery beach is a known turtle nesting area. The area has not been developed and as such there is no light pollution onshore to confuse the navigation instincts of returning turtles coming to lay eggs. Two species of turtles have been reported nesting in the area including the greenback and the Hawksbill turtles. Turtles favour nesting on remote, clean sandy beaches, preferably under some type of vegetative cover. Their nesting behaviour can be very easily disturbed by beach development or activity, noise and light pollution, litter, disease and many other variables. Construction of buildings and other structures near or on beaches used by hawksbills can alter the beach and destroy the vegetation and other conditions needed for successful reproduction. As such measures must be taken to ensure that the natural state of the beach is not directly or indirectly compromised in a manner that could deter turtles from nesting on the beach.

Soil Erosion and Changes in Drainage Patters Clearing vegetation, site grading, construction, excavation and concentrated discharge of collected runoff could impact the existing drainage patterns in the area resulting in erosion and increased sedimentation, if not properly controlled.

Removal of trees and other vegetative cover on the site and the subsequent construction and excavation activities required for infrastructure installation (paving of roads, laying of water/sewage pipes, electrical cables, etc.) will impact the existing drainage patterns in the area. More specifically, the clearing of the riparian vegetation along the east and west borders of the property, along the seasonal waterways which receive waters from the watershed via culverts located along the highway will lead to soil erosion and excess run-off especially during the rainy season. Seasonal streams provide natural waterways that can facilitate the management of runoff from the property serving as principal pathways for storm water run-off from the site near the eastern and western boundaries of the property. Loss of topsoil due to soil erosion as well as excessive runoff into the reef lagoon is a cause for concern which must be addressed prior to the clearing phase. Due to the location and the elevation of the project site soil erosion will remain a problem during the clearing, the construction and the operational phases if proper measures are not implemented. In addition to soil erosion and run-off, lack of proper drainage ways could result in localized pooling and flooding on the project site, providing ideal conditions for the proliferation of nuisance pests such as mosquitoes. Excessive runoff, especially during heavy rains, could also lead to elevated nutrient loading into the reef lagoon. The compounded effect of turbidity and sedimentation would negatively impact the inshore water quality and the seagrass beds in the reef lagoon.

Transportation and Storage of Construction Materials Transportation of heavy machinery and building supplies/materials implies heavy traffic on the roads leading to the site with possible negative impacts such as gas emissions, dust, petroleum spillage and noise to the surrounding area. Use of uncovered trucks for transporting building materials as well as improper storage of building materials, especially gravel, sand and cement on the construction site could lead to inadvertent dispersal of materials during heavy rains or high winds during dry periods. This could have a negative impact on the coastal waters. Improper storage or handling of hazardous or flammable materials, including fuel, paints and solvents) could result in soil contamination.

Airborne and Noise Pollution The increased traffic to the area, use of heavy equipment during the clearing of the site and transportation of building materials will create noise and raise dust which could further disturb the habitat of the existing fauna, in particular the birds nesting in the area, as well as the plants and insects they feed on. Dust and emissions from the construction vehicles and heavy machinery are inevitable both during the site clearing as well as during construction phases. Airborne pollution, in particular dust resulting from clearing of the land and from exposed piles of building materials (e.g. sand, cement, etc.) may further stress the local flora and fauna, and may also pose a health risk to construction workers and residents in the vicinity who suffer from asthma or other respiratory ailments.

Disposal of Construction Debris Construction debris generated throughout the construction cycle of the development must be managed efficiently through a waste management plan in order to avoid negative impacts to the site and the surrounding area. Cut vegetation resulting from the clearing of the area could pose a fire hazard and affect air quality if burned on location. Other construction materials including concrete waste, wood, steel, packaging plastics could be dispersed and could end up blocking drainage channels if not disposed of at approved disposal sites.

Sewage and Garbage Disposal Inadequate provision of portable restrooms and garbage dumpsters at the construction site could lead to unsanitary conditions. Resulting impacts could vary from unsightly littering of the site, fly and vermin infestations to increased nutrient levels in the stream leading into the bay. Reliable sewage treatment systems are a long term concern for the area. It is essential for the villas, cottages and the nearby beach recreation area to have proper sewage treatment systems capable of handling increases in capacity while ensuring that there is no direct discharge of untreated effluent into the porous substrate which drains directly into inshore marine waters.
Other concerns include:

- Density of building area to land area
- Given the typically poor standard of environmental management practice on construction sites in Jamaica, particular attention should be paid to the monitoring of the construction works (Monitoring plan).

SOCIO-ECONOMIC IMPACTS

Socioeconomic impacts include construction and post-construction impacts. These are summarized in the Impact Matrix in Appendix IV.

Construction Impacts

Land Use

Land use impacts of the proposed development are limited to the change of use from vacant land to residential development. The proposed land use is located within an area identified as "Coastal Development Area Boundary" on the St. Ann Development Order.

Employment and Income

Employment and income would be impacted positively by the proposed development. The positive impact is represented by the creation of jobs during construction of the development.

Transportation

Transportation impacts may be temporary. There may be an increase in vehicular traffic with the movement of construction materials and equipment on and off site.

Community Development

Lands within 0.5km of the site are undeveloped vacant lands. As such, there will be no construction impact on the community.

Post-Construction

The post-construction impacts of the proposed development include national/regional impacts, land use, employment and community development/recreation.

National/Regional Development

The proposed development includes the construction of a residential community with recreational facilities. This will contribute to overall housing development and will increase the housing stock of the nation.

There may be employment generation for security personnel, domestic workers and staff for the recreational facilities on site. This will contribute to the reduction of the unemployment rate of the parish of St. Ann (regional) and the country.

Land Use

The proposed development's post-construction impact on land use is limited to change in use from undeveloped vacant land to a residential community.

Employment

As mentioned above in the national/regional impacts, the post-construction phase of the proposed development will provide employment on the local, regional and national scale.

Transportation

Post-construction impacts on transportation include increased vehicular traffic from increased movement with additional residents moving into the area. However, the proposed development is located along the North Coast Highway which is adequate to accommodate the expected increased activity.

Community Development/Recreation

The post-construction impacts on the community/community development and recreation are both positive and negative. The positive impact is long-term and direct. There is the potential for increased employment opportunities which may result in increased economic activities in the area. Increased employment will lead to increase incomes, which will affect other economic activities such as shopping facilities for the population with increased residual incomes to spend on consumer goods. The proposed development will also increase the availability of recreation facilities within the community as the proposal includes recreational facilities including a restaurant and club house with fitness centre and spa, swimming pool and a beach.

The proposed development has the potential for increasing employment, housing stock and therefore has the potential for increasing the population of the area. There will be increased vehicular traffic and the need for services (for example, banks and ATMs) will increase. The existing social services (schools, waste disposal systems) may not be able to facilitate the increased activities anticipated in the SIA study area.

HYDROGEOLOGICAL IMPACTS

- The major, temporal impacts occur during construction as the land is developed and most vulnerable to the impacts of atmospheric events. The impacts are mitigable if sediment and erosion control planning objectives aligned to those outlined in Section 4.4 are implemented and maintained over the duration of the project.

- During operation the major sources of impacts to water and soil resources are considered to the open channel flow and channel maintenance. The implementation of the concrete open channel will benefit river bed integrity in the lower reach. Consequently surface water quality will see a small, positive impact as fine soil material that normally would be mobilized within the lower reach. Maintenance of the channel may also contribute negatively to downstream water quality, if done during the annual wet seasons.

RECOMMENDED MITIGATION

ENVIRONMENTAL CHEMISTRY

The development of a mitigation strategy should include a consideration of the following:

During Construction

1. Ensure adequate covering of haulage vehicles.
2. Use of wheel washing or gravel beds to reduce deposition of earth on roadways from truck wheels
3. Sprinkling of site to prevent aeolian dust dispersion
4. Provide approved portable sanitary facilities for site staff
5. Use of adequate measures to contain site run off.

6. Disposal of construction debris and solid waste at an approved location.

Post Construction

1. Employment of tertiary sewage treatment to prevent any contribution to nitrogen load.
2. Reservation of adequate land area to modulate surface run off from the developed site
3. Adequate set back from the highway and the marine environment.
4. Use of vegetation to buffer the corrosive effect of the marine atmosphere.
5. Use of vegetation to modulate noise from the highway.

ECOLOGY

Construction of a subdivision such as the Llandovery Project represents a permanent and irreversible commitment of land resources. Although the area proposed for the project has been previously exploited, it will no longer be available for other uses especially not for rehabilitation to its natural state. The loss of natural habitat as well as a loss of the option for alternative uses of the land is a significant negative impact. The following recommendations are based on fundamental principles outlined in The National Land Policy (1996) which acknowledges the direct relationship between the use of land for domestic, commercial, industrial or agricultural purposes, the generation of waste by these uses and the impact on the quality of both surface and groundwater resources. The land policy addresses specific land use and water resource management issues and speaks to the following:

- the need to preserve and reforest watersheds to ensure the recharge of aquifers and reduce the problem of flooding and turbidity in rivers
- the institution of programs to eliminate the pollution of rivers and streams by pesticides, herbicides and other pollutants
- preserving vegetation along water courses.

Clearing Phase

Mitigating Loss of Habitat and Biodiversity

Impact mitigation calls for protecting and restoring as much of the original condition on the development site as possible. Additional measures must be considered to further minimize negative impacts on the terrestrial ecology in the area, more specifically:

Mitigating Loss of Vegetation

Prior to the commencement of site clearing and construction, a qualified landscape manager (hired for the duration of the project) should be tasked with creating a landscape plan, which includes a vegetation map clearly identifying all mature and ecologically valuable trees (trunk diameter >30cm) earmarked for protection. The identified trees must be clearly marked and protected. This map can be used to adjust final construction plans as well as individual lots with the goal of minimizing tree removal.

A landscaping plan includes action items corresponding to each phase of the project ensuring gradual, albeit partial, restoration of the site's ecological characteristics. A landscape plan would ensure that designated trees are protected and/or if absolutely necessary, relocated and that areas suitable for replanting are identified and landscaped using only local tree and shrub species used for feeding by local bird species. Selecting appropriate plant species for replanting is essential in determining the types of birds, butterflies and other fauna that will re-inhabit the site upon completion of the project. Landscaping is deemed to be a powerful mitigation activity with a positive impact by**:**

- Maintaining and replanting green areas on the development site with trees and shrubs that would continue to attract avifauna to the area
- An integral part of the landscape plan should also address means of protecting and monitoring the wetland areas during site clearing and construction phases to ensure that the ecological integrity of the area is maintained.
- Incorporate as far as possible into the landscaping plan the natural vegetation typical of the area. Plant large trees on perimeter of compound to create a natural windbreak, which will also serve the purpose of being a sight screen
- In an effort to preserve the existing biodiversity, naturally occurring plants such as those used primarily by the birds for food and shelter should be harvested during the site clearing phase and relocated to a nursery, to serve as a source of plants for replanting at a later date. This would ensure that primarily native plants are used in the landscape plan thus minimizing the use of imported species and eliminating the introduction of potentially invasive species.

Mitigating Impact on Avifauna

Suggested mitigations especially with respect to the land birds, is the use of native species able to tolerate the soil composition (which is mostly sand), as a part of the replanting ("greening") of the development. These native trees would encourage the return of some bird species and new species to the area. Using bird feeders may encourage the displaced avifauna to remain in or return to the general vicinity, thus maintaining the existing biodiversity.

Minimizing Impact to the Beach and from the loss of Wetland Areas

All of the potential impacts listed in the previous section under impacts, especially loss of biodiversity, soil erosion, runoff and garbage dispersal, can have a detrimental effect on the beach and the wetland areas. Mitigating actions call for minimising the impact of construction near or on the beach. If construction is necessary then suspended and elevated structures supported by columns or piles with minimal footprint should be used. The true value of the beach lies in its natural setting and as such preserving the natural state of the beach is a priority. The most effective mitigation measure for the beach and wetland areas would be to avoid the construction of permanent structures on or immediately near the beach. Maintaining or enhancing the wetland areas on either side of the property is essential to mitigating the loss of habitat and maintaining biological diversity in the area. The wetland immediately east of property is slated to receive drainage water from the drainage plan being proposed. The development plan calls for the filling in of the western wetland to accommodate the construction of two buildings. Mitigation for the loss of this unproductive wetland area is centered around the drainage plan for the development. This plan calls for the creation of several water detention ponds within the boundaries of the development totaling an area equal to approximately three times the size of the wetland area to be lost. These detention ponds will be stocked with appropriate flora and fauna which will enhance the productivity of the system ensure its long term viability and also be an aesthetically pleasing aspect of the development. Detained water from ponds will flow through a filter system before being released out to sea. Further the sewerage plan for development will also include a constructed wetland in the south eastern area of property.

Protecting Turtle Nesting Grounds

Providing long-term protection to turtle nesting beaches is paramount to protecting the species. Eliminating threats such as beachfront development, beach erosion resulting from sand mining, eliminating vehicles on the beach, working with local authorities, scientists and volunteer groups to report turtle sightings, nesting activities and poaching activities are critical to the long-term management of this species. Landscaping plans, while favorable, must ensure that native vegetation is protected on the beach area. Existing vegetation can provide additional benefits such as screening out artificial beachfront lighting which can interfere with nesting behavior and disorient hawksbill hatchlings. Landscaping plans must ensure that any introduced plants are not harmful to the development and hatching of sea turtle eggs (e.g. *Casaurina* and Sea oats (*Uniola)* have been found to be lethal to hawksbill eggs). Highly visible signs should be posted on the beach at appropriate locations warning of the legal penalties for interfering with turtles and their nests. Lighting on the beach must meet the standards for Model Lighting Ordinance for Marine Turtle Protection (Coastal Roadway Lighting Manual - Appendix H, 2008).

Soil Erosion and Change in Drainage Patterns

This is a potentially significant impact that can be reduced to a less-than-significant level by implementing the following mitigation measures:

- Site clearing activities should be conducted in stages to minimize the area of exposed soil at any given time. Exposed soil should be seeded with grass or other appropriate cover as soon as possible to minimise soil erosion. Monitoring and maintaining proper storm water drainage systems, use of catchment/settlement areas and redirecting flows during periods of heavy rain are steps that can minimize erosion and surface runoff into the bay.

- Restrict grading and earthwork during the rainy season (September - October and May - June) and stabilize all exposed soils and graded areas prior to onset of the rainy season through mulching and reseeding. Temporary mulching and reseeding (using a biologist/botanist approved native seed mix) will reduce erosion by establishing quick growing plants to stabilize disturbed areas which will not have permanent landscaping installed for a period of time or which may be redistributed at a later date. Permit grading during the rainy seasons only with installation of adequate sediment and erosion control measures.

- Install and maintain silt basins and fences or sand bags along drainage paths during construction to contain on-site soils until bare slopes are vegetated. Carefully stockpile graded soils away from drainages.

- Replanting cleared/graded areas with appropriate native plant species (as determined by a qualified botanist) immediately upon completion of grading.

- Mitigation of potential drainage impacts include:

    - Maintaining natural drainage ways by :

    - Stabilizing the slopes on the banks of the seasonal streams and/or gullies by planting and/or maintaining erosion resistant shrubs.

    - Maintaining or planting erosion resistant riparian vegetation along the seasonal stream pathways or gullies to maintain natural drainage and minimize soil erosion and

    - Retaining the vegetation around the seasonal stream pathways, including the large trees to provide shade and to absorb water

    - Preventing blockage of waterways (through rubbish dumping) must be strictly prohibited both during the construction and post-construction phases

Site preparation and Construction Phases

Transportation and Storage of Construction Materials

Arrangements should be made with contractors and subcontractors to ensure that the vehicles used for transporting building materials to the site are appropriately sealed and covered to minimize dust. Dust producing building materials such as sand or cement should be stockpiled in low enclosures and covered, away from drainage areas where they could easily be washed away during rainfall.

Ensure that all material (sand and aggregate) stockpiled on the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping.
Ensure that all trucks carrying aggregate and sand are covered during delivery to the site. Care must be taken in the unloading of aggregate, sand and cement to prevent spillage.
Extra care must be taken to reduce dust in periods when wind speed are greatest which is between June and July, e.g. extra wetting of the compound to suppress dust.

All staff employed at the construction site must be provided with dust masks and be asked to use them. All raw materials must be sourced as close as possible to the construction site. Where possible waste must be transported off-site for processing, not burnt or stored for any longer than is necessary.

Ensure that all vehicles involved in the transport of construction material and staff, and machinery involved in the construction are properly maintained and serviced.
Machines must not be left idling for unnecessary periods; this will save fuel and reduce emissions and noise pollution.

Airborne and Noise Pollution

The site clearing plan should provide for 10-15m wide green buffer zones along roadsides and drainage ways to dampen the noise and dust related to construction. Access roads and exposed terrain should be sprayed by water trucks to minimize the dust. Use of heavy machinery should be restricted to daylight hours in order to minimize the noise pollution arising from the construction site. The clearing of vegetation must be carried out on a phased basis; that is, only areas designated for construction during the necessary phase of development must be cleared to minimize the dust and runoff.

Disposal of Construction Debris

A site waste management plan should be made the responsibility of the building contractor to provide for the designation of appropriate waste storage areas on the site and a schedule for the timely collection and removal of construction debris to an approved dump site. Organic waste produced during site clearing should be mechanically mulched and composted at the site and used for landscaping at a later date.

Sewage and Garbage Disposal

Providing adequate number of portable restrooms (chemical toilets or dry composting toilets) for the workmen and waste baskets and dumpsters is essential to keeping the construction site clean and pest free. Arrangements should be made for regular garbage collection and removal of sewage from the construction site. All measures must be taken to ensure that untreated sewage is not directed into the bay waters.

SOCIO-ECONOMICS

Mitigation measures for the socio-economic impacts are summarized in the Impact Matrix Table in Appendix IV. Mitigative measures are recommended to offset the negative impacts of the proposed development.

Community Development/Recreation

Mitigative measures for the negative impacts on community development include the upgrading of infrastructure and the increased provision of social services for current and future residents of the SIA study area. Consideration should be given to a proper on-site waste disposal programme that includes recycling and waste to resource initiates.

HYDROGEOLOGY

Drainage Control during Construction

During construction, features such as, site access, storage of materials, site drainage during construction and protection of surfaces from erosion and increased sediment influx to the Flat Point River require particular attention. To ensure that the flow dynamics of the lower reach of the Flat Point River are not disrupted during construction, it is recommended that the drainage works for the Flat Point River be implemented first during the normal dry season, before major site clearance. Sediment control features could then be incorporated into the site development plan to mitigate against sediment influx from site activities to the Flat Point River.

Unfortunately, in Jamaica construction practices and general workmanship have made implementation of proper site housekeeping difficult as it is not the norm for contractors to consider such activities. This makes their implementation and maintenance that much more difficult on any construction site due to unfamiliarity and the inherent difficulty in modifying human behaviour without appropriate punitive sanctions levied by the regulatory agencies.

Notwithstanding the foregoing, the site's proximity to the coast and existing Flat Point River drainage channels it is clear that erosion and sediment control will be of paramount importance during construction in order to reduce discharges to nearby water bodies. In order to mitigate any deleterious impact the following guidelines are recommended in developing the erosion and sediment control plans:

- Implement the major drainage works for the Flat Point River prior to other site activity.
- Determine the extents of clearing and grading on the other parts of the site
- Determine permanent drainage features and define the limits of construction activities.
- Determine the extent of any temporary channel containment for the existing drainage pathways that lead to the Flat Point River from the larger site.
- Determine suitable sediment controls by investigating the requirements of each drainage sub-catchment. This would assist considerably in the reduction of final discharge volumes and flow velocity.
- Determine the staging of construction with a view to minimising the period of exposure of exposed open ground.
- Identify locations for topsoil or aggregate stockpiles and temporary construction roads.

The principal objectives of the erosion controls during construction should:

- Implement the Flat Point River training to the final agreed channel location prior to other site works.
- Limit or reduce soil erosion, sediment movement and deposition to water bodies of all land

disturbing activities.

- Seek to establish temporary or permanent cover as soon as possible after final grading has been completed. Surface stabilisation should be considered for areas not at final grade which may remain undisturbed for more than 30 days. Given that Jamaica is prone to short intense rainfall events, especially in the afternoon, consideration should be given to controlling sediment movement through temporary covers, silt fences, and diversion ditches for areas within 30m of a water body.

- Design all temporary and permanent facilities for the conveyance of water from disturbed areas at non-erosive velocities.

Erosion and Sediment Control techniques that should be considered are:

- Routing runoff through existing vegetation to control sediments and reduce downstream velocities. Manage vegetation clearance in a manner that preserves pockets of existing vegetation for use as vegetative control devices.

- Install gravel diversion trenches upstream of exposed land, bearing in mind that depth to groundwater may limit vertical depth.

- Temporary sediment traps/basins to reduce velocities.

- Silt fences placed at the toe of earth slopes or stockpiles.

- Construction road stabilisation with stones immediately after grading to prevent erosion during wet weather due to vehicular traffic and to reduce the need for regrading for permanent roadbeds between initial and final stabilisation.

Drainage Control during Operation

Surface Water Drainage including existing Flat Point River

Drainage design for the Flat Point River will be designed to the 4% in any one year (1 in 25yr) event with site drainage being designed for the more frequent 20% in any year (1 in 5yr) rainfall event. The WRA had recommended an evaluation of the 50yr and 100yr flood inundation levels that would be produced by hydrologic events of the same frequency.

A preliminary look at the 50yr and 100yr hydrologic event was evaluated above and the peak discharges for the 50yr and 100yr event are presented in Table 4-14. The results indicate that the predicted runoff, based on the Forestry Department land use maps and Ministry of Agriculture soil maps, were both less than the very conservative 80m^3/s predicted in the drainage report. On balance this would indicate that the 80m^3/s design criteria should be sufficient for both the HEC-HMS predicted 50 yr and 100yr events.

Pollution Control Measures during Operation

Pollution control measures are likely to include a mix of the following:

- Earth swales
- Detention Ponds with Gravel filters
- Sand berms for storm surges

It is further recommended that:

- All storm drain outlets during construction have suitable designed structures to reduce velocity and mobilization of sediment. Swales and or temporary storage devices should be incorporated into the overall construction phase drainage control plan to provide areas of temporary storage and settlement.
- During operation source control techniques such as harvesting roof runoff, permeable pavements and infiltration devices should be considered for the hard surfaces. Dealing with the water locally not only reduces the quantity that has to be managed at any one point, but also reduces the need for conveying the water off the site. Additionally, the reuse of roof water for on-site irrigation would reduce the requirement for mains water.
- Drainage interceptors, gravel filters, and manholes must be checked as part of the regular maintenance to remove accumulated debris. The annual maintenance of the open channel prior to the approach of the annual wet seasons should be considered a requirement for development and be incorporated within the permit document.

1.0 INTRODUCTION

Sagicor Jamaica Limited (formerly Life of Jamaica - LOJ) proposes to develop a beachfront property in Llandovery in the Parish of St. Ann. This development is now subject to a feasibility study which includes an Environmental Impact Assessment (EIA) which is a requirement of the National Environment and Planning Agency (NEPA) in exercising their powers under the NRCA Act 1991. Technological and Environmental Management Network (TEMN) Limited has been engaged by Life of Jamaica, through Reliance Consulting Group Limited to carry out the EIA, and this report presents the findings thereof.

1.1 TERMS OF REFERENCE

The Terms of Reference as approved by NEPA is located in Appendix I**.** This forms the basis for this study.

1.2 IMPACT ASSESSMENT

The Environmental Impact Assessment was carried out by a multidisciplinary team, and utilised skills in biological assessments, hydrogeology, environmental chemistry, socioeconomics, oceanography and project management. A comprehensive evaluation of the study area was carried out and the environmental character of the area determined. This was related to the development plans and the potential impacts identified. Recommendations are made which are aimed at ensuring compliance with relevant environmental statutes, and ensuring the preservation or restoration of the ecological balance through the mitigation of anticipated impacts.

2.0 PROJECT DESCRIPTION

2.1 BACKGROUND

2.1.1 Historical information

The site is located within the district of Llandovery (Latitude N 18^{o}29'57.3", and Longitude W077^{o}38'27.9"), St. Ann which is situated on Jamaica's north-west coast. "St. Ann is one of the oldest populated areas in the island of Jamaica tracing back to 600 - 650 A.D. It is believed to be the earliest Taino/Arawak settlement in Jamaica. When Christopher Columbus first came to Jamaica in 1494, he landed on the shores of St. Ann. The parish of St. Ann was named after Lady Anne Hyde the first wife of King James II of England. Ocho Ríos later began to develop as a modern town and a favourite tourist destination in Jamaica." (http://www.jamlib.org.jm/stann_history.htm).

2.1.2 Geography

St. Ann, otherwise called the "Garden Parish" is located at latitude 18°12'N, longitude 77°28'W. It is bordered by Clarendon, St. Catherine, St. Mary and Trelawny. Its coast washed by the Caribbean Sea, St. Ann covers an area of 1,212.6km, making it the largest parish. The population was an estimated 168,726 in 2001. The highest elevation in the parish is in the Dry Harbour Mountains at 762 metres above sea level. Because of its limestone formation, the parish is noted for its 59 caves and numerous sinkholes. There are two distinct tourist areas in the parish - Ocho Rios and Runaway Bay. Ocho Rios ranks with Montego Bay and Negril as the three most popular tourist destinations in the island. However, it leads in cruise ship arrivals. The industry is a major employer and supports other businesses in the resort areas and parish" (http://www.jamlib.org.jm/stann_history.htm). Within the Rio Bueno White River Watershed Management Unit, St. Ann is noted for its many rivers such as the Negro, St Ann, Great, Roaring, Cave, Pedro, Dunn, Cistern and Flat Point River to name a few. The latter traverses a small section of the property proposed for development.

2.2 PROPOSED DEVELOPMENT

Plate 2-1 showing the Llandovery development site plan

The development proposes to have 300 habitable units on 4.087 hectares of beachfront property inclusive of studios, apartments and townhouses. Along with an administration building and a club house with spa, commissary, kitchen, dining, sports bar, kiddies pool and adult swimming pool with swim up bar, on the beach front side.

There are also plans for development of a boardwalk and viewing deck alongside a natural stand of mangroves. Road ways will be made of asphalted concrete while parking spaces (278) will be made of turf block (to minimise surface drainage). National Work Agency (NWA) requested a 9.14m building set back from front boundary adjacent to the Highway while NEPA requested 31.25m building set back from the high water mark on sea frontage except for the beach swim up bar. Buildings will be 2 and 3 storey high built of 6" concrete blocks and reinforced concrete floors. Most rooms will have two-wall exposure with large windows for maximum cross ventilation. Mini Split air conditioning units will be used only when necessary as ceiling fans will be installed in most rooms. Sewage treatment will be via Chromoglass® package plant and Constructive Wetlands with adjoining Retention Tanks for recycling irrigation to landscape areas

Pre-construction activities would include bushing to allow for surveyor to establish levels and the establishment of site office inclusive of temporary on site pit latrine. Construction method and works would be conventional i.e. Strip or raft foundation.

Duration of construction phase should not exceed 6 months for road and sewage. The construction of the Beach Cottages should not exceed 12 months. Both activities could go on simultaneously.

Water and electricity will be supplied in the usual manner. Solid waste disposal will be carried out by the National Solid Waste Management Agency (NSWMA). Storm water flows will be captured and dispersed to the main drain using storm water pipes of the required size.

3.0 METHODOLOGY

3.1 ENVIRONMENTAL CHEMISTRY

The environmental chemistry component of the EIA is required to review background levels of critical physical/chemical indicators as well as identify and quantify actual and/or potential impacts associated with the implementation of the proposed housing development at Llandovery. Based on the nature of the proposed development and in keeping with the Terms of Reference, the environmental chemistry assessment is based on the following indicators:

- Nitrate (NO_3)
- o-Phosphate (o-PO_4)
- Coliform bacteria (total and faecal)
- Biological Oxygen Demand (BOD)
- Suspended solids
- Dissolved Oxygen
- Salinity
- Conductivity
- Temperature
- Noise

This assessment included a review of pertinent standards and fieldwork to collect physical chemical data on the near-shore marine environment. Fieldwork was conducted on Thursday June 14, 2007 to collect field data for dissolved oxygen, salinity, conductivity, temperature and noise. GPS locations for sampling sites are given in Table 3-1. Rainfall, temperature and humidity data for the sampling period was obtained from the Meteorological Division - U.W.I. Discovery Bay Marine Laboratory site, while data on wind speed and direction (where available) was also obtained from the Meteorological Division – Norman Manley International Airport (NMIA). Wind data from the Meteorological Division is only available from the NMIA and or the Donald Sangster International Airport. Hence data from the NMIA was used as it was determined to be more representative of the proposed development site. The locations of the sampling sites are shown in Plate 3.1.

Noise level was monitored using the Type 2 CEL – 328 Integrating Octave Band Sound Level Meter. Readings were recorded minutely between 12:35 PM and 12:50 PM at the proposed development site along the eastern boundary approximately 40m from the main road (Plate 3-1 below). Spot determinations of maximum sound level (L_{max}) were performed using the A weighting to enable comparison with the international standards. Noise measurements are supported by descriptive information on activities associated with noise levels.

Table 3-1 Showing Monitoring Sites for LOJ's - Llandovery Development 2007

Station ID	Description	Parameters Monitored	Coordinates N 18^o	Coordinates W 77^o
1	East Boundary, Wetland Lagoon Near Shoreline	Water Quality	28.012	17.114
2	Marine Environment,	Water Quality	28.026	17.119
3	West Boundary Near Shoreline	Water Quality	28.022	17.209
4	Near East Boundary Approx 40m From Main Rd	Noise	27.910	17.148

Air quality was assessed by literature review and field observations.

3.1.1 Water Quality

Some international and local standards/draft standards are presented in Table 3-2. Standards are Draft NEPA standards unless otherwise indicated.

Table 3-2 showing Ambient Standards for Marine Waters

Parameters	NRCA Draft Ambient Marine Standards
Dissolved Oxygen (mg/L)	≥4.8*
BOD (mg/L)	0.57-1.16
Nitrate (mg/L)	0.001-0.081
TSS (mg/l)	10**
Phosphate (mg/L)	0.001-0.055
Total Coliform (MPN/100ml)	48-256
Faecal Coliform (MPN/100ml)	<100

* (USEPA Standard)
** (Draft National Policy for the Protection of Coral reefs - NRCA)

In addition to the dissolved oxygen (DO) standard another important value is the saturation value of oxygen (DOsat), the maximum level of oxygen that can be dissolved in water at a particular temperature, salinity and altitude/barometric pressure. For a healthy water body, where oxygen is replenished at about the same rate that it is consumed, dissolved oxygen will be slightly lower than or equal to DOsat. In cases where the water body is overloaded with biodegradable organic waste, DO will be substantially lower than DOsat and can approach total depletion. High nutrient levels on the other hand (especially N and/or P) can lead to the proliferation of algae which by photosynthesis produce levels of DO during the day time that far exceed the saturation value of oxygen (TEMN 2007). This condition referred to as eutrophication is also characterised by very low DO levels during the night time with the cessation of photosynthesis and the additional burden placed on available DO by the respiratory requirements of the massive amount of algae. The difference between the actual DO and DOsat is called the DO deficit, which ideally should be 0. We can also speak of deficit in terms of the level of saturation (DO_{sl}), which is the percentage of the saturation value (DOsat) achieved. The level of saturation should ideally be at or near 100% and will tend to zero where there is significant organic pollution. Where there is an algal bloom such as is associated with high nutrient levels the saturation level during daytime will be significantly higher than 100%.

Samples were analysed by a local laboratory, in accordance with APHA, AWWA, Standard Methods for the Analysis of Water and Wastewater:

Nitrate was determined using the cadmium reduction method.
Phosphate was determined by the molybdenum colorimetric method.
Suspended Solids was determined by filtration through 0.45u filter paper and gravimetry.
Turbidity was measured by photometry,
Dissolved Oxygen, temperature and **salinity** were measured using the YSI Model 33 S-C-T-O meter calibrated in ambient air.
BOD was determined using the bottle method.
Coliform bacteria were determined by the membrane filter method.

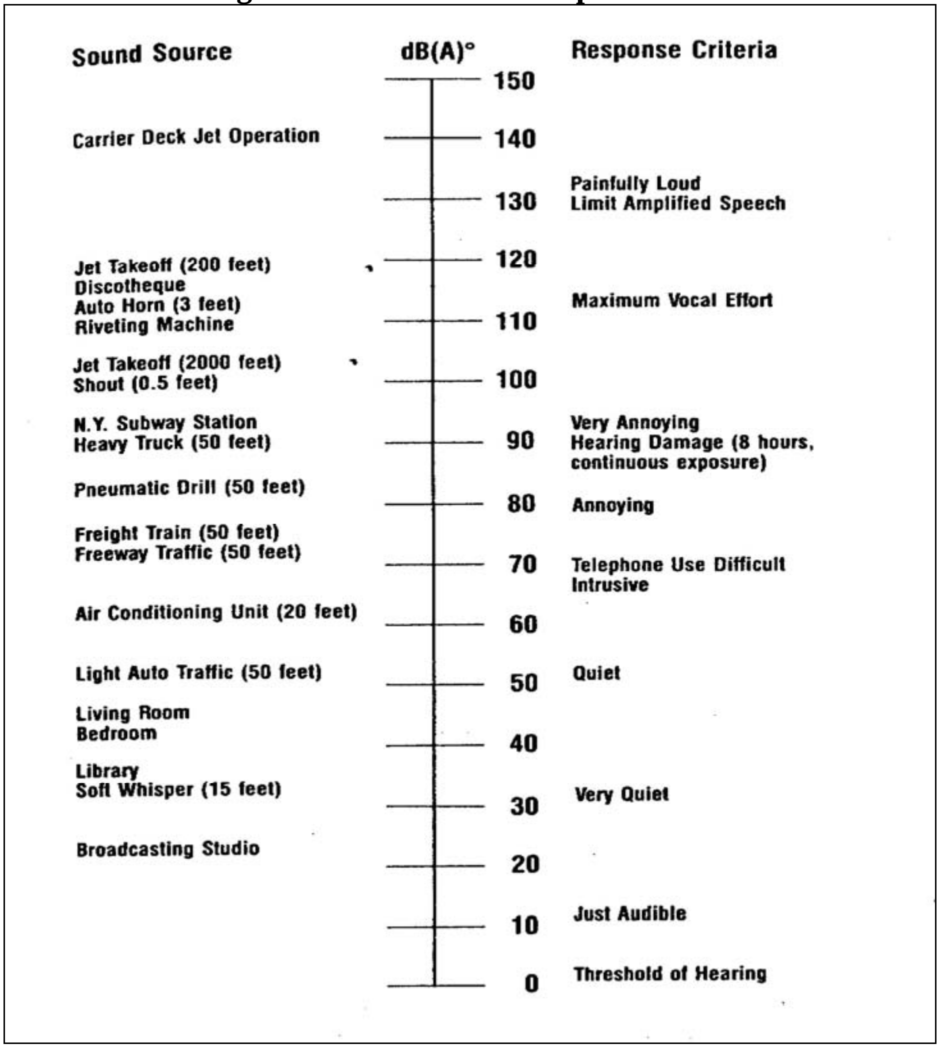
3.1.2 Noise (Background)

Noise is defined as any loud, discordant or disagreeable sound or sounds. More commonly, in an environmental context, noise is defined simply as unwanted sound. The impact of Noise is a function of sound level and the effect of that noise on people. Depending on the level and duration, noise can be a minor intrusion, a definite disturbance, or a threat to ones hearing to actually causing pain (Table 3-3 below).

A reasonable goal for any permitted operation should be to minimise increases in sound pressure level above ambient levels at the chosen point of sound reception based on known reactions of humans to these increases (Table 3-4 below). Increases ranging from 0-3 dB should have no appreciable effect on receptors. Increases from 3-6 dB may have potential for adverse noise impact only in cases where the most sensitive of receptors are present. Sound pressure increases of more than 6 dB may require a closer analysis of impact potential depending on existing Sound Pressure Levels (SPLs) and the character of surrounding land use and receptors. SPL increases approaching 10 dB deserve consideration of avoidance and mitigation measures in most cases (NYDEC).

In the absence of local ambient standards for noise, standards from other countries are presented in Table 3-5. This assessment compares noise levels measured at the undeveloped site to the USEPA standard of 55dB for residential areas.

Table 3-3 showing Sound and Human Response Criteria



Source: Original Chart: The Aggregate Handbook, 1991

Table 3-4 showing Human Reaction to Increases in Sound Pressure Level

Increase in Sound Pressure (dB)	Human Reaction
Under 5	Unnoticed to tolerable
5 - 10	Intrusive
10 - 15	Very noticeable
15 - 20	Objectionable
Over 20	Very objectionable to intolerable

Source: (Down and Stocks - 1978)

Table 3-5 showing Noise Standards from Other Countries

Country	Industrial Area	Commercial Area	Residential Area	Silence Zone
	Day / Night	Day / Night	Day / Night	Day / Night
Australia(1)	65 / 55	55 / 45	45 / 35	45 / 35
Australia(2)	65 / 65	60 / 60	50 / 40	45 / 35
Canada(1)	60 / 55	60 / 55	55 / 45	-
Canada(2)	65 / 60	65 / 60	55 / 45	-
India	75 / 70	65 / 55	55 / 45	50 / 40
Israel	70	55	50	45
Japan	60 / 50	60 / 50	50 / 40	45 / 35
Mauritius	60 / 55	60 / 50	60 / 50	-
U.S.(1)	75 / 75	65 / 65	60 / 60	-
U.S.(2)	65 / 65	65 / 65	65 / 55	-
U.S.(3)	70	62	55 / 50	-
U.S.(4)	80 / 75	65 / 60	55 / 50	-
U.S.(5)	60 / 55	60 / 55	55 / 50	-
U.S.(E.P.A.)	70	60	55	45
W.H.O. & E.C	65	55	55 / 45	45 / 35

From : (J.L. McTavish).

The last two rows are recommended values (not legislated) from the United States Environmental Protection Agency. The European Community endorses those of the World Health Organization.

Australia(1) = Australian Capital Territory
Australia(2) = Australian Northern Territory
Canada(1) = District of North Vancouver
Canada(2) = District of Burnaby
U.S.(1) = State of Minnesota (from Pollution Control Agency)
U.S.(2) = State of Delaware (from Department of Natural Resources)
U.S.(3) = Huntsville, Alabama
U.S.(4) = Denver, Colorado
U.S.(5) = Davis, California
U.S.(EPA) = Environmental Protection Agency

3.1.3. Air Quality

Given the nature of the proposed development, air quality is not expected to be a problem during the operational phase and potential impact during the construction phase is likely to be associated with dust generated by land clearing/earth moving and the movement of heavy-duty equipment. The potential for nuisance is also limited as neighboring lands are not presently populated. Typical background levels may easily be inferred from another undeveloped green-field site in a similar setting.

Plate 3-1: Showing noise level sampling stations for the LOJ – Llandovery Development

3.2 Ecology

Terrestrial and marine ecological assessments of the area surrounding the proposed location of the Llandovery condominium complex were conducted in June and August 2007. The objectives of the assessment were to:

- Provide a baseline evaluation of the biological status of the project area,
- Identify direct and indirect as well as short and long term impacts to the ecology of the area resulting from the proposed development activities,
- Assess alternative development options and suggest appropriate mitigation for the proposed development.

3.2.1. Terrestrial Ecology

3.2.1.1 Vegetation

For the purpose of this EIA the boundaries of the study area were determined from site maps and development plans provided. A "walk-through" survey method was conducted in June and August 2007 (Plate 3-2 below) to determine the presence or absence of ecologically or commercially important species of flora and fauna on the site. Species of flora and fauna were identified on location and selected samples collected and photographed for further verification. Six, 5m wide belt transects, of varying lengths were conducted to create a comprehensive plant species list for the vegetation found on and adjacent to the proposed development site.

Plate 3-2 showing aerial image of terrestrial transects.

3.2.1.2 Avifauna

An avifaunal survey conducted in November 2007 was used to (Plate 3-3 below):

a) Determine the bird species composition found on and in the vicinity of the proposed development site

b) Identify the potential impacts of the proposed development on the avifauna.

Birds were identified and enumerated according to the Fixed Radius Point Count Census Method which is based on the principle of counting individuals from a defined location and estimating the distance to the individual contact. A point was selected from where all bird contacts (seen and heard) were recorded, and the distance estimated (< 25m or >25m) for each contact. The procedure was repeated every 10 min (Bibby et al., 1998), before moving to another location within a 100m radius. Avifaunal species observed between point counts were also recorded.

Avifauna identified was ranked according to the following criteria:
R = resident, E = endemic, I = introduced, W = winter migrant, S = summer migrant

DAFOR Scale: D= 9-10; A= 7-8; F= 4-6; O=2-3; R=1

Economic Scale Value – this value was based on four components: Status, DAFOR, IUCN rating (Scale: 1:10,000)

Ecological Scale Value – this value was based on Status and Feeding Guild of the species; 1 – lowest, 5 - highest

Advantages of this method include:

- Ease of observation of the birds and their habitats from a stationary position
- More time available to identify contacts
- Greater opportunity to identify cryptic and skulking species
- Easier to relate bird occurrence to habitat features

This method was used and a total of six (6) points done over a one day period (morning), following the parochial road, as well as along other paths within the area. Notation of species observed between survey points formed the basis of transect counts for the area. All species observed using point counts and transect counts were added generating the species list.

Plate 3 -3 showing avifauna (bird) count sample points

3.2.2. Marine Ecology

Surveys of the marine environment were conducted in June and in August 2007. The surveys focused on the lagoon/back-reef area immediately north of the development site as well as on the fore-reef area (Plate 3-4 below).

Towline swims using underwater scooters were carried out to assess the general features and the status the marine ecosystem in the shallow back-reef area. A quantitative assessment, using photo-quadrates (0.5-1.0 m^2) was conducted in the back-reef area to describe the substrate composition and to generate an abundance rating (DAFOR) for species encountered.

Photo transects were used to quantify the benthic components at randomly chosen, representative sites on the fore-reef area. Two x 20m long transects (0.5m x 20m) were photographed at each location. Random dot analysis of transect photos, was used to determine the substrate composition. Corals and algae were identified to the species level where possible while all other reef components were grouped into categories (e.g. sponges, anemones or gorgonians). Fish counts were conducted along the same transect lines.

Plate 3-4 showing aerial image of marine (back reef & fore reef) transects.

3.3 Socio-economic Assessment

The socioeconomic impact assessment (SIA) examines the socio-economic and cultural setting of the study area and identifies potential impacts of the proposed development. The study area for the SIA includes the proposed site and areas within two kilometers (2km) of the site. Any new development in a community will have both local (micro), regional and national and (macro) impacts. For the purpose of this SIA the local impacts included the proposed site and the area within 2km of the site. Regional impacts were those at the Parish level while national impacts were island wide. The SIA included desktop research as well as a socioeconomic and public perception survey. A site reconnaissance and socioeconomic and perception survey were conducted on the 23rd and 24th June 2007. The land use survey for this SIA included a review of satellite imagery of Jamaica, topographic maps and a land use survey which was conducted for this study on June 23rd and 24th, 2007.

3.3.1 Land Use

3.3.1.1 On-site

The subject site is located along the North Coast Highway and consists of a 4.087 hectares undeveloped parcel that contains low lying vegetation and scattered trees. An area appearing to be a small wetland was observed close to the centre of the site.

3.3.1.2 With-in 0.5km of the Site

The lands within 0.5km of the site consist mainly of undeveloped vacant lands. The Caribbean Sea is located immediately north. The lands to the east and west of the site consist of vacant land with low lying vegetation in some areas. The North Coast highway is immediately south of the site, beyond which is undeveloped vacant land.

3.3.1.3 With-in 0.5km-2km of the Site

Lands within 0.5km-2km of the site stretches from the easternmost portion of the community of Salem in the west, Beverly to the south, just west of Laughlands to the east and the Caribbean Sea to the north. The lands to the west consist of residential, commercial and resort (hotel and guest houses) uses. The area to the far south and southwest consist of mainly residential land uses. The remaining areas consist of undeveloped vacant lands and unused agricultural lands.

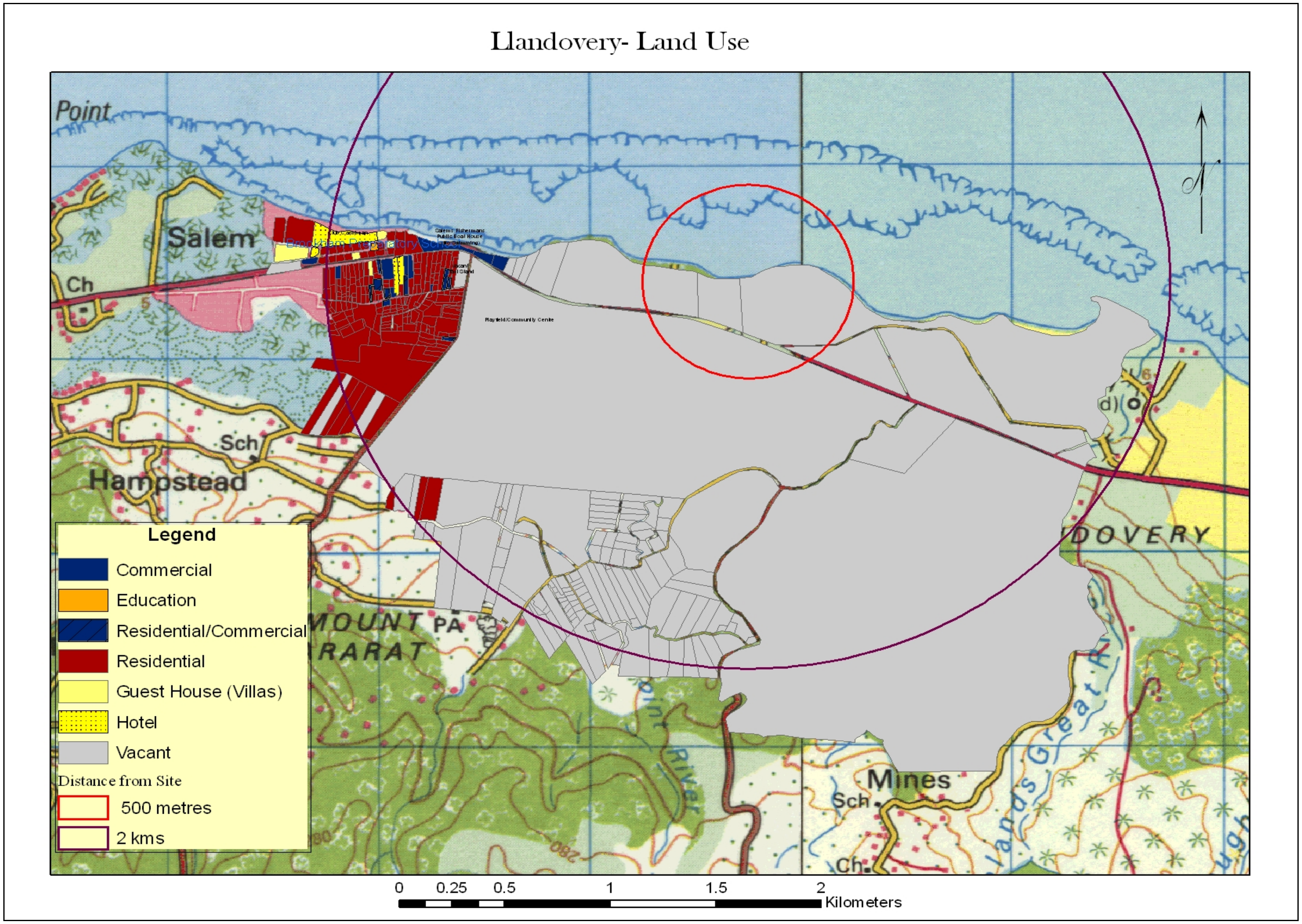


Figure 3-1 showing Land Use Map of Llandovery and its environs

3.4 HYDROGEOLOGY

3.4.1 Background and Approach

This report satisfies Task #2A (i) and Task #5 TORs of the proposed Llandovery Condominium Development at Llandovery, St. Ann. These aspects include:

- A definition of the study area, based on the drainage area of which this development is a part. These boundaries will be demarcated based on a desktop review of available topography maps and limited field reconnaissance along open and traversable access ways.

- Baseline data collection on the study area (hydrology, geology, hydrogeology, geomorphology, etc.) and review of existing reports and other information relevant to the study area.

- Review the collected data with a view to determine:

  1) Water demand of the development which will be reconciled against the available water supply.
  2) Pre and post project runoff rates for 25 year (yr) return period and 50yr and 100 yr
  3) Possibility for contamination of the coastal waters as a result of the proposed project.

- Identification of Potential Environmental Impacts relating to:

  1) Flooding of the site or to adjacent areas as a consequence of the development.
  2) Soil erosion to and from the site.
  3) Utilization of existing water supply sources and/or the development of new source(s) e.g. well source.

- Explorative Drainage Assessment to determine:

  1) Drainage for the site during construction, including sediment control mitigation.

2) Drainage for the site during operation, including sediment control and pollution control.

3) Drainage control for the Flat Point River that discharges onto the property, to include impacts that this will have on the aesthetics, water quality and sedimentation of the beach area, etc.

The available data that was referenced for this study is listed below:

- Satellite Photographs of site taken from Google Earth
- 1: 50,000 Series Geological Sheet 14 (Provisional) undated
- Water Resources Authority (WRA) Data Request – Llandovery, 2007 and 1990 Water Resources Development Master Plan
- Office of the Disaster Preparedness and Emergency Management (ODPEM)
- The National Water Commission (NWC) website and local library searches
- The archives of TEMN where pertinent to the study area

The hydrological assessment was made using the ArcHydro extension of ArcGIS to perform the initial terrain and watershed processing and the data was then input into HEC-HMS and cross referenced with WinTR-55 both of which are used around the world for peak flow estimation of small rural drainage basins and is the most widely used method for urban drainage design. Terrain analysis (i.e. watershed delineation) was carried out using the Llandovery Digital Elevation Models (DEM) and the inputs fed into GeoHMS.

Discharges for return periods of 25, 50 and 100 years were evaluated for the Flat Point catchment and 5yr design storm for site-created runoff pre- and post- development changes were assessed.

Written environmental searches were undertaken through the WRA, NWC and ODPEM. In addition, website searches of the National Environment and Planning Agency (NEPA), and the National Water Commission (NWC) was undertaken to obtain any further relevant information. The results of the returned written searches are included in Appendix VI-B.

3.4.2 Explorative Drainage Assessment

The explorative drainage assessment looks to:

1) Determine and describe how stormwater will be disposed of both during construction and site operation;

2) Determine the environmental impacts of discharges of stormwater and the suitability of proposed mitigation measures; and,

3) Determine the suitability of the proposed options for both construction and operation phases particularly on the open canals to the southeast of the site.

3.4.3 Site Description

This desktop report was compiled from limited field reconnaissance, current public domain reports held within various governmental and non-governmental bodies and through internet searches.

The site is centred on UTM 258570mE, 2043270mN (see Figure 1, Appendix VI-A) and is roughly bound by the Northern Coastal Highway to the south, the Caribbean Sea to the north and scrubland to the east and west.

The land slopes imperceptibly toward the coast. Ground elevations range from 7m above sea level (asl) at the boundary with the Northern Coastal Highway to sea level along the beach front.

3.5 COASTAL DYNAMICS

Smith Warner International Ltd. (SWIL) was contracted by TEMN Ltd. to carry out an assessment of hurricane wave conditions and storm surge levels to support the design of a of townhouse and condo development along the shoreline in the Llandovery area, on the north coast of Jamaica. Of primary concern is how various return period storm surges will affect the proposed development. In addition, there is the need to determine a safe floor level for this development. The required tasks are outlined below.

Task 1 – Collection of Bathymetric Data

Bathymetric data will be collected in front of and close to the project area out to a depth of approximately 30 meters, to ensure that nearshore seabed data is accurately recorded.

Task 2 – Wave Climate and Storm Surge Modeling

The deep water wave climates obtained (extreme) will be input to a 2-dimensional near-shore transformation model, SWAN, to give the wave climate within the Llandovery nearshore area. The SWAN model takes into account the processes of wave shoaling, refraction and reflection, and also includes the computation of wave set-up, which can be an important aspect of storm surge. The results of the model will be used to indicate the extent the storm surge inundation of the proposed development. Design water levels will be evaluated, taking into account tides, storm surge, global sea level rise and wave set-up.

3.5.1 Location and Bathymetry

The project is located in St. Ann, north coast of Jamaica. It consists of a property extending from the main road down to the coastline, and has a beach frontage of approximately 185 meters. The beach is protected from storms and hurricane waves by a barrier reef located about 450 meters offshore.

A detailed bathymetric survey in the near-shore region was carried out (depths up to 50m) in order to properly compute the wave transformation in this area. The survey was carried out from a boat using a depth sounder and GPS system that was able to record depths at 1 second intervals along pre-determined tracks. Data measurements were focused in the vicinity of the project site. Additional deep water depths taken from nautical charts were appended to produce a final bathymetric map (Figure 3-2). The map shows two distinct morphological regions separated by the reef barrier: Seaward of the reef, the seabed has a steep and constant slope; from the reef barrier to the coastline the seabed is composed of very shallow reef patches, which are generally separated by areas 5 meters deep.

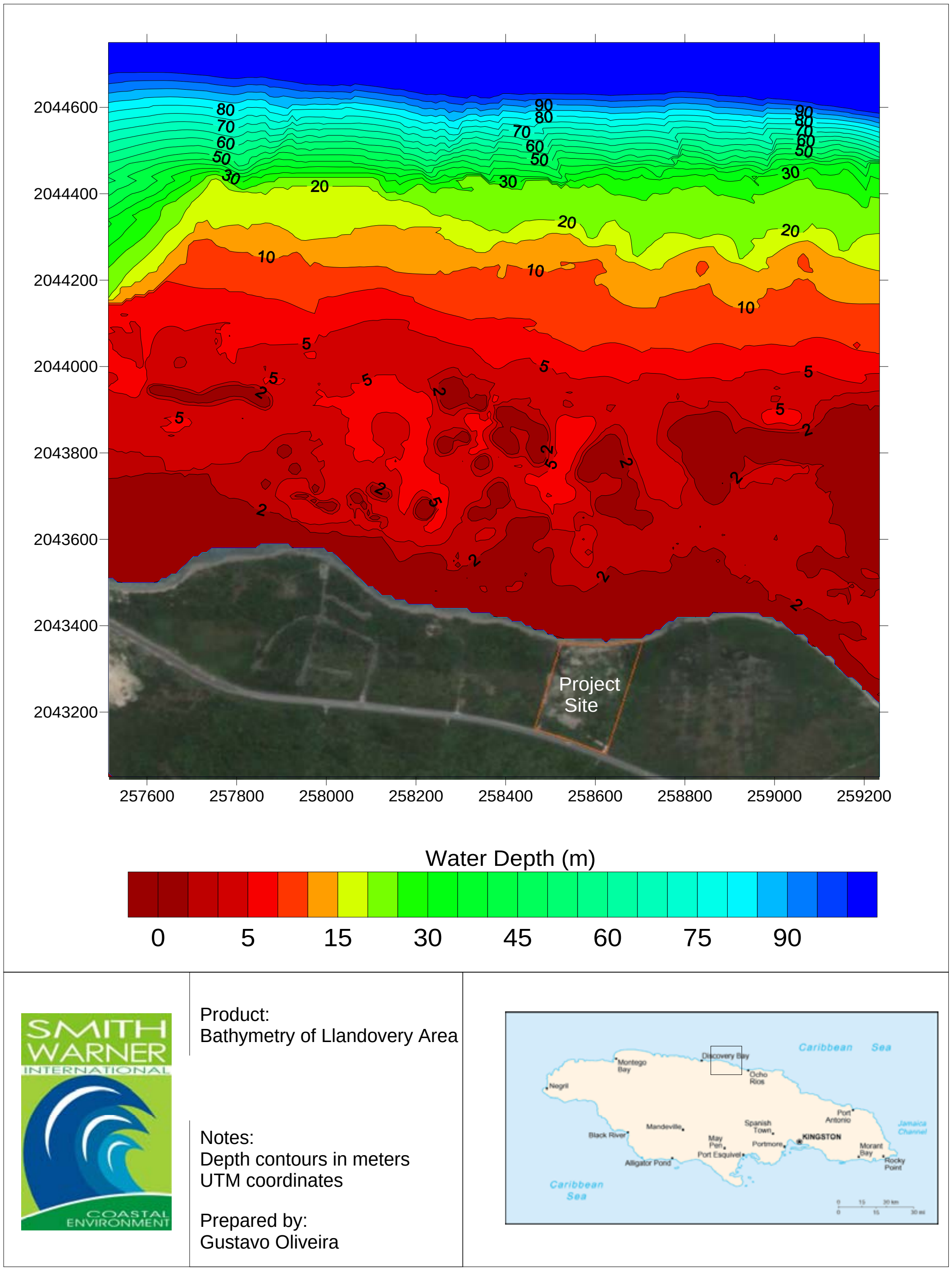


Figure 3-2 Bathymetric map of the coastal area adjacent to the project site

4.0 THE ENVIRONMENTAL SETTING

4.1 ENVIRONMENTAL CHEMISTRY

4.1.1 Water Quality

Water quality monitoring was carried out under fair weather conditions during low tide. Seas were slightly choppy with a sustained northeast wind. Rubble brought down via the culvert towards the southeastern corner of the site (Plate 4-1) was observed to have accumulated along the eastern boundary (Plate 4-2). At the north eastern boundary a sand bar was observed across the mouth of the short canal draining the small adjoining wetland (Plate 4-3). Another area appearing to be a small wetland was observed close to the centre of the site (Plate 4-4). Erosion was observed in the vicinity of the northwest corner of the site (Plate 4-5).

Plate 4-1

Plate 4-2

Plate 4-1: Culvert towards southeastern end of site.

Plate 4-2: Accumulated rubble

Plate 4-3: Small adjoining mangal wetland at northeastern boundary of site

Plate 4-4: Small herbaceous wetland in the centre of the site

Plate 4-5: Erosion observed at northwest corner of site

Results from the analysis of water samples are summarised in Table 4-1.

Table 4-1 showing LOJ – Llandovery Development, Coastal Water Quality Data (June 14, 2007)

ID	TIME (24 hour)	SAL. (ppt)	COND. (ms)	TEMP. (^oC)	BOD_5 (mg/l)	DO (mg/l)	TURB. (NTU)	TSS (mg/L)	PO_4 (mg/l)	NO_3 (mg/l)	FC (MPN)	TC (MPN)
LOJ 1	11:07	12.2	22.6	29.8	1.6	2.0	2	4.5	0.046	0.490	2	490
LOJ 2	11:30	33.4	55.8	30.5	1.4	7.9	4	13.0	0.035	0.529	0	0
LOJ 3	12:00	34.2	57.8	31.4	1.0	8.3	6	13.0	0.018	0.299	0	0
STD					1.2	4.8		10.00	0.055	0.080	100	256

ppt – parts per thousand; mg/l – milligrams per liter; NTU – Nephelometric Turbid Units; ms - millisiemens ; MPN - most probable number per 100ml.

TSS was in the range 4.5 - 13mg/l for all sites monitored (Figure 4-1). The highest value was determined for the samples taken in the sea while in the lagoon TSS was lowest.

Turbidity at all sites was in the range 2 - 6NTU. Turbidity showed a similar pattern to TSS being higher for the samples taken from the sea (Figure 4-1).

Biological Oxygen Demand (BOD) was in the range 1.0 - 1.6mg/l for all sites (Figure 4-2). The highest BOD was determined for the sample taken in the wetland lagoon (Station 1). The sample taken in the sea at the eastern boundary (Station 2), had a BOD of 1.4mg/l, while at the western site (Station 3), BOD was 1.0mg/l.

Dissolved Oxygen was in the range 2.0 - 8.3mg/l (Figure 4-2). DO was lowest in the wetland lagoon while in sea water, DO exceeded the saturation value (DO_{sat}) to have a saturation level well in excess of 100%.

Figure 4-1: LOJ - Llandovery, TSS & Turbidity, June 14, 2007

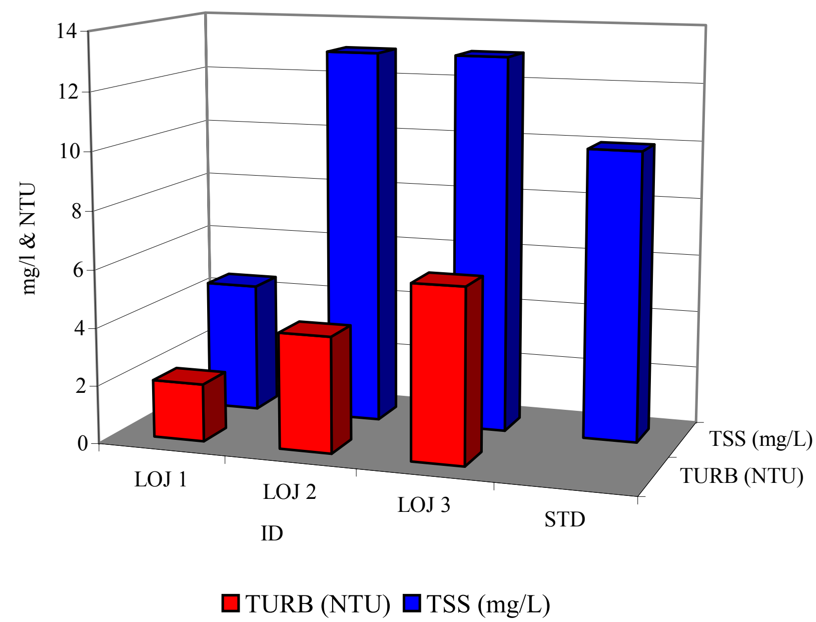
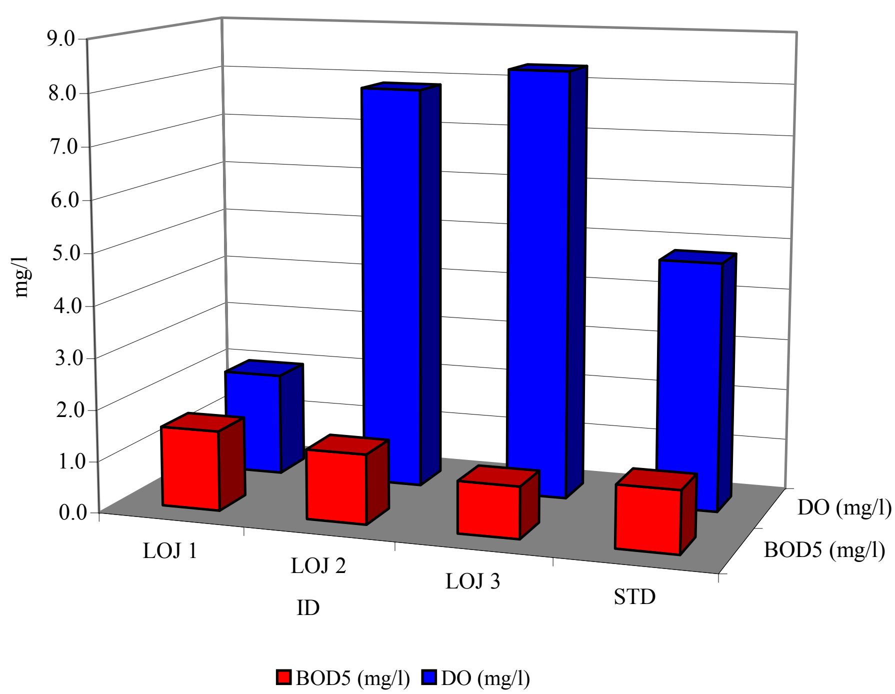


Figure 4-2: LOJ - Llandovery, BOD & Dissolved Oxygen, June 14, 2007.



Nitrate was determined to be in the range 0.299 to 0.529mg/l (Figure 4-3). The highest level was determined o the east of the site (Station 1) while to the west (Station 3) nitrate was lowest (0.299mg/l). In the wetland lagoon (Station 1) nitrate was 0.490mg/l.

Phosphate was in the range 0.018 to 0.127mg/l for the sites monitored (Figure 4-3). Phosphate was slightly higher in the wetland lagoon (Station 1) than at the marine sites. In the lagoon the level was 0.046mg/l while at Stations 2 and 3 the levels were 0.0635mg/l and 0.018mg/l.

Total Coliform was detected only in the sample taken from the wetland lagoon, for which a level of 490MPN/100ml was determined (Figure 4-4).

Faecal Coliform was absent in all samples with the exception of that taken from the wetland lagoon, which gave a value of 2MPN/100 (Figure 4-4).

Figure 4-3: LOJ - Llandovery, NO3 & PO4, June 14, 2007

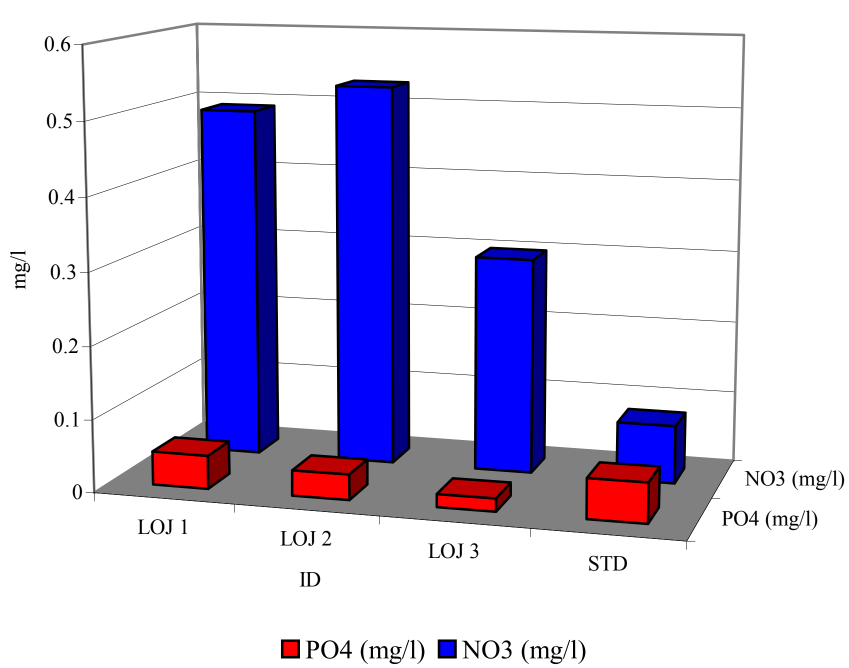
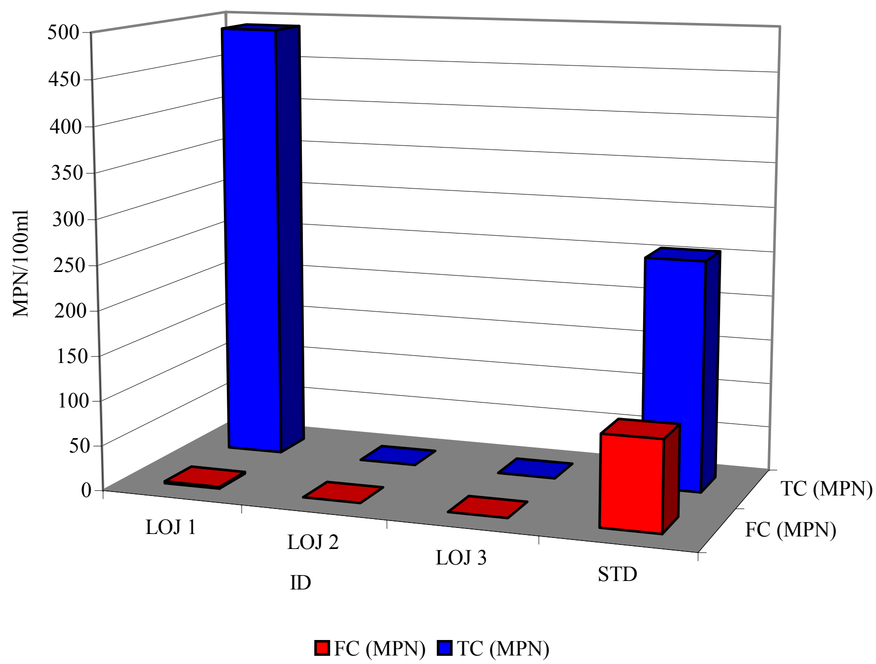


Figure 4-4: LOJ - Llandovery, Total & faecal Coliform, June 14, 2007



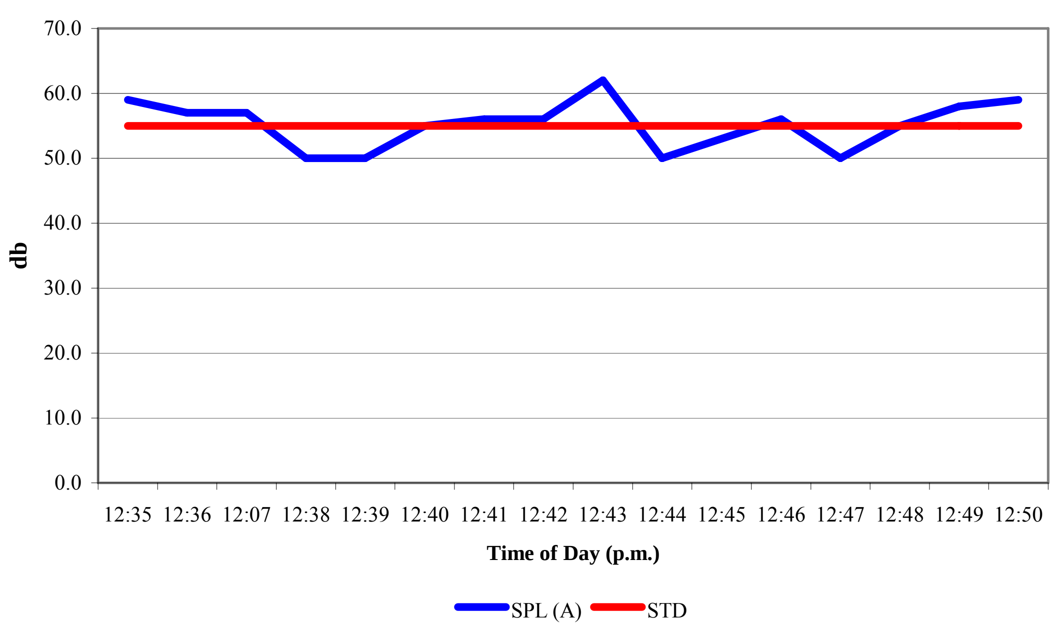
4.1.2 Noise (Observations and Results)

Background sounds of mainly birds chirping, rustling of foliage and traffic were the only sources of noise perceived. Average SPL was 55.2dB with a maximum of 62dB and a minimum of 50dB (Figure 4-5). The maximum was associated with a truck passing on the highway. Other traffic sounds (cars passing), were also significant contributors to noise levels. This assessment compares noise levels measured at the undeveloped site to the USEPA standard of 55dB for residential areas. Details of the monitoring are shown in Table 4-2 below.

Table 4-2 showing the LOJ's - Llandovery Development sound pressure level at the Eastern Boundary (approximately 40m from the road) of site. DATE: March 7, 2007

Time	SPL (A)	STD	COMMENTS/SOURCE
12:35	59.0	55	Truck Passes
12:36	57.0	55	Truck Passes
12:37	57.0	55	Truck Passes
12:38	50.0	55	Background (Birds chirping)
12:39	50.0	55	Background (Birds chirping)
12:40	55.0	55	Traffic (cars passing)
12:41	56.0	55	Traffic (cars passing)
12:42	56.0	55	Traffic (cars passing)
12:43	62.0	55	Truck Passes
12:44	50.0	55	Background (Birds chirping)
12:45	53.0	55	Traffic (cars passing)
12:46	56.0	55	Traffic (cars passing)
12:47	50.0	55	Background (Birds chirping)
12:48	55.0	55	Traffic (cars passing)
12:49	58.0	55	Traffic (cars passing)
12:50	59.0	55	Traffic (cars passing)
AVG	55.2		
MAX	62.0		
MIN	50.0		

Figure 4-5: LOJ - Llandovery, Noise, June 14, 2007



4.1.3 Air Quality (and Weather data)

No sources of air pollutants were observed at or close to the site other than traffic on the main road. Typical data for a similarly undeveloped site at Silver Sands (Amaterra Resort) in Trelawny (Table 4-3) indicate that background levels of the criteria pollutants (PM10, SOx and NOx) are within the ambient standard (TEMN Ltd., 2004).

Table 4-3 showing the Amaterra Resort Development baseline Air Quality data

ID	DESCRIPTION	N 18°	W 77°	PM_{10} (ug/m3)	SO_2	NO_2
OP 1AQ	Near Silver Sands	29.232	32.199	111	ND	ND
OP 2AQ	Carey Park	28.618	33.125	28	ND	ND
OP 4AQ	Duncan's Hill	28.228	32.772	56	Not done	Not done
STD	NEPA 24-HR Standard			150		

ND – Not detected.

For the month of May (2007) winds were generally lighter in the early morning (zero wind speed recorded at 1:00AM on two occasions towards the end of the month) picking up towards the afternoon. Average early morning wind speed in for the month before sampling was 9km/hr while the average in the early afternoon was 27km/hr from the NNE. Wind data was not yet available for the data collection month of June (2007) (See Appendix VII for detailed climate/weather data).

4.2 ECOLOGY

4.2.1. Terrestrial Flora

The area can best be described as a disturbed woodland area (Grossman *et al.* 1991), of fairly low elevation with vast open areas interspersed with isolated tree stands. The site reaches a maximum height of 7m (based on survey areas) above sea level. The access to the area is through a parochial road leading to the beach area.

4.2.1.1. Southern border of property (Transects D, C, J – Plate 3-2)

The site of the proposed development contains degraded forest terrain with areas that had been previously cleared and which are now overgrown grassland areas scattered with shrubs and a few mature trees (Transect C). The forest has been impacted by human activity including clearing, construction of paths and roads, garbage dumping and illegal sand mining (Plates 4-6 a & b).


a.


b.

Plates 4-6 a & b showing the terrain along Transect C.

The south east corner of the property, just north of the highway, has been cleared in recent years, presumably to allow for the construction of the concrete culvert (Plates 4-7 a & b). West of the culvert is a short stretch of paved road that leads into the property. The surrounding area remains clear of grass and the tracks suggest that the property is frequently traversed by vehicles. The southern edge of the property along the North Coast Highway is dominated by larger trees and shrubs that serve as a natural screen and noise barrier between the road and the property.

a.

b. 

Plates 4-7 a & b showing area cleared for culvert and drainage-way construction.

The vegetation found along the eastern border of the property (Transect D), following the path of the seasonal stream that meanders to the beach is comprised of a mixture of riparian vegetation and species typical of succession growth (Plate 4-8). The existing forest cover along the drainage path is of importance in maintaining the physical integrity of the natural drainage system on the property, controlling erosion during heavy rainfall as well as providing habitat for the local fauna, primarily birds. A representative list of species found in the area is found in Table 4-4.

Plate 4-8 showing vegetation cover along the seasonal stream path (Transect D)

Table 4-4 showing representative species of flora identified on the proposed development site (Transects D, C, J), Llandovery.

Scientific Name	Common Name	Economic/ Ecological Value	Form	DAFOR D	DAFOR C	DAFOR J
Andropogon scoparius	Giant reed	Craft	Grass			A
Cyperus ligoris	Razor grass	-	Grass	A	D	D
Aborescens mill.	Bamboo	Craft	Tall grass		A	
Cynerium sagittatum	Wild cane	Craft	Tall grass	A	A	
Achyranthes indica	Devil's horse whip	Medicine	Shrub		O	
Bidens cynapiifolia	Spanish needle	Animal feed	Shrub	A	A	
Blechum pyramidatum	Marsh miller	-	Shrub		O	
Borrichia arborescens	Seaside marigold	-	Shrub		A	
Coccoldoa		Wild grape	Shrub		O	
Croton linearis		Wild rosemary	Shrub		O	
Eupatorium odoratum	Jack in the bush	Medicine	Shrub	R		O
Euphorbiacere phyllanthus		-	Shrub			O
Jatropha gossypiifolia	Cassada marble	-	Shrub		O	
Lantana camara	Red sage	Poison	Shrub	O		
Lipianodiflora		-	Shrub		O	
Mallotaniagnaphalodes	Sea lavender	-	Shrub		O	
Moghania strobilifera	Wild hops	-	Shrub			O
Pluchea cardinensis	Wild tobacco	-	Shrub			O
Pothomorphe umbellate	Cowfoot	Animal feed	Shrub	R		
Sida acuta	Broom weed	Medicine	Shrub			O
	Wild cocoa	Ornament	Shrub	O	O	
	Cow tongue	Medicine	Shrub			O
Ambrosia penuviana	Wild Tansy		Shrub		A	
Sapindus saponaria	Soap bush		Shrub		D	
Smilax auricalata	Smilax		Shrub		D	
Mimosa pudica	Sensitive plant	Medicine	Creeping shrub		A	
Bursera simaruba	Red berch	Gum	Tree	R		
Cassia siamea	Cassia (Senna)	Animal feed	Tree	F		
Cecropia peltata	Trumpet	Medicine	Tree	O	O	O
Crescantia cutete	Calabash	Craft/medicine	Tree			O
Ficus aurea	Strangular fig	Bird feed	Tree	O		
Guazama ulnifolia	Bastard (Baseda) cedar	Animal feed	Tree	A		A
Prosopis juliflora	Cashaw	Firewood	Tree			A
Psidium guajava	Guava	Food/medicine	Tree			O
Ricanus communis	Castor oil	Medicine/cosmetics	Tree	O		
Samanea saman	Guango	Timber/shade	Tree	F	O	F
Spathodea campanulata	Flame of the forest		Tree	O		R
Therminalia catappa	Almond	Food	Tree	A		A
Thespecia populnea	Sea cotton (Mahoe)	Timber/Shade	Tree		O	
Albizia lebbeck	Mimosa (woman tongue) -		Small Tree	A		A
Guilandina crista	Nicol (Nicker bean)	Craft	Small Tree	O		O
Imopoea tiliacea	Wild potato slip	Animal feed	Vine	A		A
Pseudelephantopus spicatus	Kuaku bush	Medicine	Vine	A		A
Yucca aloifolia	Spanish bayonet			R		

4.2.1.2. Beach and Wetland Areas (Transects K, I, H – Plate 3-2)

Three representative transects were located on the beach along the northern border of the property, to the east and the west of the boundary lines. Transect K, located along the west border of the property along the beach is dominated by grass, flowering shrubs and scattered trees such as trumpet trees (*Cecropia peltata*), almond trees and sea grape (*Coccoloba uvifera*). A traveled path winds adjacent to the property providing direct access to the beach. The sandy beach (Transect I) is bordered by grass and low coastal vegetation. The area behind the grassy border has been cleared of vegetation possibly due to prior cultivation and sand mining (Plates 4-9 a & b).

a.

b.

Plates 4-9 a & b showing the North boundary of the property. View from beach (Transect I).

The western (Transect K) and eastern (Transect H) boundaries of the property contains, or border on, wetland areas. The western wetland area (approximately 1600m^2 in area) occupies the north-western corner of the property (Plate 4-10) is a degraded area and has little in the way of canopy. It supports wetland associate, terrestrial vegetation and limited seashore flora. No mangrove species observed. It was created by illegal sand mining activities in the early 1980's which resulted in ponding (pers. comm. caretaker of property). The water in the wetland has limited communication with the sea (salinity of 7 ppt from a one time sample) suggesting that it is sustained by storm water drainage from the road and property to the south of it. Few faunal species (1 fish < 2cmFL) were seen in the standing water pools perhaps because of the wide variations in salinity and temperature expected in a pond of this size with restricted circulation. The muddy/sandy sides of the pond displayed numerous crab burrows (likely *Pachygrapsus* or *Sesarma* spp.). Only fallen, rotting vegetation was visible in the pond with no sign of any colonization of the floral structures by other submerged flora or fauna.

The eastern wetland, approximately 1, 000 m^2 in size and bordering the north eastern limits of the property supported a mixed stand of black mangrove (*Avicennia germinans*), red mangrove (*Rhizophora mangle*) and white mangrove (*Laguncularia racemosa*) as well as other seashore species such Seaside Mahoe (*Thespecia populnea*) and sea grape (*Coccoloba uvifera*) (Plate 4-11). Both wetland areas are degraded or immature and in process of evolving from terrestrial systems into wetland areas. Sand mining near the coast has allowed seawater to intrude inland carrying with it opportunistic mangrove seedlings which have colonized the calm banks of the embayment. Because of the highly intermittent and limited access of fresh or marine water to the western pond it appears stalled in its development and is not productive in terms of its ability to produce significant floral or faunal biomass. The eastern wetland, though smaller appears to receive a better water supply and therefore more species of mangroves occur with a fairly well developed canopy. Despite their state of limited development they appear to serve as seasonal waterways for storm water run-off from the upland areas to the south of the highway. Table 4-5 below shows species of flora identified along the beach and wetland areas on the proposed development site.

Plate 4-10 showing wetland at the west border of the property as seen from the beach (Transect K)

Plate 4-11 showing wetland at the east border of the property as seen from the beach (Transect H)

Table 4-5 showing representative species of flora identified along the beach and wetland areas (Transects K, I and H) on the proposed development site, Llandovery.

Scientific name	Common name	Economic/ Ecological value	Form	DAFOR K	DAFOR I	DAFOR H
Adriantum fragile	Wreath fern	Craft	Fern			O
Polypodiaceae	Polypodium	Ornament	Fern	O		
Cyperus ligoris	Razor grass	-	Grass		A	
Panicum maximum	Guinea grass	Animal feed	Grass		D	
Rhynchospora nervosa	Star grass	-	Grass		A	
Typha domingensis	Reed mace	-	Grass		A	
Uniola peniculata	Sea oats	-	Grass	A		A
Cynerium sagittatum	Wild cane	Craft	Tall grass		D	
Phlebodium	Cabbage palm fern	Ornament	Palm	R		
Sapindus saponaria	Soap bush	-	Shrub	D		D
Batis maritime	Jamaica samphire	-	Shrub		O	
Lantana camara	Red sage	Poison	Shrub			O
Pothomorphe umbellate	Cowfoot	Animal feed	Shrub			O
Tragia Volubilis	Twining cow-itch	Medicine	Shrub		F	
Turnera ulnifolia	Ram goat dash along	Medicine	Shrub	O		R
Vinca rosa	Perriwinkle (white)	Med/ornament	Shrub	R		
Stachytarpheta jamaicensis	Vervine	Medicine	Shrub	O	O	O
Avicennia germinans	Black mangrove	Fishing gear	Tree	A		A
Cassia siamea	Cassia (Senna)	Animal feed	Tree	A		A
Cecropia peltata	Trumpet	Medicine	Tree	O		
Cocoloba uvifera	Sea grape	Food	Tree	A		
Comocladia pinnatifdia	Maiden plum	Lumber	Tree		O	
Gliricidea sepium	Quick stick	Medicine	Tree	A		
Guazama ulnifolia	Bastard (Baseda) cedar	Animal feed	Tree		A	
Haematoxylum campechianum	Logwood	Honey bees	Tree			O
Laguncularia racemosa	White mangrove	Firewood	Tree	A		
Psidium guajava	Guava	Food/medicine	Tree	R		
Rhizophora mangle	Red mangrove	Timber	Tree	A		A
Spathodea campanulata	Flame of the forest	Medicine	Tree	R		
Therminalia catappa	Almond	Food	Tree	O		A
Thespecia populnea	Seaside Mahoe	Timber/medicine	Tree	O		A
Albizia lebbeck	Mimosa (woman tongue)	-	Small Tree	A		A
Coccoldoa	Wild Grape	-	Small Tree		A	
Guilandina crista	Nicol (Nicker bean)	Craft	Small Tree			O
Centrosema sp.	Twiner climber	-	Vine			O
Dalbergia ecastophyllum	Coin vine	-	Vine			A
Ipomoea pes-capre	Morning glory	-	Vine	A		
Imopoea tiliacea	Wild potato slip	Animal feed	Vine			A
Merremia dissecta	'Know you' climber	-	Vine			A
Sissus sicyoides	Pudding (snake) with	-	Vine			O
Thumbergia grandiflora	Sky vine	-	Vine	A		
	Virgin rose	-	Vine	A		
Rhipsalis baccifera	Currant cactus (Mistletoe)	-	Hanging vine			O

4.2.2. Terrestrial Fauna

4.2.2.1. Bird Composition, Distribution and Habitat Usage

A total of twenty-two bird species were observed for the censure period. A breakdown based on species status shows the following:

- 5 Resident Species
- 6 Endemic Species
- 4 Endemic Sub-species
- 4 Winter Migrant Species
- 2 Species which can either be resident or migrants

The bird species observed (Table 4-6 below) present a clustered distribution. The anthropogenic disturbance in the area can be considered negligible in terms of its effect on the avifaunal population. The area supports small "wetland" areas which are deemed essential in supporting the observed diversity of bird species. Species such as Great Egret, Yellow-Crowned Night Heron and Yellow Warbler were found in the wetland areas.

The habitat usage for avifaunal species is primarily as a feeding area. All birds observed are using specific niche areas to acquire necessary food. There were observed nests (possibly Bananaquits), but these species are noted to construct nests for sleeping and not necessarily for nesting purposes.

Table 4-7 below shows the DAFOR Ratings, Ecological and Economic Values of avifaunal species observed. Species considered to be of high Ecological Value were, the Jamaican Euphonia, the Loggerhead Kingbird, and Bananaquit. Ecological Value was based on the **status** and **feeding guild** of the species.

The species considered of significant economic value was the Yellow-Shouldered Grassquit. Other species of fairly high economic value, included: the Jamaican Vireo (Endemic), the Jamaican Oriole (Endemic subspecies), the black-Crowned Night Heron (Resident) and the American Redstart (Winter Migrant). The value was based on DAFOR and IUCN ratings.

Table 4-6 showing bird species observed from point counts and transects

Proper Name (Alpha Coding)	Scientific Name	Number Observed	Status
Jamaica Euphonia (JAEU)	*Euphonia Jamaica*	2	Endemic
Jamaican Woodpecker (JAWO)	*Melanerpes radiolatus*	1	Endemic
Jamaican Crow (JACR)	*Corvus jamaicensis*	2	Endemic
Jamaican Vireo (JAVI)	*Vireo modestus*	1	Endemic
Yellow – shouldered Grassquit (YSGR)	*Loxipasser anoxanthos*	1	Endemic
Jamaican Oriole (JAOR)	*Icterus leucopteryx*	2	Endemic subspecies
Common Ground Dove (COGD)	*Columbina passerina*	6	Endemic Subspecies
Loggerhead Kingbird (LOKI)	*Tyrannus caudifasciatus*	4	Endemic Subspecies
Bananaquit (BANA)	*Coereba flaveola*	3	Endemic Subspecies
Olive-throated Parakeet (OTPA)	*Aratinga nana*	3	Resident
Saffron Finch (SAFI)	*Sicalis flaveola*	1	Resident
White-Crowned Pigeon (WCPI)	*Columba leucocephala*	4	Resident
Black-Crowned Night Heron (BCNH)	*Nycticorax nycticorax*	2	Resident
Yellow Warbler (YEWA)	*Dendroica petechia*	2	Resident / Migrant
Great Egret (GREG)	*Ardea alba*	1	Resident / Migrant
Prairie Warbler	*Dendroica discolor*	1	Migrant
Black-Throated Blue Warbler (BTBL)	*Dendroica caerulescens*	1	Migrant
American Redstart (AMRE)	*Setophaga ruticilla*	1	Migrant
Unidentified Sandpiper		1	Migrant

Table 4-7 showing DAFOR Ratings, Ecological and Economic Values of avifaunal specie observed.

Proper Name (Alpha Coding)	DAFOR	Economic Value (, 000)	Ecological Value
Jamaica Euphonia (JAEU)	O	10	5
Jamaican Woodpecker (JAWO)	R	10	2
Jamaican Crow (JACR)	O	10	1
Jamaican Vireo (JAVI)	R	10	3
Yellow – shouldered Grassquit (YSGR)	R	100	3
Jamaican Oriole (JAOR)	O	10	2
Common Ground Dove (COGD)	F	1	2
Loggerhead Kingbird (LOKI)	F	1	4
Bananaquit (BANA)	O	1	4
Olive-throated Parakeet (OTPA)	O	10	2
Saffron Finch (SAFI)	R	1	1
White-Crowned Pigeon (WCPI)	F	1	2
Black-Crowned Night Heron (BCNH)	O	10	1
Yellow Warbler (YEWA)	O	10	2
Great Egret (GREG)	R	1	1
Prairie Warbler	R	10	2
Black-Throated Blue Warbler (BTBL)	R	10	2
American Redstart (AMRE)	R	10	1
Unidentified Sandpiper	R	1	1

4.2.2.2 Other Fauna

In terms of other species of fauna observed during the day and evening terrestrial surveys, the Llandovery property can be characterized as species poor. Most of the fauna observed were associated with the wetland areas, which in addition to birds, included butterfly and wasp species common to the rest of the north coast habitat as well as land crabs (*Cardisoma guanhumi*). Blue land crab burrows are found within the mangrove areas along the beach as well as within the wooded areas throughout the property. Land crabs are harvested locally as a food source. At the local scale, it is believed that population numbers have been negatively impacted by the construction of the highway. As such, the proposed development will further contribute to fragmenting the land crab habitat range in the area.

Mongoose were observed along roadside transects. They were introduced to Jamaica in the 1800s and their status as an invasive/pest species is attributed to their indiscriminate predation on animals ranging from rats to ground-nesting birds and their eggs, snakes, lizards, toads as well as crabs.

Although the survey results did not yield direct observations of indigenous and endemic species that require special conservation considerations, it is important to note that the proposed site is part of habitat corridor along the island's north coast which historically supported a wide range of floral and faunal species e.g. various bats; the Jamaican yellow boa as well as sea turtles that in particular used the vast stretches of rapidly disappearing undisturbed sandy beaches as nesting grounds.

4.2.3. Marine Flora and Fauna

The coastline consists of a sandy beach sloping gently seaward toward the reef crest. The back-reef area is turbid and sediment impacted most probably due to run-off from the gullies and the river to the east of the area.

4.2.3.1. The Back-reef and Reef crest

The sandy beach along the northern boarder of the development site gives way to a shallow lagoon (1-4m) comprised primarily of seagrass beds and sand. Seagrass beds (*Thalassia testudinum* and *Syringodium filiforme*) are present throughout the lagoon, occurring in thick pockets closer to shore and become sparser and mixed with algae (*Halimeda sp*.) and sand in areas closer to the patch reefs and the reef crest. Seagrass occupies approximately 60 - 70% of the lagoon substrate (Site C). Due to high sedimentation in the bay the seagrass and algae throughout the site area were coated with a fine layer of particulate matter (Plates 4-12 a & b).

a.

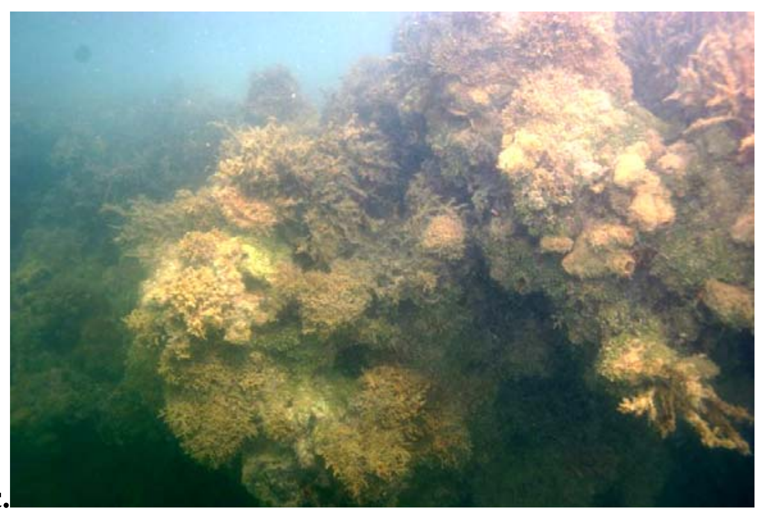
b. 

Plates 4-12 a & b showing sediment covered seagrass bed.

Coral cover in the lagoon is generally sparse, comprised primarily of a few scattered coral boulders (*Siderastrea siderea*). To the west, the lagoon is interspersed with dead patch reef formations which are in certain cases entirely overgrown with algae (Site E), particularly red algae *Bryothamnion triquetrum* and *Bostrychia tenella* as well as brown algae *Dictyota* sp., *Lobophora* and *Padina* sp (Plates 4-13 a, b, & c). Small colonies of *Diploria sp. Montastrea cavernosa, Montastrea faveolata, Porites porites* as well as *M. complanata* and the gorgonian, *Briareum asbestinum* were observed on the leeward side of the reef crest (Sites G and D).

a. 

b. 

c. 

Plates 4-13 a, b & c showing dead reef patches observed in the lagoon overgrown with macroalgae.

The fish community in the bay is comprised primarily of juvenile fish including wrasses, grunts, Harlequin basses, juvenile parrotfish, and damselfish. Due to very poor visibility it was not possible to carry out a proper assessment of the fish population in the lagoon. Sea urchins, namely *Diadema antillarum* and *Tripneustes esculentus* were notably absent in the back-reef area. Other echinoderm species such as *Lytechinus veriegatus* and *Holothuria Mexicana* were occasionally found in the seagrass beds.

The windward side of the reef crest (sites D, B and A), which is also subject to high sedimentation, supports a diverse coral community. The relatively high coral cover ranges from 15 to 30% and can be attributed to the presence of large encrusting coral colonies primarily *Montastrea faveolata* (~0.5m ^{2}), *Siderastrea siderea, Diploria labyrinthiformis* and *Colpophyllia natans* (Plates 4-14 a & b). Other frequently occurring coral species include *Porites porites, Porites asteroides sp*, *Montastrea cavernosa*, and *Agaricia sp*., including *Agaricia tenufolia* (Table 4-8).

a.


b.


Plates 4-14 a & b showing coral cover on the windward side of the reef crest.

Table 4-8. Representative species found at sampling stations in the lagoon at Llandovery.

Scientific Names	Common Name			DAFOR			
		A to B	C	D	E	F	G
Stony Corals							
Acropora palmata	Elkhorn Coral	R					
Colpophyllia natans	Boulder Brain Coral	F					
Porites colonensis	Honeycomb Plate Coral	R					
Porites porites	Finger Coral	F		O			
Porites furcata	Branched Finger Coral	O				O	
Madracis decactis	Ten-ray Star Coral	R					
Montastrea annularis	Boulder Star Coral	O					
Montastrea cavernosa	Great Star Coral			O	O	F	O
Montastrea faveolata	Boulder Star Coral	A		F		O	O
Dichocoenia stokesii	Elliptical Star Coral						
Porites asteroides	Mustard Hill Coral	F				O	
Siderastrea radians	Lesser Star Coral						
Siderastrea sidarea	Massive Starlet Soral	O		O			
Diplora labyrinthiformis	Brain Coral	F					O
Diploria clivosa	Knobby Brain Coral					O	
Diploria stigosa	Symmetrical Brain Coral	F				O	
Meandrina meandrites	Maze Coral					O	
Agaricia lamarcki	Lamarck's Sheet Coral	O		O			
Agaricia agaricites	Lettuce Coral	O		F			
Agaricia humilis	Low Relief Lettuce Coral			R		R	
Agaricia tenufolia	Thin Leaf Lettuce Coral	O		O			
Favia fragum	Golf-ball Coral					R	
Eusmilia fastigiana	Smooth Flower Coral			R		R	
Stephanocoenia intersepts	Blushing Star Coral			O			
Hydrocorals							
Millepora alcicornis	Branching Fire Coral					O	
Millepora complanata	Blade Fire Coral	F			O	O	
Octocorals							
Briareum asbestinum	Corky Sea Finger	F		F			F
Erythropodium caribaeorum	Encrusting Gorgonia A	R					
Plexaura flexuosa	Bent Sea Rod F					O	
Gorgonia vetalina	Common Sea Fan A	O				O	O
Eunicia spp	Knobby Sea Rod					R	
Cnidarians							
Sertularella speciosa	Branching Hydroid	O					
Condylactis gigantea	Giant Anemone			O	O		O
Palythoa caribaeorum	White Encrusting zooanthid					O	
Porifera							
Aplysina fulva	Scattered Pore Rope Sponge	R					
Aplysina fistularis	Yellow Tube Sponge					O	
Cliona				O			
Echinodermata							
Lytechinus variegatus	Variegated Urchin		R	R			
Holothuria mexicana	Sea Cucumber				O		

Macroalgal cover is also high ranging from 30 to 60% in areas and is dominated by red algae including *Bryothamnion* sp., *Bostrychia* sp., *Galaxaura* sp., *Peysonellia* sp., green algae such as *Halimeda* sp. and *Avrainvillea* sp. (Table 4-9) Crustose coralline algae, namely *Peysonellia* sp. and *Hydrolithon,* were occasionally observed among the dominant macroalgal cover on the patch reefs. The ratio of macroalgae to crustose coralline algae, which is used an indicator of reef health, is quite high in the back reef area suggesting that the reef is in a degraded state due in large part to heavy sedimentation and the high macroalgal cover.

Table 4-9 showing representative algal species found in the back reef area at Llandovery

Scientific Names	Common Name			DAFOR			
		A to B	C	D	E	F	G
Sea Grass							
Thalassia testudinum	Turtle Grass	F	A		A		F
Siringodium filiforme	Manatee Grass	O	D		A		O
Algae							
Phaeophyta							
Dictyota sp.	Y Branched Algae			F	A	F	
Padina jamaicensis	White Scroll Algae				O		O
Labophora variegata	Encrusting Fan-Leaf Algae	A		A	F	O	F
Sargassum natans	Sargasso Weed			O		F	
Turbinaria tricostata	Saucer Leaf						O
Stypopodium zonale	Leafy flat-blade alga					O	
Chlorophyta							
Avrainvillea longicaulis	Saucer Blade Alga			O			
Enteromorpha flexuosa	-				O		
Caulerpa racemosa	Green Grape Alga	F			F		
Caulerpa verticillata	-			O	F		F
Caulerpa cupressoides	-				F		F
Caulerpa sertulariodides	Green Feather Alga						O
Dictyospaeria cavernosa	Green Bubble Weed			O	O		F
Codium isthmocladum	Dead Man's Finger				O		
Halimeda tuna	Stalked Lettuce Alga	F		F	A	F	A
Halimeda goreaui	Small Leaf Hanging Vine				A		
Penicillus pyriformis	Flat Top Bristle Brush						
Penicillus dumetosus	Bristle Ball Brush				O		F
Rhipocephalus phoenix	Pine Cone Alga				O		
Venticaria ventricosa	Sea Pearl	O		R			O
Valonia macrophysa	Elongated Sea Pearls	O		R			O
Udotea sp.	Mermaid's Fan			O	O		O

Scientific Names	Common Name			DAFOR			
		A to B	C	D	E	F	G
Rhodophyta							
Galaxaura sp.	Tubular Thicket Algae O	F		F	F		
Amphiroa rigida	Y Twig Alga O				F		
Bostrychia tenella	-			A	F		A
Bryothamnion triquetrum	-			A	A		A
Ceramium	-				A		A
Gelidiella acerosa	-			F	F		
Jania sp.	Pink Segmented Algae	F		F	F		F
Gracilaria sp	-				F		F
Hydrolithon	Reef Cement			O			O
Peyssonnelia	Burgandy Crust Algae	F		F			F

4.2.3.2. Fore-Reef Area (Sites F and H)

The fringing reef is located approximately 500 m from the shore displays the typical spur and groove reef formation. The shallow fore-reef area (Site F) is in relatively poor condition comprised primarily of bare substrate with little vertical relief. The area is subject to continuous wave action and strong surge (Plates 4-15 a & b).

a.

b. 

Plates 4-15 a & b showing substrate found on the shallow fore reef area at Station F, Llandovery.

The average coral cover on the shallow fore-reef site F at 5-6m is 11% +/- 4.1. Most common coral species observed include *Siderastrea siderea*, *Agaricia* sp. and *Porites asteroides* which are scattered across the bare substrate which accounted for 29% of the substrate cover (Figure 4-7). Macroalgal cover was variable throughout the area, ranging from 16 to 57% and was comprised primarily of turf algae as well as *Dictyota* sp. and *Sargassum* sp. Coralline algal cover is low at 4% (Table 4-11 with algal species).

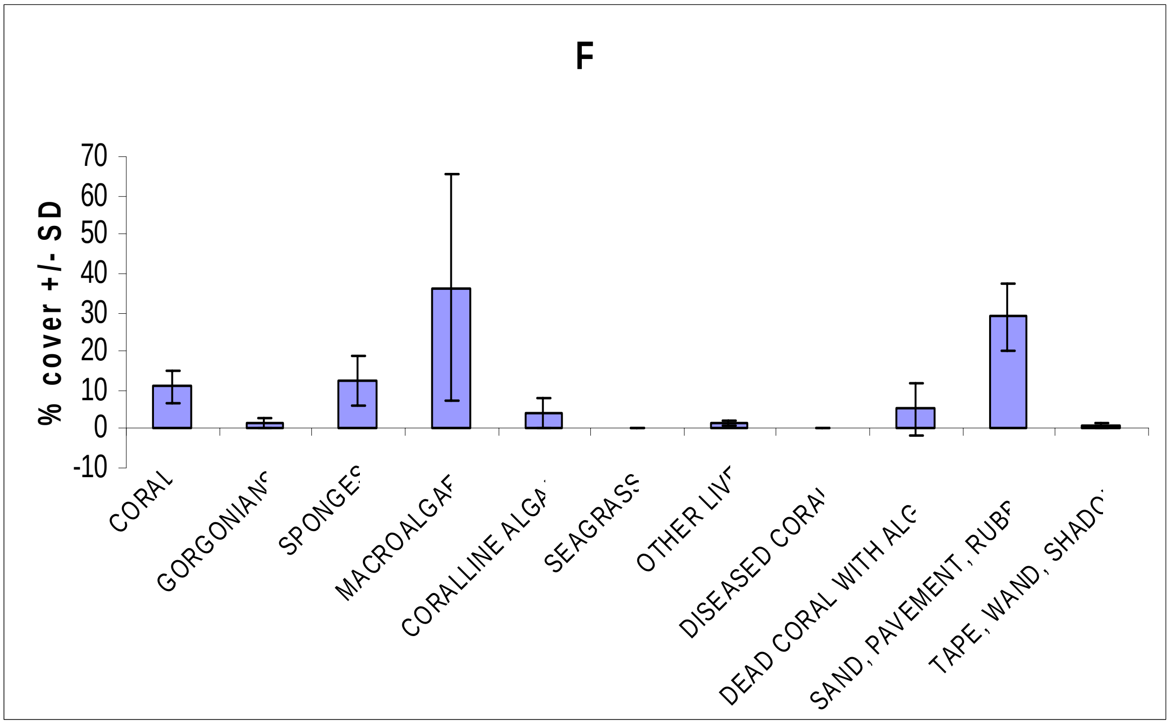


Figure 4-7 showing percent cover (+/- SD) of benthic organisms on the shallow fore-reef station F at a depth of 6m

The gently sloping fore-reef substrate gives way to well developed buttresses separated by unusually deep sand channels sloping gradually towards the drop-off. In contrast to many other areas of north coast reefs, healthy colonies of *Acropora palmata* (which is a CITES[iii] protected species) were frequently observed atop the buttresses (Plates 4-16 a, b, c, d &e).


a.

b.

c.

d.

e.

Plates 4-16 a, b, c, d & e showing sand channel between two buttresses with healthy *Acropora palmata* colonies.

The average scleractinian coral cover on the buttress was 21.1% +/-4, with *Porites asteroides, Agaricia sp.* and *Montastrea faveolata* being the most common species encountered at the 8-10m depth range (Table 4-10). Sponges, primarily encrusting and boring sponges such at *Cliona sp.*, accounted for 16% +/- 0.8 of the substrate.

The relatively high coral cover and the presence of *Acropora spp.* in shallow water was a rare sight and has potential in terms of the possibility of this reef acting as a reproductive reservoir for various species of coral. It also stressed the need for the protection of this area from further anthropogenic impact.

Gorgonians, which contributed to approximately 2% of the substrate cover, include species such as the Common Sea Fan (*Gorgonia ventalina*) and the Encrusting Gorgonian (*Erythropodium caribaeorum*).

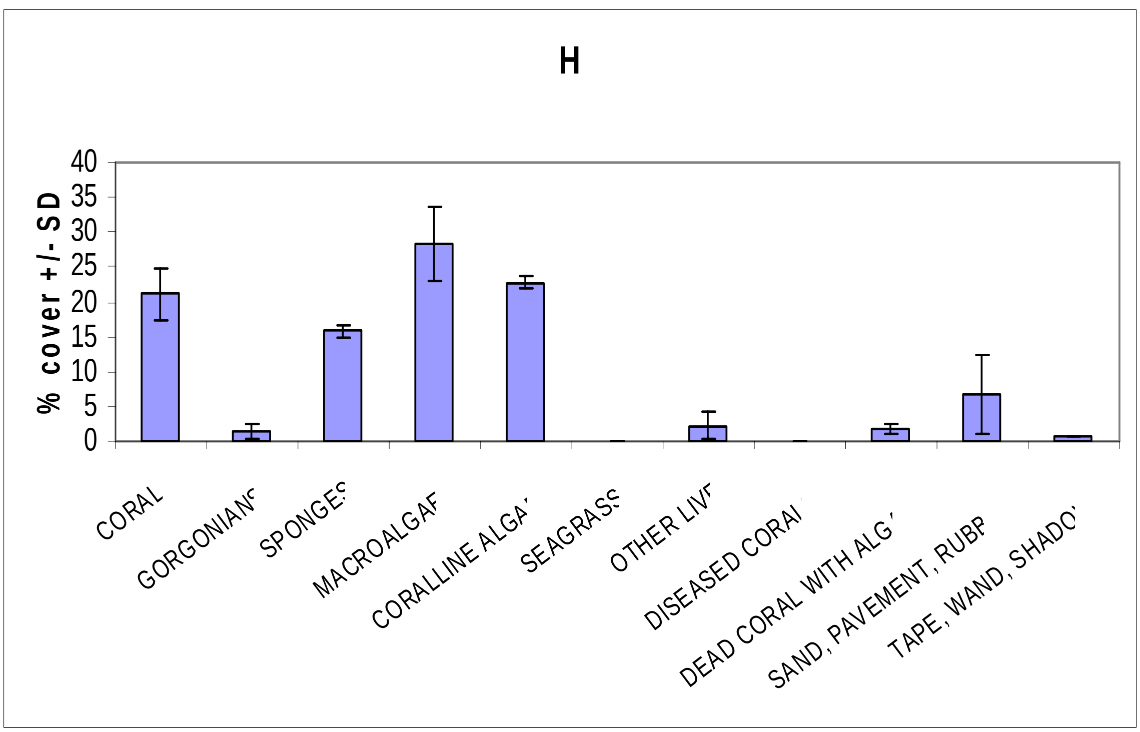


Figure 4-8 showing Percent cover (+/- SD) of benthic organisms on the shallow fore-reef station F at a depth of 6m

Table 4-10 showing coral species identified on the shallow fore-reef and on the buttress at 10m at Llandovery

Common Name	Scientific Name	F (6m)		H (10m)	
Coral	***Coral***	Mean	SD	Mean	SD
Elkhorn coral	*Acropora palmata*	-	-	0.45	0.3
Lettuce coral	*Agaricia agaricites*	1.09	0.6	2.12	0.6
Dimpled sheet coral	*Agaricia grahamae*	-	-	0.18	0.3
Low relief lettuce coral	*Agaricia humilis*	-	-	0.65	0.6
White star sheet coral	*Agaricia lamarki*	-	-	0.96	0.3
Sheet coral	*Agaricia sp*	0.19	0.3	-	-
Scroll coral	*Agaricia undata*	-	-	0.07	0.1
Boulder brain coral	*Colpophyllia natans*	-	-	0.33	0.5
Grooved brain coral	*Diploria labyrinthiformis*	-	-	0.66	0.9
Symmetrical brain coral	*Diploria strigosa*	0.25	0.1	0.06	0.1
Smooth flower coral	*Eusmilia fastigiata*	0.10	0.1	-	-
Ten-ray star coral	*Madracis decactis*	-	-	0.12	0.2
Yellow pencil coral	*Madracis mirabilis*	-	-	0.26	0.4
Maze coral	*Meandrina meandrites*	0.27	0.2	0.12	0.2
Fire coral	*Millepora sp*	1.04	0.1	1.20	0.6
Boulder star coral	*Montastraea annularis*	-	-	1.07	0.4
Great star coral	*Montastraea cavernosa*	0.48	0.7	0.63	0.1
Boulder star coral	*Montastrea faveolata*	0.19	0.3	1.62	1.1
Mustard hill coral	*Porites astreoides*	0.84	0.4	9.39	6.5
Thin finger coral	*Porites furcata*	0.08	0.1	0.26	0.4
Finger coral	*Porites porites*	0.10	0.1	0.18	0.3
Lesser starlet coral	*Siderastrea radians*	0.25	0.1	0.19	0.1
Massive starlet coral	*Siderastrea sidereal*	5.56	2.5	0.39	0.2
Blushing star coral	*Stephanocoenia intersepta*	0.33	0.2	0.12	0.2
	Coral juvenile	0.19	0.3	-	-
Percent coral cover (%)		**10.97**		**21.07**	

The algal community at the 8-10m depth range was dominated by fleshy species including, *Dictyota* sp., *Lobophora* sp. and *Sargassum sp.* which contribute to approximately 28.3% +/- 5.2. Calcareous macroalgae (including Crustose Coralline algae) account for up to 22.7% +/- 0.9 of the substrate within this depth range and are represented by *Halimeda* sp. (Table 4-10).

Table 4-11 showing algal species identified on the shallow fore-reef and on the buttress at 10m.

Common Name	Scientific Name	6m		10m	
Macroalgae	***Macroalgae***	**Mean**	**SD**	**Mean**	**SD**
Green-grape alga	*Caulerpa* sp.	-	-	0.33	0.29
Dead man's fingers	*Codium* sp.	0.24	0.34	-	-
Y branched alga	*Dictyota* sp.	5.44	3.05	5.01	0.91
Encrusting fan-leaf alga	*Lobophora* sp.	0.45	0.18	3.24	0.46
	Meristiella sp.	0.10	0.14	-	-
Sargassum	*Sargassum* sp.	2.41	1.51	1.89	0.80
Turf	Turf algae	27.64	24.91	17.82	3.29
Percent Cover		36.27		28.29	
Common Name	**Scientific Name**	**6m**		**10 m**	
Coralline Algae	***Coralline Algae***	**Mean**	**SD**	**Mean**	**SD**
Twig Alga	*Amphiroa* sp.	0.08	0.11	0.78	0.40
Tubular thicket alga	*Galaxaura* sp.	-	-	0.07	0.09
Watercress alga	*Halimeda sp.*	0.29	0.41	15.09	2.98
Pink segmented alga	*Jania* sp.	-	-	0.44	0.25
White scroll alga	*Padina* sp.	0.08	0.11	-	-
Burgundy crust alga	*Peysonellia* sp.	0.10	0.14	-	-
Mermaid's fans	*Udotea* sp.	0.08	0.11	-	-
Crustose coralline algae		3.21	3.64	6.34	3.58
Percent Cover		3.83		22.71	

Diadema antillarum a keystone species (Lessios, 1988) were frequently observed on the fore reef area and exhibited a patchy distribution throughout the habitat (Plate 4-17). At 6 m *Diadema* densities ranged between 2 and 14 urchins per m^2 and were slightly lower at 18m with densities ranging between 2 and 8 urchins per $m^{2.}$

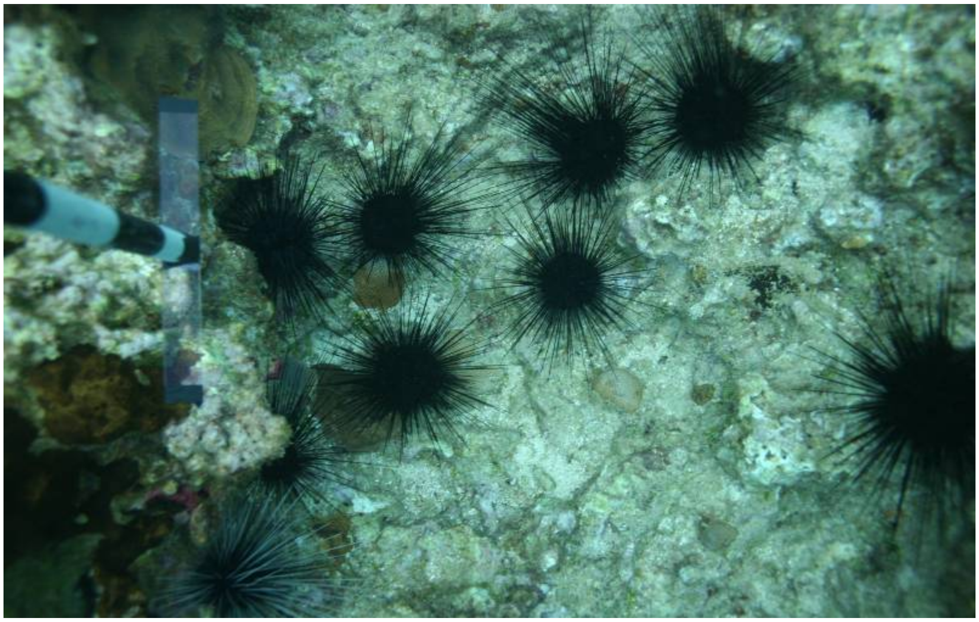


Plate 4-17 showing presence of *Diadema antillarum* on the fore reef area

4.3 SOCIO-ECONOMIC ASSESSMENT

4.3.1 Demography

The population for the Parish of St. Ann was estimated as 172,200 at the end of 2006 (STATIN in ESSJ 2006). This represents a 3.2 percent growth from the 2001 population of 166,800. The Parish has been characterised by slow to moderate growth rates illustrated by population figures of 120,000, 137,700, 147,000, and 166,800 for the periods 1970, 1982, 1991 and 2001 with corresponding annual growth rates of 1.15, 0.73 and 1.35 percent respectively (Table 4-12). Assuming an annual growth rate of 1.35, it is projected that the population of St. Ann will be 181,689 in 2010 and 207,762 by 2020. The male to female ratio in the 2001 census was 1:1.

Table 4 - 12 showing population for the Parish of St. Ann

Year	Total	Males	Females	Intercensal Change %	Annual Rate of Growth
1970	120,000	59,500	60,500	-	-
1982	137,700	69,300	69,300	14.75	1.15
1991	147,000	73,800	73,200	6.75	0.73
2001	166,800	83,915	82,773	13.40	1.35
2006	172,200				0.65

Source: STATIN, Jamaica

The population of the Socio-Economic Impact Assessment (SIA) study area falls within several enumeration districts (Table 4 - 13). The 2001 population census indicated that the population of the enumeration district within which the SIA site is located was approximately 389. However, visits to the area revealed that there were no residences or other evidence of population within 0.5km of the site. The population was 3004 within 2km of the site. Assuming annual growth rates of 0.65 percent, the population of the SIA area would be 6,139 in 2006 and 3083 in 2010 and 3289 in 2020.

The socio-economic and perception survey results indicated that the average household size of the SIA study area is 4 individuals with ranges from 1 to 14 persons per household. This average exceeds the national average of 3.3 (Survey of Living Conditions [SLC] 2005). It also represents an increase from the Parish average in 2002, which was 3.5 (SLC 2002). Sixty four percent (64%) of respondents were the head of their households. Of this, 76 percent were males and 24 percent were females. This represents a significant increase from the 57.8 percent male-headed households reported for the parish of St. Ann in the 2002 SLC. Twenty eight percent (28%) of the heads of households were between ages 30-39 and 24 percent were between 40 and 49. Fifteen percent (15%) were in 18-29 age group, 14 percent were in the 50-59 age group and 8 percent were in the over 60 age group. Four percent (4%) of the household heads did not identify the age group to which they belonged. The proposed development includes the construction of 108 residential units. Assuming average household size of 4.1, the proposed development may introduce an additional 443 persons to the SIA study area. This would change the population projections to 3492 in 2010 and 3726 in 2020.

Table 4 – 13 showing population within SIA Study Area

Enumeration Districts (EDs)	Male	Female	Total
Within 0.5 km			
06NW027	0	0	0
Within 2km			
06NW020	289	344	633
06NW021	277	310	587
06NW022	126	265	391
06NW026	281	311	592
06NW027	164	225	389
06NW028	117	295	412
Total	1254	1750	3004

Source: STATIN-2001, Jamaica

4.3.2 Employment and Income

Of the respondents interviewed, 67 percent were employed outside of the home. Of this, 32 percent had full-time jobs, 20 percent were self-employed and 16 percent had part-time jobs. The main occupation types included hospitality workers (e.g. housekeepers, care takers, receptionists and waiters), law enforcement officers, business owners, construction workers, vendors, store clerks and cashiers. Twenty seven percent (27%) of respondents earned over $10,000 per week. Nineteen percent (19%) earned $3,000-$5,999 per week, 12 percent (12%) earned $6,000-$9,000. Thirty eight percent had no response and five percent earned less than $3,000 per week.

Ten percent of respondents interviewed indicated that they worked one mile or less (0.62 km) from their homes. Twenty three percent (23%) worked between 1-5 miles, 10 percent worked 6-10 miles, two percent (2%) worked between 11-20 miles and 3 percent worked over 20 miles from home.

4.3.3 Transportation

The survey indicated that the most frequent mode of transportation utilised within the SIA study area was public transportation in the form of buses and taxis. A large number of respondents used their private vehicles while a smaller percentage walked short distances within the SIA area. Mini and mid size buses were also used to travel to other areas such as Ocho Rios, St. Ann's Bay, Discovery Bay, Falmouth, Montego Bay and Kingston.

4.3.4 Social Services

The survey indicated that over 90 percent of applicable respondents shopped outside the SIA study area. Thirty two percent (32%) shopped in St. Ann's Bay, 4 percent in Ocho Rios, three percent (3%) in Runaway Bay, 2 percent in Browns Town and 1 percent in Discovery Bay and Montego Bay. There was a supermarket and several retail stores, wholesales and restaurants within the SIA area.

The respondents also obtained health care outside of the SIA study area. The majority of the respondents obtained health care from the Saint Ann's Bay Hospital, which is located approximately 8km from the SIA study area. Health care was also obtained in Runaway Bay, Ocho Rios, Falmouth and Montego Bay.

There were no Fire or Police Stations within the SIA study area. The closest police and fire stations are located in Runaway Bay and St. Ann's Bay, respectively.

4.3.5 Education

There are no public schools within the SIA study area. However, a private preparatory school is in Salem. Two public schools, Hampton and Glen Preparatory, are located in Runaway Bay. Public schools are also located in St. Ann's Bay.

The average household size within the SIA study area was 4 comprising of an average of 3 children under 18 years old. Approximately 65 percent of applicable respondents had children attending schools that are located five miles or from home. The main schools attended were Runaway Bay All Age, York Castle High, Hampton Preparatory, St. Ann's Bay Primary, Ocho Rios High, Browns Town High and Buckingham Prep.

Assuming per household average of 3 children under 18 years (survey), the proposed development may introduce an additional 702 children in the SIA study area. This will have implications for education as the educational facilities in the area may not be sufficient to serve the relevant population being introduced.

Five percent (5%) of heads of households interviewed indicated that they had no schooling. Thirty percent (30%) attained up to primary level, 49 percent attained up to secondary/high school level and 14 percent attained up to college/university levels.

4.3.6 Housing

The survey revealed that 46 percent of respondents owned the house in which they live. This figure is less than the figure recorded for the parish in the 1991 census (63.1 %) and the 2002 SLC (59.6 %). Forty one percent (41%) of respondents owned or leased the lands on which their homes are situated. Seventy seven percent (77%) of respondents' dwellings were constructed of reinforced concrete while seventeen percent (17%) were constructed of wood and other materials. The majority of the roofs of dwellings were constructed of zinc (44 %) and concrete (19 %). This is consistent with the construction material of dwellings in the parish percent (52.5 %) in the 2002 SLC).

The majority of respondents lived in houses containing 1-4 bedrooms (94 %) and 1-2 bathrooms (91 %). Eighty percent (80%) of houses were equipped with indoor toilet facilities (water closets) and five percent (5%) had pit latrines. The majority of households had access to public piped water into their houses (64 %) or their yards (22

%). There was some access to residential phones (27 % of respondents); however, the majority used mobile phones.

4.3.7 Solid Waste Disposal

The survey indicated that there was a regular solid waste disposal system serving the area. Approximately 75 % of respondents had their garbage collected by public garbage trucks operated by the municipality (North-Eastern Parks and Waste Management Ltd.). Four percent (4%) had private arrangements for garbage collection, while 15 % burned their garbage. Three percent (3%) of respondents reported that they disposed of their garbage in the gully. Fifty nine percent (59%) of respondents had their garbage collected once to twice per week.

The National Solid Waste Management Authority (NSWMA) is the government agency with the mandate to regulate the solid waste industry in Jamaica. The NSWMA currently collects, treats and disposes of domestic solid waste. However, the NSWMA is not responsible for the collection, treatment or disposal of commercial, agricultural, industrial or hazardous waste. Therefore, the NSWMA would be responsible for the collection of solid waste for only the residential portions of the proposed development. The parishes of St. Ann, Portland and St. Mary are located in the North-Eastern Parks and Waste Management Ltd. (NEPM) waste shed. The NSWMA indicated that NEPM Ltd. consisted of a fleet of 16 trucks in 2006, which is inadequate to meet the needs of the waste shed. The proposed development will result in an increase of domestic waste, which will further stress the activities of the NEPM.

4.3.8 Community Fabric/Cohesion

Community fabric and cohesiveness may be considered relatively strong in the study area. Sixty four percent (64%) of respondents reported that they participate in activities within their communities and the study area including street dances, sporting activities, church group activities and youth clubs. There is a community centre (Salem Community Centre) and a fishing/bathing beach within 2km of the SIA site.

4.3.9 Cultural Heritage

The Jamaica National Heritage Trust indicated that there are no Historical Sites within the SIA study area. Jamaica Heritage sites identified beyond the study area include The St Ann Parish Church, the St. Ann's Bay Fort and Cardiff Hall Great House in Runaway Bay.

4.3.10 Public Perception

Seventy one percent (71 %) of respondents indicated that they were not aware of the proposed residential development. Eighty percent (80%) of respondents thought that the proposed development would have a positive impact on the community, while five percent (5%) thought that the impacts would be negative.

Respondents were asked what effects they think the proposed development will have on employment, housing, the environment, tourism and them personally. Over 50 percent (50%) of respondents indicated that the development would result in increased job opportunities. Respondents also thought that the development would increase the availability of housing in the area. Some respondents however noted that based on the site's location and the type of housing being proposed the prices of the units would be unaffordable to many. Respondents also noted that there would be less vacant land and the community would be more aesthetic. Two percent (2%) of respondents thought the proposed development could result in increased squatting from migrant workers.

Only seven percent (7%) of respondents indicated that the proposed development would negatively impact the environment, and that it may result in increasing flooding of the area.

Most respondents thought that the proposed development would have no impact on them personally. However, others indicated that there would be increased availability of housing solutions which they may be able to afford. Others thought they would not be able to afford the units.

The respondents commented that the proposed development will provide more housing solutions which may alleviate squatting. Others commented that the jobs would be provided which would cut unemployment and "give the young people something to do." The main area of concern expressed was whether the residents of the community would benefit from the community.

4.4 HYDROGEOLOGY

4.4.1. Geology, Topography and Soils

Published geological information (Geological Sheet 14, 1:50,000 Imperial Series, extract shown in Figure 2, Appendix VI-A) indicates the solid geology of the site comprises elevated reefs and Gravel Fans of the Falmouth Formation of the Pleistocene Coastal Group. These reefs can be up to 40m thick and contain well preserved fauna of corals and molluscs. The gravel fans form a continuous belt along the coast and comprise well rounded, poorly sorted reworked White Limestone. The elevated reefs form a fringing terrace along the coast at Flat Point. The elevated reef levels are comparable to reef terrace levels found in other parts of the world[i].

The overlying superficial deposits, in the vicinity of the site, comprise a combination of reworked limestone gravels resulting from alluvial processes associated with possibly the meandering of the Flat Point River. The soils are generally insignificant or shallow. The *Geological Classification of Jamaican Rocks (1983)* presumes the bearing capacity of such soils as reasonable (600 – 2000 KN/m^2), however the presence of wetlands would suggest the presence of low permeability soils such as clays which typically have a low to very low bearing capacity especially if peat or organic soils are present. No intrusive borelogs were available for the site at the time of this report.

The Hampton Well cave is identified by the WRA in the Beverley area 700m southwest of the site. The cave is characterised by a plunge pool and is also referred to as "Sailor Hole".

The foregoing Quaternary Deposits are further underlain by Miocene Montpelier Limestone Formation of the White Limestone Group. Both the Quaternary and the older Miocene formations are lumped classified as aquicludes by the WRA (Figure 3, Appendix VI-A). No significant structural systems (faults, etc.) are indicated on the geological sheet within 500m of the site footprint. The beach sand is likely to consist of fine to coarse, moderately sorted calcareous sand derived from the existing coastal reef systems.

4.4.2 Groundwater and Surface Water Resources

The nearest, named surface watercourse to the site is the Flat Point River, which lies along the eastern boundary of the site. Its drainage basin is approximately 3.7 km^2. The second closest watercourse is the Cistern River located approximately 1km east of the site. The closest stream flow gauging stations are located 1.5km east of the site, on the Laughlands Great River.

No water quality records were held by the WRA for the Flat Point River. The WRA is not aware of any material groundwater or surface water contamination issues, but does suggest that groundwater quality at the coast may be impacted by the marine environment (i.e. tidal influenced) and as such may be brackish.

Figure 3, Appendix VI-A shows no wells or boreholes within the 1km of the site. No licensed surface or groundwater abstractions are noted within 1km of the site. The nearest licensed abstraction is that at the Cardiff Hall well 4km southwest of the site.

The 30-yr mean annual (1951-1980) rainfall for St. Ann was obtained from the Meteorological Office for June and July is recorded at 150mm and 50mm respectively. In June 2006 and June 2007 the rainfall figures stood at 123mm and 147mm respectively. By the Met Service's calculations this rainfall is 7% greater than the 30-yr average.

Mains water, according to the National Water Commission (NWC) comes from the recently implemented a J$2.4 billion Martha Brae/Harmony Hall water supply project that supplies developments along the north coast from Falmouth to Port Maria, St. Mary in the east. The project involved the refurbishing of the Martha Brae treatment plant to increase output from 4 million gallons per day (mgd) to 6mgd. There will also be the construction of over 19 kilometres of pipelines, two service reservoirs and a booster station. The project was successfully completed in 2006. Given the projected capacity of the system the proposed project will have more than adequate water supply should it be undertaken. Currently negotiations are underway to decide whether the 20" supply line should be extended to the development or the current north coast 8" pipeline would be used.

4.4.3. Sewerage Facilities

There are no recorded sewerage facilities within 1km of the site.

4.4.4. Flooding or other disaster incidents

The WRA has no floodplain maps of the site. The ODPEM records indicate one flood event at Scarlett, St. Ann 2 km west of the site. No details were given as to the date, cause, or extent, of the flooding.

Given the proximity of the site to the coast, shallow depth to groundwater and the low-lying nature of the land, flooding from both storm surges and the Flat Point River are realisable hazards. A brief review of the flooding hazard is discussed in Section 4.4.9 .The storm surge analysis is in section 4.5.

4.4.5. Seismic Hazard

The seismic hazard map of Jamaica shows that the project site lies in an area that can expect a Modified Mercalli Intensity of 7 with a 10% chance of exceedance in any 50 year period. Expected horizontal ground velocity is predicted to be between 18 -16 cm/sec and horizontal ground acceleration between 270 – 245 gals[ii].

4.4.6. Landslip Hazard

The topography and geology would suggest that land slippage would be a negligible risk. And any created slopes would need to be done according to the geotechnical design specifications to mitigate the risk of failure.

4.4.7. Pollution Incidents

No major groundwater or surface water pollution incidents are recorded within 1000m of the site by the WRA.

4.4.8. Hydrological Assessment

4.4.8.1 Existing and Projected Water Demand

Based on the habitable density taken from the site layout plan (see Figure 3, Appendix VI-A) water demand should be a minimum of 84 m^3/day (22,000 US gallons/day) based on a 294 habitable units. Given the throughput of the current mains water supply system the site demand will be able to be met by existing supplies.

4.4.8.2. Stormwater Runoff

The ArcHydro extension of ArcGIS was used to determine the watershed characteristics (slope, drainage area, longest drainage lines etc). The files were further pre-processed in GeoHMS to make them ready for import and use within the main watershed model HEC-HMS. HEC-HMS was used to obtain the predicted runoffs for the catchment for the 25, 50 and 100 year return periods. WinTR-55 was then used to cross-validated the output of HEC-HMS. The evaluation was done using the SCS curve number method with the average CN (Curve Number) being determined from available soils (obtained from the Ministry of Agriculture soils maps) and land use maps(obtained from the Forestry Department).

For determining the storm runoff in Jamaica the 24-hour, 25-year return period storm is normally accepted as the design flow period for major drainage systems. However, this can be modified by the regulatory agencies based on their specific appreciations of the site. Instead of return period, it is more accurate to think in terms of the exceedance probability (p), where p=1/T. Thus, a "25 year storm" actually designates a rainfall event which has a 4% chance of occurring in any given year. While a 50 and 100 year storm has a 2% and 1% chance respectively of occurring in any given year.

The computed and published 24hr rainfall intensity for the Llandovery site as tabled below. Table 4-14 show close agreement between the computed and recorded rainfall intensities, based on this is was deemed reasonable to use the published St. Ann’s Bay figures.

Table 4-14 Site computed 24hr rainfall intensity and rainfall intensity obtained from the Meteorological Service of Jamaica

Exceedance Probability	100% (1yr return)	50% (2yr return)	20% (5yr return)	10% (10yr return)	4% (25y return)	2% (50yr return)	1% (100yr return)
Computed rainfall intensities[1]	-	-	-	181	237	-	301
24-hr rainfall (mm) – St. Ann Bay	-	119	166	199	239	269	300

Total Catchment Storm Runoff – Flat Point Hydrologic Basin

The catchment of the Flat Point hydrologic basin is approximately $3km^2$, whilst the area considered for development is approximately 1% of the total catchment but is located at the outlet of the Flat Point River. Figure 4-9 shows the delineation of the Flat Point River catchment with the derived main drainage pathway based on terrain processing of the DEM.

[1] The estimates for the peak rainfall for different return periods were computed with the regression equations given by the regional flood frequency study (Thomas, 1987).

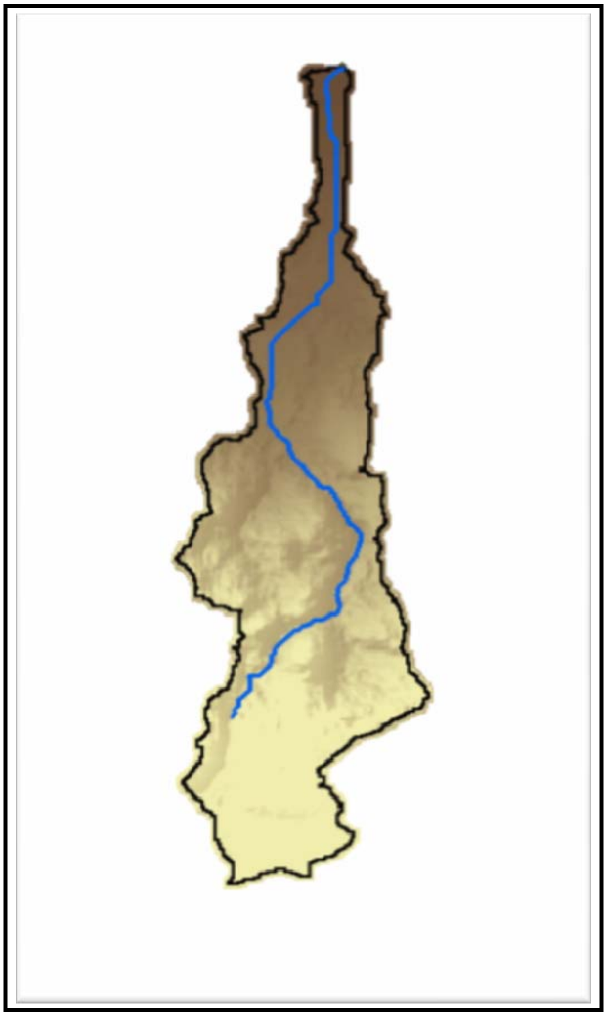


Figure 4-9 Hill shaded catchment of the Flat Point River. *The lighter colours indicate higher elevations and the dark the lower elevations. The site is located adjacent to the outlet at the top of the page. The blue line shows the derived river from the DEM which corresponds well with the actual river course.*

The preliminary engineering drainage assessment[2] reports the peak 25 year design event flow at 80m^3/s from the catchment. Predictions using the above terrain model and HEC-HMS and TR-55 are tabulated below. The HEC-HMS predicted results were in good agreement when cross-validated with TR-55 using generally the same predicted catchment characteristics obtained from the terrain pre-processing. No baseflow was assumed and this corresponds well with the actual catchment as the Flat Point River has no discharge outside of sustained rainfall

[2] Preliminary Drainage Report by Foreman, Chung & Sykes, August 2007 prepared for Life of Jamaica

events. The differences in the models are due mostly to the assumptions that are incorporated into either modeling programmes (Table 4 - 15).

Table 4 - 15 - Predicted peak flows for the Flat Point River catchment

Design Event	HEC-HMS Predicted Peak Flows	WinTR-55 Predicted Peak Flows	Engineering Report Peak Flows
25 yr	23.6 m^3/s	36.4 m^3/s	80 m^3/s
50 yr	29.4 m^3/s	45.3 m^3/s	-
100 yr	35.6 m^3/s	54.7 m^3/s	-

Appreciating the assumptions in both simulation models (HEC-HMS and WinTR-55), and specific conservative assumptions chosen by individual modelers, it is more likely that the results show a range of discrete points along a discharge continuum for the Flat Point catchment. And additionally, do show discharges within the same order of magnitude and as such, given the assumptions used, would on balance suggest reasonably likely discharge quantities with 80m^3/s likely representing the most conservative, upper boundary of the catchment. In the end the final design must be based on the engineer's drainage report. Once this is done it is likely that the design parameters for the open channel within the site should be sufficient to handle event the 100 yr design even storm.

The models also validate what residents verbally confirm – that the Flat Point River is a "flashy" river. This would be a river which responds very quickly to rainfall events, the flow of water rising rapidly to a high peak before receding similarly quickly. Flat Point River's modeled hydrograph suggest peak flows being reached rather rapidly, within 1-2 hours then declining to post-event levels within 4 hrs (see hydrograph Appendix VI-C).

4.4.9. Flooding Potential

It is understood that the design event on the North Coast Highway (NCH) box culvert that the Flat Point River crosses before entering the site is designed for a 10yr storm event. If correct, this design criteria places severe constraints on the type developments that can occur within the upper catchment of the Flat Point River as the NCH culvert will act as fixed, outlet control structure. Consequently, future developments (legal and illegal/informal) within the upper catchment will have to be heavily ordinanced to ensure zero-runoff changes in order to not change the flow regime on the Flat Point River which could lead to an exceedance of the safe design capacity of the NCH Flat Point box culvert.

Scour evidence on the site shows that the Flat Point River has two outlet points, the main channel to the east defined by the 6.4m (21ft) concrete box culvert and a smaller subsidiary outlet serviced by a 0.9m (3ft) diameter concrete pipe culvert) to the west. The two outlets suggest that the Flat Point River may have formerly meandered within the space defined by the two channels; with the eastern channel being the current dominant outlet and the western channel accommodating localized topography-controlled drainage. Changes to the lower catchment during the NCH construction (filling and grade changes etc.) would have hydraulically confined the river to its current eastern corridor and made it unlikely for such meandering to continue without destroying the road infrastructure works.

With the proposed open culvert being designed by the consulting engineers to accommodate a $80m^3/s$ peak flow, and given that the final floor invert levels of the open channel will be graded toward its discharge point and be at least 3m lower than the final site grade, it is unlikely that the Flat Point River would reclaim is old course over the projected life span of the development.

Preliminary scoping calculations within Hec-RAS (v4), hydraulic simulation software developed and used by the US Army Corps of Engineers, gave scoping levels ranging between 1.5 – 3m outside of the main eastern channel for the 4% exceedance event. These results were obtained using the DEM to create the river cross-sections. Although the channel slope resolution is substantially reduced on the DEM (allowing for more out-of-bank exceedance, or instances of flooding), it is unlikely that the predicted out-of-bank levels will be as high in actuality. If this were the case then the lands adjacent the Flat Point River, and the NCH, would be repeatedly inundated during recent rainfall events (in Nov/Dec 2007) and this was patently not the case.

To be able to provide a more refined look at the inundation levels a more detailed mapping of the lower reach of the Flat Point would be necessary to increase the model's resolution and this was outside the scope and budget of this report. The WRA had required that the consulting engineers do an evaluation of the 50yr and 100yr flood inundation levels post development.

In addressing the issue of flooding the engineers report does state that "building floor levels will be set above the 1 in 50yr flood level." This presumes that some modeling will be done to obtain the flood levels across the site. It further indicates that the coastal engineer has recommended a minimum of 3m lift above mean sea level for storm surge protection. Based on the data in hand, these design criteria coupled with the open channel invert below site grade and mandatory annual debris-clearing maintenance should be sufficient to mitigate the flood risk from storm surges, and probably riverine flooding on the site to acceptable levels. The flood assessment will further clarify this position.

It should be pointed out that there is no recent anecdotal, or recorded, evidence to suggest that the NCH box culvert, or the site for that matter, has been overtopped or significant flood levels have been noted, respectively, due to the Flat Point River.

4.4.10. Site Storm Runoff

Given the site's location and its proposed macro drainage works for the Flat Point River it is most likely the case that site-derived runoff will be the major precursor to site runoff. Currently, site drainage direction is principally toward the coast with localized area draining toward the western and eastern drainage lines for the Flat Point River (Table 4-16).

4.4.10.1. Pre-development

The current site is approximately 1% of the total catchment area at approximately 42,000m^2. Currently the site is covered with trees and shrubs and has no hard surfacing. Expectedly runoff will be much lower than compared to the post development scenario. Using the

Rational Method, the predicted total-site storm runoff with a 20% (1 in 5 yr) chance of occurrence in any one year is $0.4m^3/s$.

4.4.10.2. Post-development

For post development storm runoff land use determinations were based on the proposed site layout. Post-development, the predicted runoff with a 20% (1 in 5yr) chance of occurring in any given year is estimated to be $1.2m^3/s$.

Table 4-16 showing the predicted run-off figures with pre- and post- development comparisons

Site Area	Site Runoff with a 20% exceedance probability
Pre-development (i.e. predicted existing)	$0.4\ m^3/s$
Post-development (i.e. predicted expected)	$1.2\ m^3/s$
Increase above existing	$0.8\ m^3/s$
Percentage increase above existing	167%

From Table 4-16 the expected increase in runoff above existing is largely due to the addition of hard surfaces which are required for project development. Although this increase is largely unavoidable, the clients, through their consulting engineers, have proposed a site drainage plan (Figure 7-1 and discussion below) that reduces the site into ten (10) sub-drainage areas. Each sub-catchment will have a peak discharge of below $0.3m^3/s$. The design will also see the use of "low impact" drainage measures that see building runoff being directed to driveways and then to earth swales. These swales will then discharge to suitable detention ponds with gravel filters prior to final seaward discharge.

Additionally, it should be borne in mind that the site will not impact on any downstream infrastructure as the development is at the coast.

Appendix VI - C presents the Excel analysis for the report referred to in this section.

4.5 COASTAL DYNAMICS

4.5.1. Hurricane Waves and Storm Surge

4.5.1.1. Historical Records

Between the months of June and November, the north coast of Jamaica is vulnerable to tropical storms and hurricanes. This fact has a significant impact on the design of coastal structures. Tropical storms can generate extremely high waves because of high wind speeds combined with sufficient wave fetch. In addition, unusually high water levels, known as storm surge, can have devastating effects. In order to predict future extreme wave heights and storm surge levels, we used an in-house hurricane wave and statistical package called HurWave. The first step in this analysis was to search the National Hurricane Center (NHC) historical records for storms that passed within the area over the last 100 years.

Figure 4-10 shows the temporal distribution of occurrence of tropical storms and hurricanes since 1900 that have passed within a 200 km radius from the project site. It is apparent from this chart that at least one tropical storm is likely to occur every year. These storms have different scales of damage and are commonly classified according to the highest wind speed attained. The Saffir-Simpson Scale classifies them from 0 (Tropical Storm) to 5 (the most powerful hurricane). Figure 4-11 shows the distribution of storms since 1900 according to their Saffir-Simpson scale. Tropical storms (Category 0) are much more common than hurricanes and only a few Category 5 hurricanes have passed close by the site. Recently, Hurricane Dean (Category 4) passed to the south of the island causing severe damage.

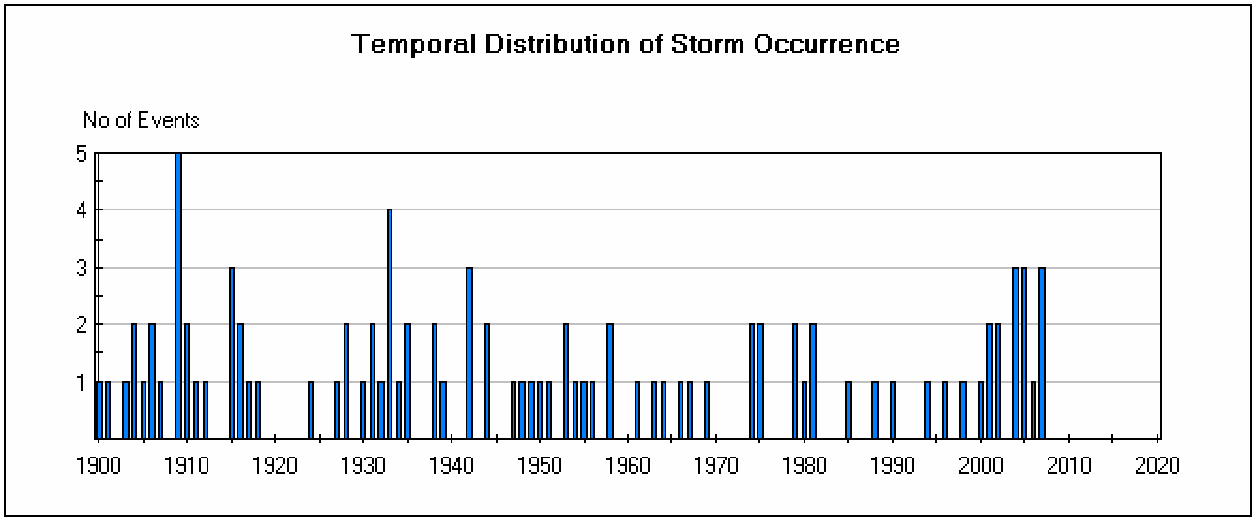


Figure 4-10 showing temporal distribution of tropical cyclone occurrences in the Caribbean Basin

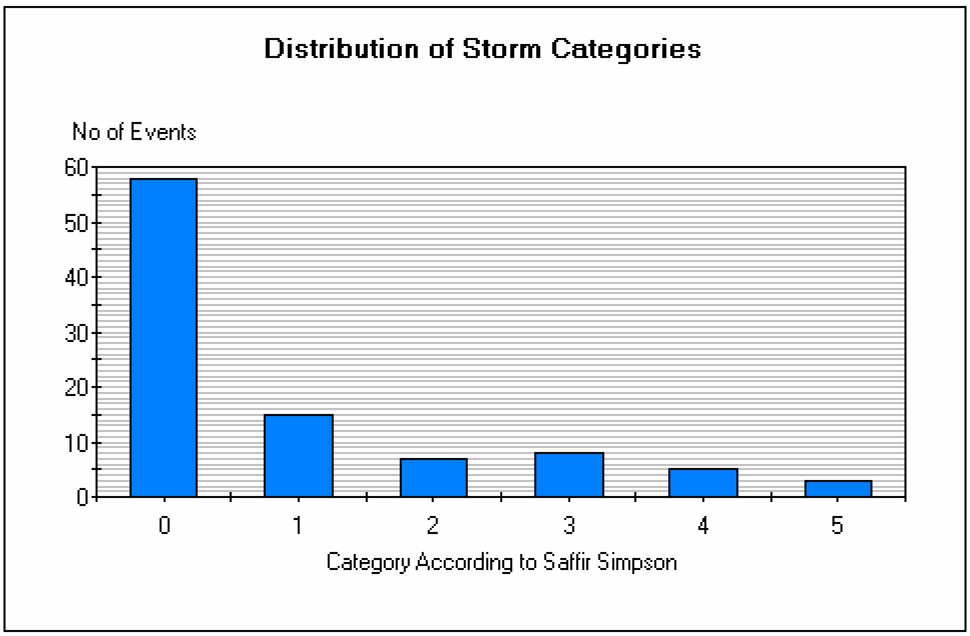


Figure 4-11 Saffir-Simpson category distribution of tropical cyclone occurrences in the Caribbean basin

4.5.1.2 Wave heights and Return Periods

With information on relevant storms in hand, HurWave applies widely accepted parametric models to estimate the wave conditions in deep water for a range of directional sectors. Within this context, wave conditions are often described in terms of a return period, which is the average time period between successive occurrences of an event being equaled or exceeded. Depending on the type of development and its relative importance, the return period will determine to what degree engineering designs should be carried out for it to withstand the forces propelled by nature. The greater the return period, the larger the design significant wave height will be. Higher return periods will yield a safer design standard, but the associated cost of the development will also be higher. A level of risk must therefore be taken into consideration for the design to balance safety with economy. The higher the return period for a storm, the less likely its chance of occurring within the lifetime of the facility, but if it does occur, the more damage it will cause. Table 4-17 shows the probability of occurrence of storm events for various design life assumptions. For example, if the proposed structure is expected to have a 50 year design life, and it is designed to withstand the 1 in 50-year storm event, there will be a 64% chance of this occurring over the life of the facility.

Table 4-17 showing the probability of occurrence for various Return Periods and Design Life

Return Period (years)	**Design Life (years)**		
	25	**50**	100
25	64%	87%	98%
50	40%	64%	87%
100	22%	39%	63%

By best-fitting the values of wave heights that were estimated using the parametric model to a Weibull distribution, we arrive at the deep water wave heights. Table 4 -18 shows the estimated deep water wave conditions for various return periods from each of the relevant directional sectors for the project site (West, North-west, North, North-east, and East).

Table 4-18 showing deep water wave conditions off the project site for various return periods

Direction	Return Period (years)	Sig. Wave Height (m)	Wave Period (s)
North	25	7.23	11.47
	50	7.57	11.82
	100	7.99	12.22
Northeast	25	8.05	12.27
	50	10.04	14.11
	100	11.86	15.67
East	25	10.85	14.82
	50	13.1	16.69
	100	15.24	18.36
West	25	5.85	10.04
	50	6.19	10.4
	100	6.55	10.79
Northwest	25	6.83	11.07
	50	7.2	11.44
	100	7.64	11.88

4.5.1.3. Storm Surge Analysis

The elevated water level that accompanies hurricanes creating flooding and damage to coastal infrastructure is known as storm surge. A storm surge is the rise in the water surface elevation of the sea above its mean level. The storm surge is made up of mainly five components:

1. The Inverse Barometric Rise (IBR)

2. Highest Astronomical Tide (HAT)
3. Global Sea Level Rise (GSLR)
4. Wind Setup
5. Wave Setup.

The IBR is the rise in the water surface elevation caused by the low pressure in the centre of the hurricane. It has its peak at the eye of the storm and decreases with increased distance from the center or "eye".

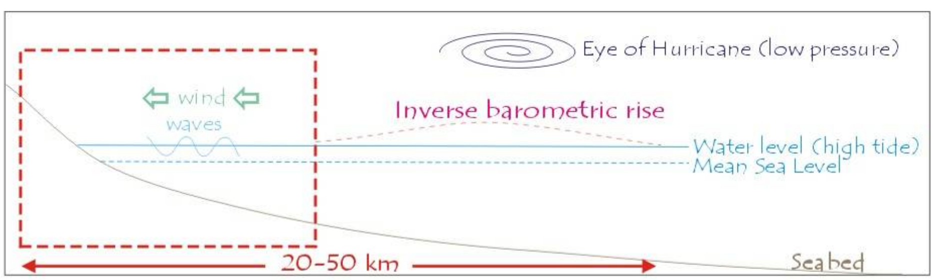
The HAT is the highest level that daily tidal variations may reach. This level can be accurately predicted and is available from tide charts. It is important to include this water level in the computation of storm surge, as it is possible for the storm to occur while the sea level is already at this elevation.

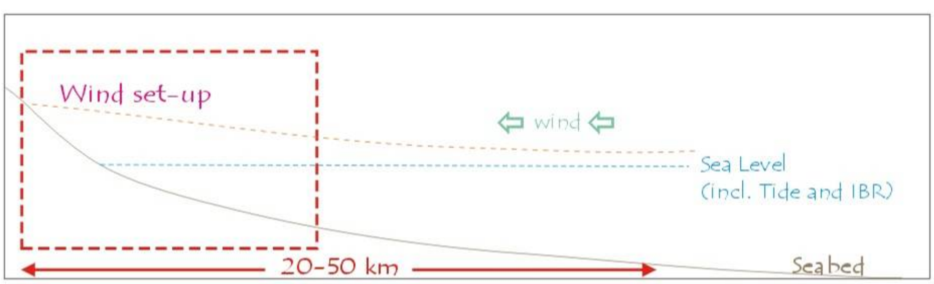
Global Sea Level Rise (GSLR) has been predicted by scientists according to current rates of sea level rise and forecasting of the effects of global warming on the thermal expansion of the seas and the melting of glaciers and polar ice caps. The increase in sea level over the next century (until 2100) is estimated in the *Intergovernmental Panel on Climate Change – Third Assessment Report* to range between 90 and 880 mm, with a central value of approximately 480mm. This corresponds to approximately 0.25 m over the next 50 years, which is the assumed design life of the project.

Wind setup is a result of intense winds blowing over the water surface. This tends to push water towards the land. This water will rise more steeply in areas where there is a shallow offshore shelf, and therefore further add to the water level rise in near-shore areas.

Wave setup includes the increase in water elevation due to the dissipation of wave energy as waves approach the shoreline and start to break. At the point of wave breaking, there is a shift in energy from a kinetic to a potential state, thereby resulting in an increase in water levels. Figure gives a diagrammatic representation of the components of storm surge and their spatial extents of impact. As with wave heights, water level rise due to inverse barometric pressure was computed from each historical storm, and the data fitted to various statistical distributions. Because of the non-directionality of this phenomenon, the analysis was not carried out on a directional basis. The results for various return periods are shown in Table 4-19.

Because of its components, storm surge is considered to be static during the hurricane event, as the time period over which it occurs is far greater than the periods of the waves generated from the hurricane winds. The HAT and GSLR are assumed to have constant values, as the maxima are used for design purposes. The IBR is dependent on the pressure drop of the storm system; therefore it varies for different return periods. The summation of the IBR, HAT and GSLR may be seen as the basic static components of the storm surge phenomenon, as they determine the values of the wind and wave setup. This is so because the wind and wave setup are a function of the water depth at the time of the hurricane, to which the IBR, HAT and GSLR are contributing factors.





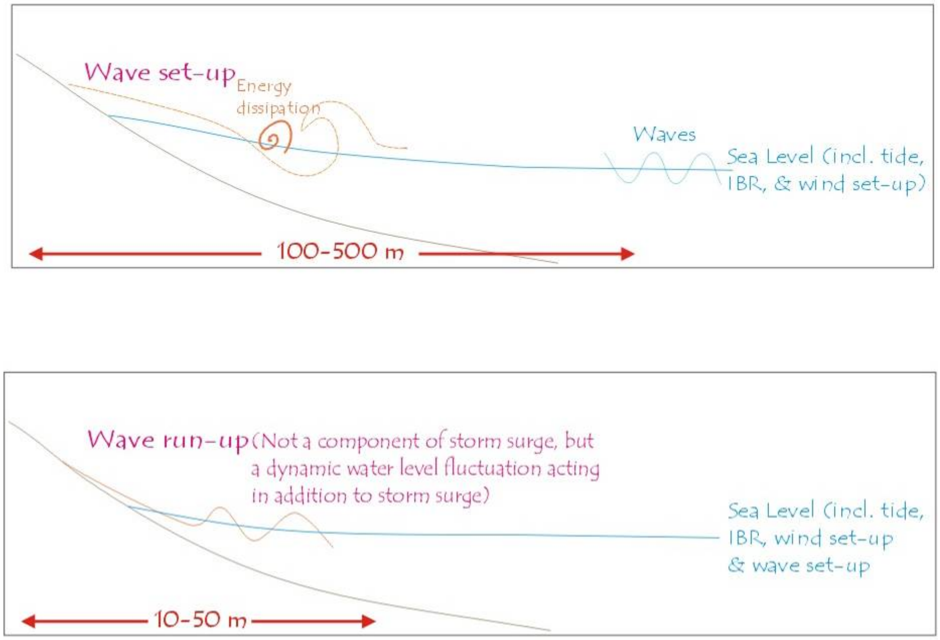


Figure 4-12 illustrating components of Storm Surge

4.5.1.4. Nearshore Transformation of Waves and Storm Surge

Parametric models are limited to determining storm surge and wave conditions in deep water. At shallower depths, the effects of wind and wave setup need to be taken into consideration, with regard to the storm surge; and wave reflection, refraction, diffraction and shoaling with regard to the deepwater waves. All of these processes are dependent on the bathymetry of the nearshore. The effects are complex and require equally complex numerical programs to perform proper simulations. The transformation of the deep water hurricane waves to the nearshore, as well as the computation of wave setup, is discussed in this section.

The 2-dimenstional model SWAN (Simulating WAves Near-shore, Delft Institute) was used to calculate the transformation of deep water wave conditions as estimated in the previous section. SWAN is a third-generation wave model that computes random, short-crested wind-generated waves in coastal regions and inland waters. As well as wave heights, SWAN can calculate the wave setup, an important component of storm surge.

Figure 4-13 and 4-14 show the modeled wave height and static storm surge in the vicinity of the project site. It can easily be seen that the reef barrier (around the 5 m contour line) shelters the coastline but at the same time increases the storm surge. Only the spatial results for deep water waves coming from the north-east are shown here because they represent the worst-case scenario.

Finally the significant wave height and static storm surge were extracted at a location in front of the property. These values were used to calculate the wave run-up along the beach slope, which is the maximum elevation of wave up-rush above still-water level. The inundation level is estimated by adding the run-up to the static storm surge level.

The nearshore wave conditions and storm surge levels for the worst-case scenario, produced by waves coming from the north-east, are summarized in Table 4-19. These are the recommended building floor levels for various return periods. Use Table to find the acceptable amount of risk for each return period. In the Caribbean region, the 1-in-50 year storm event is generally used in the design of developments along the coast.

Table 4-19 Nearshore wave conditions and storm surge levels for the worst-case scenario and various return periods, measured above MSL

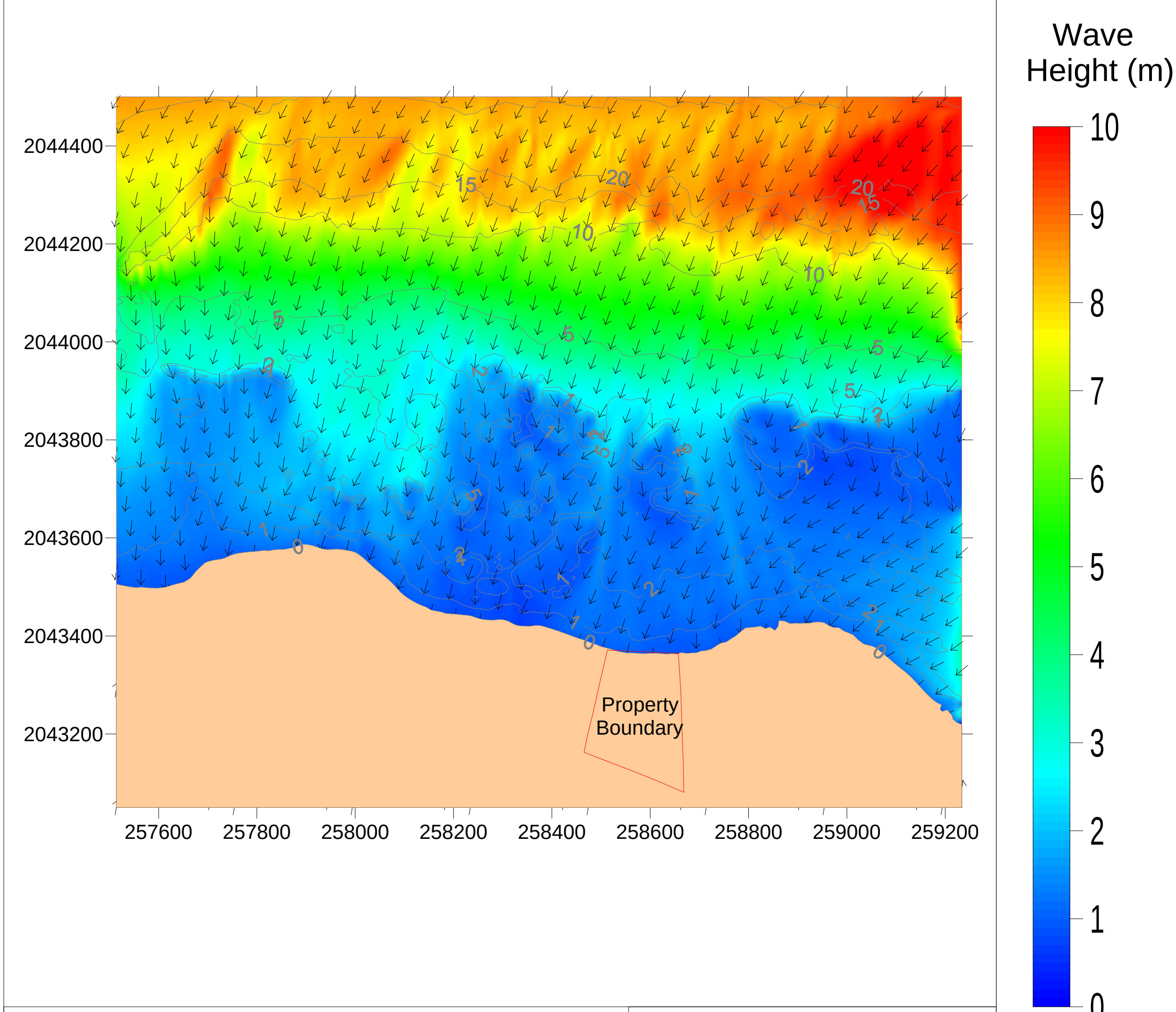
Return Period (years)	Wave Period (s)	Wave Height (m)	Static Surge Level (m)	Run-up (m)	Inundation Level (m)
25	12.27	0.85	1.13	0.48	1.61
50	14.11	1.02	1.45	0.59	2.04
100	15.67	1.16	1.79	0.69	2.49

Investigation Details:

Hs = 10.04 m
Tp = 14.11 s
Dir = NE

Wind speed = 29.95 m/s
Wind direction = NE
Water Level (IBR+HAT+GSLR) = 0.80

SMITH WARNER INTERNATIONAL
COASTAL ENVIRONMENT



Depth countours in meters
Direction where waves are going to

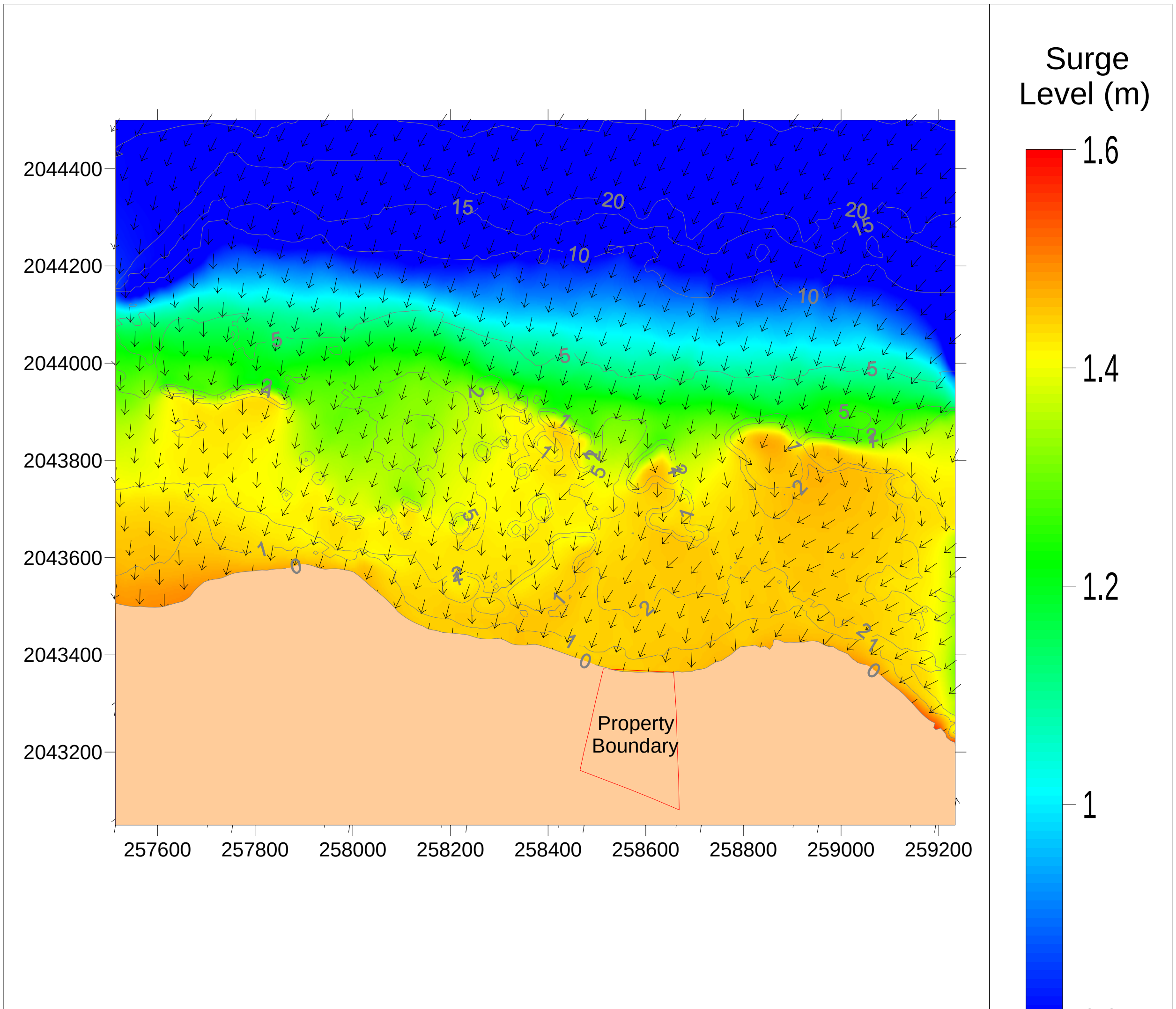
Prepared by:
Gustavo Oliveira

Figure 4-13 showing nearshore wave heights in the vicinity of the project site for waves coming from the north-east and with return period of 50 years

Investigation Details:

Hs = 10.04 m
Tp = 14.11 s
Dir = NE

Wind speed = 29.95 m/s
Wind direction = NE
Water Level (IBR+HAT+GSLR) = 0.80



Depth countours in meters
Direction where waves are going to

Prepared by:
Gustavo Oliveira

Figure 4-14 showing nearshore storm surge levels in the vicinity of the project site for waves coming from the north-east and with return period of 50 years

5.0 STAKEHOLDERS AND PUBLIC CONSULTATION

The St. Ann Parish Council and the St. Ann Chamber of Commerce were contacted for the organisations' views of the proposed development. However, despite repeated reminders, responses were not received at the date of completion of this report.

6.0 ENVIRONMENTAL IMPACT ASSESSMENT

These are summarized in the Impact Matrices in Appendix IV

6.1 ENVIRONMENTAL CHEMISTRY IMPACTS

6.1.1 Present Impacts

TSS and turbidity results were consistent with the fact that no obvious sources of pollution were observed in the immediate vicinity. However physical evidence photographed, point to moments of high flow, which may contain considerable amount of silt and rubble.

Phosphate levels were close to, but just within the draft marine standard. Nitrate levels however exceeded the standard suggesting impact from land-based sources external to the development site.

The absence of faecal coliform indicates no direct impact from sewage or livestock waste on coastal water quality at the time of sampling.

6.1.2 Projected Impacts

During Construction potential impacts will be associated with the movement of traffic engaged in the transportation of construction material as well as earth movement. Specific impacts could include:

1. Silt laden run off from the site to the marine environment,
2. Spillage of earth and debris from trucks onto roadways
3. Aeolian dispersion of dust
4. Deposition of earth on roadways from truck wheels
5. Disposal of sewage generated by site workers
6. Disposal of solid waste generated by construction activity

Post Construction Impacts to the environment will be associated with the populating of the area and the conversion of soft surface to hard surface. Specific impacts anticipated include:

1. Increased run off to the marine environment
2. Sewage discharge to the environment
3. Introduction of household solid waste to the area.

Post Construction Impacts to the development will be associated with the location of the development adjacent to a major highway to the south, the marine environment to the north, and a major drain to the east. Specific impacts likely include:

1. Corrosion of metallic fixtures and materials
2. Susceptibility to intrusive noise from traffic
3. Susceptibility to tidal influence and storm water runoff from the nearby hilly region.

6.2 ECOLOGICAL IMPACTS

Development of residential development projects with multiple units designed as integrated scheme on single expanse of land such as the Llandovery property brings with it a series of environmental impacts. The following section identifies anticipated environmental impacts resulting from the proposed project based on the information provided and on the surveys conducted in the area. The environmental impacts are summarised, rated and classified as immediate, short-term, long-term or deferred in the Impact Matrix (Appendix IV).Environmental impacts of significance during and post construction phases include:

6.2.1 Loss of Land Use

The portion of the Llandovery property that has been proposed for the condominium development has been partially cleared and has been previously exploited (possibly as agricultural or pasture lands). Construction of condominium units represents a permanent and irreversible commitment of land resources, eliminating all other land use options including agricultural uses or rehabilitation of the area as a nature reserve.

6.2.2 Loss of Habitat and Biodiversity

6.2.2.1 Loss of Vegetative Cover

The clearing of the site in preparation for the construction phase represents an immediate and negative environmental impact to the area. The removal of trees and shrubs would reduce the existing forest cover, resulting in irreversible loss of natural habitat for flora and associated fauna in the area. The construction activities and the presence of the development will impact negatively on the composition of the bird community and lead to loss of species from the area, especially of the forest-based endemic species. The development site is situated in the middle of a stretch of undeveloped coastal area and will result in permanent fragmentation of the existing habitat. This carries with it the possibility of permanently altering the movement patterns of terrestrial fauna and/or nesting and feeding patters of the avifauna thereby altering the overall function of the ecosystems in the area (Clevenger & Waltho 2003).

6.2.2.2 Loss of Avifauna

The proposed development will have negative (disruptive) effects on the bird composition of the area. There will obviously be loss of species from the area, however based on the low numbers of species observed, any loss would be negligible. It is expected that most species would relocate to more suitable habitat.

6.2.2.3 Impact on the Beach and Wetland areas

Wetland areas, common to Jamaica's coastal areas, are among the most biologically productive ecosystems and are defined as "a site where plants and animals have become adapted to temporary or permanent flooding by saline brackish or fresh water" including "permanently or temporary flooded lands with sedge or grass morass, swamp forest or mangroves". Regardless of the size, coastal wetland areas are essential to coastal stability and to reducing coastal erosion by acting as a physical buffer and against wave action and flood waters. Acting as "sinks", wetland areas are capable of absorbing and slowing down flood waters thereby reducing riverbed and coastal erosion. Wetland areas or costal marshes also act as a natural "sediment trap" playing a vital role in protecting coral reefs and seagrass beds from being smothered by silt brought downstream by flood waters.

Wetland areas support a rich indigenous flora, and fauna, with several of the species being endemic. Species of birds, crabs, fish, brackish water shrimp and also commercially important species use wetland areas as breeding and nursery grounds. The Government of Jamaica (GOJ) - NEPA (Ecosystems Management Branch) has adopted the mangrove and coastal wetlands protection policy and regulation in order to promote the management of coastal wetlands to ensure that the many benefits they provide are sustained. Wetlands are an important part of Jamaica's coastal resources and their preservation is a key component of coastal area management. In addition to the national significance, the GOJ has a wider responsibility to conserve wetlands (especially those which are waterfowl habitats) as a signatory, since February 7, 1998, to the Ramsar Convention on Wetlands of International Importance.

Wetland destruction resulting from draining and filling activities associated with land reclamation has been shown to result in loss of fishery resources as well as reduced flood control. The draining of wetlands by widening and deepening of wetland compromises the role and the capability of these areas in slowing the run-off of flood waters. The consequences of manipulating coastal wetland areas contributes to increasing freshwater flows to coastal areas contributing to the die-off of nearby coral reefs. Housing developments located on or near drained/filled wetland areas are more vulnerable to the effects of natural disasters including wave action, flash flooding and the occurrence of nuisance species e.g. mosquitoes.

The potential increase in runoff from the construction site would compound the nutrient loading into the reef lagoon which is already heavily impacted by sedimentation and could result in further deterioration of inshore water quality, with negative impacts to the marine life due to loss or degradation of the benthic habitat. Increased use of the beach area by the residents of the condominium could result in trampling of the Turtlegrass beds in the shallow waters which not only serve as a nursery habitat to numerous juvenile fish species but also serve to trap sediments in the lagoon.

6.2.2.4 Loss or Alteration of Turtle Nesting Grounds Sea turtles

The sandy Llandovery beach is a known turtle nesting area. The area has not been developed and as such there is no light pollution onshore to confuse the navigation instincts of returning turtles coming to lay eggs. Two species of turtles have been reported nesting in the area including the greenback and the Hawksbill turtles. Turtles favour nesting on remote, clean sandy beaches, preferably under some type of vegetative cover. Their nesting behaviour can be very easily disturbed by beach development or activity, noise and light pollution, litter, disease and many other variables. Construction of buildings and other structures near or on beaches used by hawksbills can alter the beach and destroy the vegetation and other conditions needed for successful reproduction. As such measures must be taken to ensure that the natural state of the beach is not directly or indirectly compromised in a manner that could deter turtles from nesting on the beach.

6.2.2.5 Soil Erosion and Changes in Drainage Patterns

Clearing vegetation, site grading, construction, excavation and concentrated discharge of collected runoff could impact the existing drainage patterns in the area resulting in erosion and increased sedimentation, if not properly controlled.

Removal of trees and other vegetative cover on the site and the subsequent construction and excavation activities required for infrastructure installation (paving of roads, laying of water/sewage pipes, electrical cables, etc.) will impact the existing drainage patterns in the area. More specifically, the clearing of the riparian vegetation along the east and west borders of the property, along the seasonal waterways which receive waters from the watershed via culverts located along the highway will lead to soil erosion and excess runoff especially during the rainy season. Seasonal streams provide natural waterways that can facilitate the management of runoff from the property serving as principal pathways for storm water run-off from the site near the eastern and western boundaries of the property. Loss of topsoil due to soil erosion as well as excessive runoff into the reef lagoon is a cause for concern which must be addressed prior to the clearing phase. Due to the location and the elevation of the project site soil erosion will remain a problem during the clearing, the construction and the operational phases if proper measures are not implemented. In addition to soil erosion and run-off, lack of proper drainage ways could result in localized pooling and flooding on the project site, providing ideal conditions for the proliferation of nuisance pests such as mosquitoes. Excessive runoff, especially during heavy rains, could also lead to elevated nutrient loading into the reef lagoon. The compounded effect of turbidity and sedimentation would negatively impact the inshore water quality and the seagrass beds in the reef lagoon.

6.2.2.6 Transportation and Storage of Construction Materials

Transportation of heavy machinery and building supplies/materials implies heavy traffic on the roads leading to the site with possible negative impacts such as gas emissions, dust, petroleum spillage and noise to the surrounding area. Use of uncovered trucks for transporting building materials as well as improper storage of building materials, especially gravel, sand and cement on the construction site could lead to inadvertent dispersal of materials during heavy rains or high winds during dry periods. This could have a negative impact on the coastal waters. Improper storage or handling of hazardous or flammable materials, including fuel, paints and solvents) could result in soil contamination.

6.2.2.7 Airborne and Noise Pollution

The increased traffic to the area, use of heavy equipment during the clearing of the site and transportation of building materials will create noise and raise dust which could further disturb the habitat of the existing fauna, in particular the birds nesting in the area, as well as the plants and insects they feed on. Dust and emissions from the construction vehicles and heavy machinery are inevitable both during the site clearing as well as during construction phases. Airborne pollution, in particular dust resulting from clearing of the land and from exposed piles of building materials (e.g. sand, cement, etc.) may further stress the local flora and fauna, and may also pose a health risk to construction workers and residents in the vicinity who suffer from asthma or other respiratory ailments.

6.2.2.8 Disposal of Construction Debris

Construction debris generated throughout the construction cycle of the development must be managed efficiently through a waste management plan in order to avoid negative impacts to the site and the surrounding area. Cut vegetation resulting from the clearing of the area could pose a fire hazard and affect air quality if burned on location. Other construction materials including concrete waste, wood, steel, packaging plastics could be dispersed and could end up blocking drainage channels if not disposed of at approved disposal sites.

6.2.2.9 Sewage and Garbage Disposal

Inadequate provision of portable restrooms and garbage dumpsters at the construction site could lead to unsanitary conditions. Resulting impacts could vary from unsightly littering of the site, fly and vermin infestations to increased nutrient levels in the stream leading into the bay. Reliable sewage treatment systems are a long term concern for the area. It is essential for the villas, cottages and the nearby beach recreation area to have proper sewage treatment systems capable of handling increases in capacity while ensuring that there is no direct discharge of untreated effluent into the porous substrate which drains directly into inshore marine waters.

Other concerns include:

- Density of building area to land area

- Given the typically poor standard of environmental management practice on construction sites in Jamaica, particular attention should be paid to the monitoring of the construction works (Monitoring plan).

6.3 Socio-economic Impacts

Socioeconomic impacts include construction and post-construction impacts. These are summarized in the Impact Matrix in Appendix IV.

6.3.1 Construction Impacts

6.3.1.1 Land Use

Land use impacts of the proposed development are limited to the change of use from vacant land to residential development. The proposed land use is located within an area identified as "Coastal Development Area Boundary" on the St. Ann Development Order.

6.3.1.2 Employment and Income

Employment and income would be impacted positively by the proposed development. The positive impact is represented by the creation of jobs during construction of the development.

6.3.1.3 Transportation

Transportation impacts may be temporary. There may be an increase in vehicular traffic with the movement of construction materials and equipment on and off site.

6.3.1.4 Community Development

Lands within 0.5km of the site are undeveloped vacant lands. As such, there will be no construction impact on the community.

6.3.2 Post-Construction

The post-construction impacts of the proposed development include national/regional impacts, land use, employment and community development/recreation.

6.3.2.1 National/Regional Development

The proposed development includes the construction of a residential community with recreational facilities. This will contribute to overall housing development and will increase the housing stock of the nation.

There may be employment generation for security personnel, domestic workers and staff for the recreational facilities on site. This will contribute to the reduction of the unemployment rate of the parish of St. Ann (regional) and the country.

6.3.2.2 Land Use

The proposed development's post-construction impact on land use is limited to change in use from undeveloped vacant land to a residential community.

6.3.2.3 Employment

As mentioned above in the national/regional impacts, the post-construction phase of the proposed development will provide employment on the local, regional and national scale.

6.3.2.4 Transportation

Post-construction impacts on transportation include increased vehicular traffic from increased movement with additional residents moving into the area. However, the proposed development is located along the North Coast Highway which is adequate to accommodate the expected increased activity.

6.3.2.5 Community Development/Recreation

The post-construction impacts on the community/community development and recreation are both positive and negative. The positive impact is long-term and direct. There is the potential for increased employment opportunities which may result in increased economic activities in the area. Increased employment will lead to increase incomes, which will affect other economic activities such as shopping facilities for the population with increased residual incomes to spend on consumer goods. The proposed development will also increase the availability of recreation facilities within the community as the proposal includes recreational facilities including a restaurant and club house with fitness centre and spa, swimming pool and a beach.

The proposed development has the potential for increasing employment, housing stock and therefore has the potential for increasing the population of the area. There will be increased vehicular traffic and the need for services (for example, banks and ATMs) will increase. The existing social services (schools, waste disposal systems) may not be able to facilitate the increased activities anticipated in the SIA study area.

6.4 Hydrogeological Impacts

- The major, temporal impacts occur during construction as the land is developed and most vulnerable to the impacts of atmospheric events. The impacts are mitigable if sediment and erosion control planning objectives aligned to those outlined in Section 4.4 are implemented and maintained over the duration of the project.

- During operation the major sources of impacts to water and soil resources are considered to the open channel flow and channel maintenance. The implementation of the concrete open channel will benefit river bed integrity in the lower reach. Consequently surface water quality will see a small, positive impact as fine soil material that normally would be mobilized within the lower reach. Maintenance of the channel may also contribute negatively to downstream water quality, if done during the annual wet seasons.

7.0 RECOMMENDED MITIGATION AND MONITORING

7.1 ENVIRONMENTAL CHEMISTRY

The development of a mitigation strategy should include a consideration of the following:

7.1.1 During Construction

1. Ensure adequate covering of haulage vehicles
2. Use of wheel washing or gravel beds to reduce deposition of earth on roadways from truck wheels
3. Sprinkling of site to prevent aeolian dust dispersion
4. Provide approved portable sanitary facilities for site staff
5. Use of adequate measures to contain site run off.
6. Disposal of construction debris and solid waste at an approved location.

7.1.2 Post Construction

1. Employment of tertiary sewage treatment to prevent any contribution to nitrogen load.
2. Reservation of adequate land area to modulate surface run off from the developed site
3. Adequate set back from the highway and the marine environment.
4. Use of vegetation to buffer the corrosive effect of the marine atmosphere.
5. Use of vegetation to modulate noise from the highway.

7.2 ECOLOGY

Construction of a subdivision such as the Llandovery Project represents a permanent and irreversible commitment of land resources. Although the area proposed for the project has been previously exploited, it will no longer be available for other uses especially not for rehabilitation to its natural state. The loss of natural habitat as well as a loss of the option for alternative uses of the land is a significant negative impact. The following recommendations are based on fundamental principles outlined in The National Land Policy (1996) which acknowledges the direct relationship between the use of land for domestic, commercial, industrial or agricultural purposes, the generation of waste by these uses and the impact on the quality of both surface and groundwater resources. The land policy addresses specific land use and water resource management issues and speaks to the following:

- the need to preserve and reforest watersheds to ensure the recharge of aquifers and reduce the problem of flooding and turbidity in rivers
- the institution of programs to eliminate the pollution of rivers and streams by pesticides, herbicides and other pollutants
- preserving vegetation along water courses.

7.2.1. Clearing Phase

7.2.1.1. Mitigating Loss of Habitat and Biodiversity

Impact mitigation calls for protecting and restoring as much of the original condition on the development site as possible. Additional measures must be considered to further minimize negative impacts on the terrestrial ecology in the area, more specifically:

7.2.1.2. Mitigating Loss of Vegetation

Prior to the commencement of site clearing and construction, a qualified landscape manager (hired for the duration of the project) should be tasked with creating a landscape plan, which includes a vegetation map clearly identifying all mature and ecologically valuable trees (trunk diameter >30cm) earmarked for protection. The identified trees must be clearly marked and protected. This map can be used to adjust final construction plans as well as individual lots with the goal of minimizing tree removal.

A landscaping plan includes action items corresponding to each phase of the project ensuring gradual, albeit partial, restoration of the site's ecological characteristics. A landscape plan would ensure that designated trees are protected and/or if absolutely necessary, relocated and that areas suitable for replanting are identified and landscaped using only local tree and shrub species used for feeding by local bird species. Selecting appropriate plant species for replanting is essential in determining the types of birds, butterflies and other fauna that will re-inhabit the site upon completion of the project. Landscaping is deemed to be a powerful mitigation activity with a positive impact by**:**

- Maintaining and replanting green areas on the development site with trees and shrubs that would continue to attract avifauna to the area.
- An integral part of the landscape plan should also address means of protecting and monitoring the wetland areas during site clearing and construction phases to ensure that the ecological integrity of the area is maintained.
- Incorporate as far as possible into the landscaping plan the natural vegetation typical of the area. Plant large trees on perimeter of compound to create a natural windbreak, which will also serve the purpose of being a sight screen.
- In an effort to preserve the existing biodiversity, naturally occurring plants such as those used primarily by the birds for food and shelter should be harvested during the site clearing phase and relocated to a nursery, to serve as a source of plants for replanting at a later date. This would ensure that primarily native plants are used in the landscape plan thus minimizing the use of imported species and eliminating the introduction of potentially invasive species.

7.2.1.3. Mitigating Impact on Avifauna

Suggested mitigations especially with respect to the land birds, is the use of native species able to tolerate the soil composition (which is mostly sand), as a part of the replanting ("greening") of the development. These native trees would encourage the return of some bird species and new species to the area. Using bird feeders may encourage the displaced avifauna to remain in or return to the general vicinity, thus maintaining the existing biodiversity.

7.2.1.4. Minimizing Impact to the Beach and from the loss of Wetland Areas

All of the potential impacts listed in the previous section under impacts, especially loss of biodiversity, soil erosion, runoff and garbage dispersal, can have a detrimental effect on the beach and the wetland areas. Mitigating actions call for minimising the impact of construction near or on the beach. If construction is necessary then suspended and elevated structures supported by columns or piles with minimal footprint should be used. The true value of the beach lies in its natural setting and as such preserving the natural state of the beach is a priority. The most effective mitigation measure for the beach and wetland areas would be to avoid the construction of permanent structures on or immediately near the beach. Maintaining or enhancing the wetland areas on either side of the property is essential to mitigating the loss of habitat and maintaining biological diversity in the area. The wetland immediately east of property is slated to receive drainage water from the drainage plan being proposed. The development plan calls for the filling in of the western wetland to accommodate the construction of two buildings. Mitigation for the loss of this unproductive wetland area is centered around the drainage plan for the development. This plan calls for the creation of several water detention ponds within the boundaries of the development totaling an area equal to approximately three times the size of the wetland area to be lost. These detention ponds will be stocked with appropriate flora and fauna which will enhance the productivity of the system ensure its long term viability and also be an aesthetically pleasing aspect of the development. Detained water from ponds will flow through a filter system before being released out to sea. Further the sewerage plan for development will also include a constructed wetland in the south eastern area of property.

7.2.1.5. Protecting Turtle Nesting Grounds

Providing long-term protection to turtle nesting beaches is paramount to protecting the species. Eliminating threats such as beachfront development, beach erosion resulting from sand mining, eliminating vehicles on the beach, working with local authorities, scientists and volunteer groups to report turtle sightings, nesting activities and poaching activities are critical to the long-term management of this species. Landscaping plans, while favorable, must ensure that native vegetation is protected on the beach area. Existing vegetation can provide additional benefits such as screening out artificial beachfront lighting which can interfere with nesting behavior and disorient hawksbill hatchlings. Landscaping plans must ensure that any introduced plants are not harmful to the development and hatching of sea turtle eggs (e.g. *Casaurina* and Sea oats (*Uniola)* have been found to be lethal to hawksbill eggs). Highly visible signs should be posted on the beach at appropriate locations warning of the legal penalties for interfering with turtles and their nests. Lighting on the beach must meet the standards for Model Lighting Ordinance for Marine Turtle Protection (Coastal Roadway Lighting Manual - Appendix H, 2008).

7.2.1.6. Soil Erosion and Change in Drainage Patterns

This is a potentially significant impact that can be reduced to a less-than-significant level by implementing the following mitigation measures:

- Site clearing activities should be conducted in stages to minimize the area of exposed soil at any given time. Exposed soil should be seeded with grass or other appropriate cover as soon as possible to minimise soil erosion. Monitoring and maintaining proper storm water drainage systems, use of catchment/settlement areas and redirecting flows during periods of heavy rain are steps that can minimize erosion and surface runoff into the bay.

- Restrict grading and earthwork during the rainy season (September - October and May - June) and stabilize all exposed soils and graded areas prior to onset of the rainy season through mulching and reseeding. Temporary mulching and reseeding (using a biologist/botanist approved native seed mix) will reduce erosion by establishing quick growing plants to stabilize disturbed areas which will not have permanent landscaping installed for a period of time or which may be redistributed at a later date. Permit grading during the rainy seasons only with installation of adequate sediment and erosion control measures.

- Install and maintain silt basins and fences or sand bags along drainage paths during construction to contain on-site soils until bare slopes are vegetated. Carefully stockpile graded soils away from drainages.

- Replanting cleared/graded areas with appropriate native plant species (as determined by a qualified botanist) immediately upon completion of grading.
- Mitigation of potential drainage impacts include:
  - maintaining natural drainage ways by :
  - Stabilizing the slopes on the banks of the seasonal streams and/or gullies by planting and/or maintaining erosion resistant shrubs.
  - Maintaining or planting erosion resistant riparian vegetation along the seasonal stream pathways or gullies to maintain natural drainage and minimize soil erosion and
  - Retaining the vegetation around the seasonal stream pathways, including the large trees to provide shade and to absorb water
  - Preventing blockage of waterways (through rubbish dumping) must be strictly prohibited both during the construction and post-construction phases

7.2.2. Site preparation and Construction Phases

7.2.2.1. Transportation and Storage of Construction Materials

Arrangements should be made with contractors and subcontractors to ensure that the vehicles used for transporting building materials to the site are appropriately sealed and covered to minimize dust. Dust producing building materials such as sand or cement should be stockpiled in low enclosures and covered, away from drainage areas where they could easily be washed away during rainfall.

Ensure that all material (sand and aggregate) stockpiled on the site to be used in construction activities are regularly sprayed to reduce the effects of wind whipping.

Ensure that all trucks carrying aggregate and sand are covered during delivery to the site. Care must be taken in the unloading of aggregate, sand and cement to prevent spillage. Extra care must be taken to reduce dust in periods when wind speed are greatest which is between June and July, e.g. extra wetting of the compound to suppress dust.

All staff employed at the construction site must be provided with dust masks and be asked to use them. All raw materials must be sourced as close as possible to the construction site. Where possible waste must be transported off-site for processing, not burnt or stored for any longer than is necessary.

Ensure that all vehicles involved in the transport of construction material and staff, and machinery involved in the construction are properly maintained and serviced.
Machines must not be left idling for unnecessary periods; this will save fuel and reduce emissions and noise pollution.

7.2.2.2. Airborne and Noise Pollution

The site clearing plan should provide for 10-15m wide green buffer zones along roadsides and drainage ways to dampen the noise and dust related to construction. Access roads and exposed terrain should be sprayed by water trucks to minimize the dust. Use of heavy machinery should be restricted to daylight hours in order to minimize the noise pollution arising from the construction site. The clearing of vegetation must be carried out on a phased basis; that is, only areas designated for construction during the necessary phase of development must be cleared to minimize the dust and runoff.

7.2.2.3. Disposal of Construction Debris

A site waste management plan should be made the responsibility of the building contractor to provide for the designation of appropriate waste storage areas on the site and a schedule for the timely collection and removal of construction debris to an approved dump site. Organic waste produced during site clearing should be mechanically mulched and composted at the site and used for landscaping at a later date.

7.2.2.4. Sewage and Garbage Disposal

Providing adequate number of portable restrooms (chemical toilets or dry composting toilets) for the workmen and waste baskets and dumpsters is essential to keeping the construction site clean and pest free. Arrangements should be made for regular garbage collection and removal of sewage from the construction site. All measures must be taken to ensure that untreated sewage is not directed into the bay waters.

7.3 SOCIO-ECONOMICS

Mitigation measures for the socio-economic impacts are summarized in the Impact Matrix Table in Appendix IV. Mitigative measures are recommended to offset the negative impacts of the proposed development.

7.3.1 Community Development/Recreation

Mitigative measures for the negative impacts on community development include the upgrading of infrastructure and the increased provision of social services for current and future residents of the SIA study area. Consideration should be given to a proper on-site waste disposal programme that includes recycling and waste to resource initiates.

7.4 HYDROGEOLOGY

7.4.1 Drainage Control during Construction

During construction, features such as, site access, storage of materials, site drainage during construction and protection of surfaces from erosion and increased sediment influx to the Flat Point River require particular attention. To ensure that the flow dynamics of the lower reach of the Flat Point River are not disrupted during construction, it is recommended that the drainage works for the Flat Point River be implemented first during the normal dry season, before major site clearance. Sediment control features could then be incorporated into the site development plan to mitigate against sediment influx from site activities to the Flat Point River.

Unfortunately, in Jamaica construction practices and general workmanship have made implementation of proper site housekeeping difficult as it is not the norm for contractors to consider such activities. This makes their implementation and maintenance that much more difficult on any construction site due to unfamiliarity and the inherent difficulty in modifying human behaviour without appropriate punitive sanctions levied by the regulatory agencies.

Notwithstanding the foregoing, the site's proximity to the coast and existing Flat Point River drainage channels it is clear that erosion and sediment control will be of paramount importance during construction in order to reduce discharges to nearby water bodies. In order to mitigate any deleterious impact the following guidelines are recommended in developing the erosion and sediment control plans:

- Implement the major drainage works for the Flat Point River prior to other site activity.
- Determine the extents of clearing and grading on the other parts of the site
- Determine permanent drainage features and define the limits of construction activities.
- Determine the extent of any temporary channel containment for the existing drainage pathways that lead to the Flat Point River from the larger site.

- Determine suitable sediment controls by investigating the requirements of each drainage sub-catchment. This would assist considerably in the reduction of final discharge volumes and flow velocity.

- Determine the staging of construction with a view to minimising the period of exposure of exposed open ground.

- Identify locations for topsoil or aggregate stockpiles and temporary construction roads.

The principal objectives of the erosion controls during construction should:

- Implement the Flat Point River training to the final agreed channel location prior to other site works.

- Limit or reduce soil erosion, sediment movement and deposition to water bodies of all land disturbing activities.

- Seek to establish temporary or permanent cover as soon as possible after final grading has been completed. Surface stabilisation should be considered for areas not at final grade which may remain undisturbed for more than 30 days. Given that Jamaica is prone to short intense rainfall events, especially in the afternoon, consideration should be given to controlling sediment movement through temporary covers, silt fences, and diversion ditches for areas within 30m of a water body.

- Design all temporary and permanent facilities for the conveyance of water from disturbed areas at non-erosive velocities.

Erosion and Sediment Control techniques that should be considered are:

- Routing runoff through existing vegetation to control sediments and reduce downstream velocities. Manage vegetation clearance in a manner that preserves pockets of existing vegetation for use as vegetative control devices.

- Install gravel diversion trenches upstream of exposed land, bearing in mind that depth to groundwater may limit vertical depth.

- Temporary sediment traps/basins to reduce velocities.

- Silt fences placed at the toe of earth slopes or stockpiles.

- Construction road stabilisation with stones immediately after grading to prevent erosion during wet weather due to vehicular traffic and to reduce the need for regrading for permanent roadbeds between initial and final stabilisation.

7.4.2 Drainage Control during Operation

Surface Water Drainage including existing Flat Point River

Drainage design for the Flat Point River will be designed to the 4% in any one year (1 in 25yr) event with site drainage being designed for the more frequent 20% in any year (1 in 5yr) rainfall event. The WRA had recommended an evaluation of the 50yr and 100yr flood inundation levels that would be produced by hydrologic events of the same frequency.

A preliminary look at the 50yr and 100yr hydrologic event was evaluated above and the peak discharges for the 50yr and 100yr event are presented in Table 4-14. The results indicate that the predicted runoff, based on the Forestry Department land use maps and Ministry of Agriculture soil maps, were both less than the very conservative $80m^3/s$ predicted in the drainage report. On balance this would indicate that the $80m^3/s$ design criteria should be sufficient for both the HEC-HMS predicted 50 yr and 100yr events.

Pollution Control Measures during Operation

Pollution control measures are likely to include a mix of the following:

- Earth swales

- Detention Ponds with Gravel filters

- Sand berms for storm surges

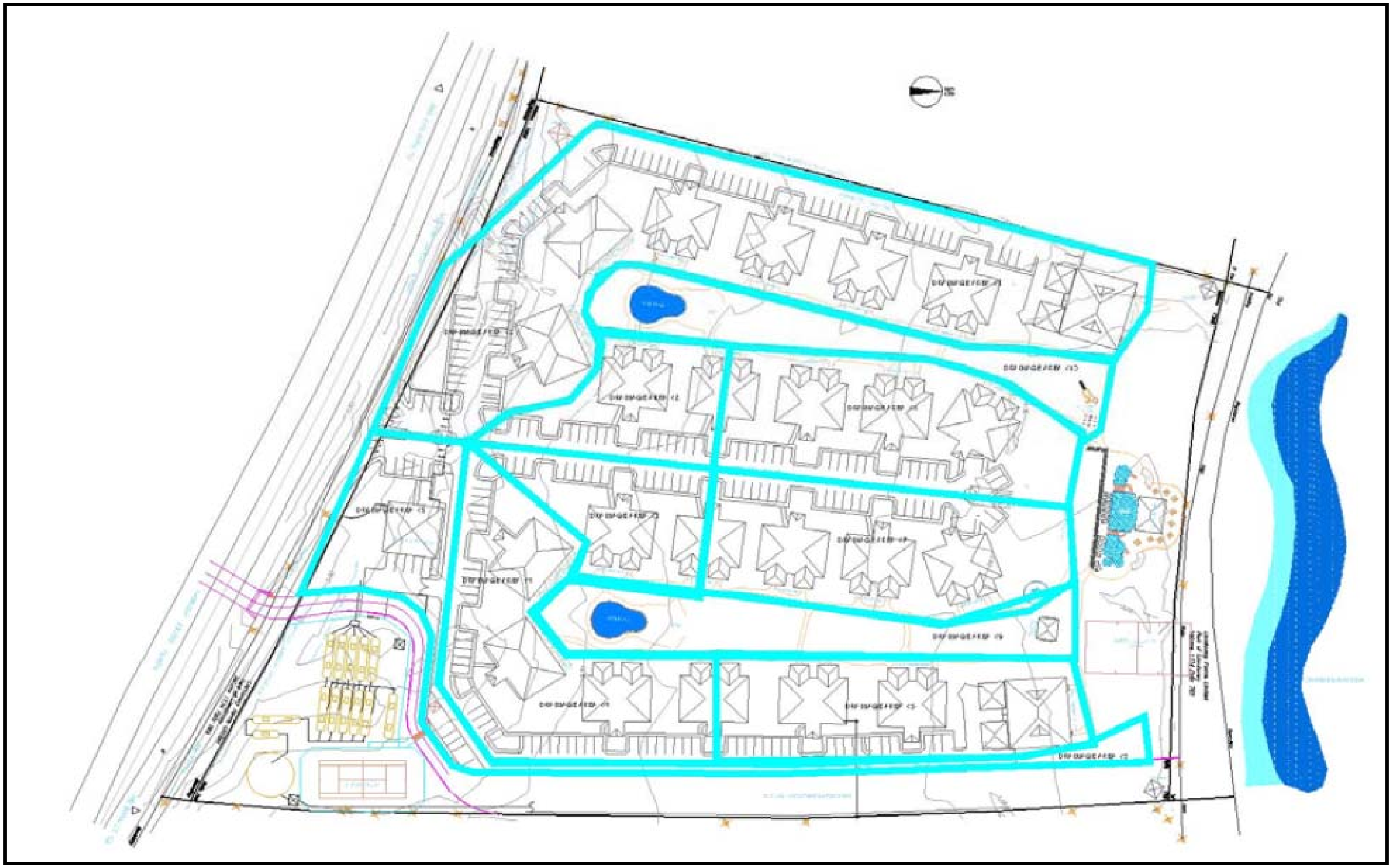


Figure 7-1 showing proposed drainage sub-catchments that will be used to reduce concentrating discharge to a single outlet. (From Foreman, Sykes, and Chung. August 2007).

It is further recommended that:

- All storm drain outlets during construction have suitable designed structures to reduce velocity and mobilization of sediment. Swales and or temporary storage devices should be incorporated into the overall construction phase drainage control plan to provide areas of temporary storage and settlement.

- During operation source control techniques such as harvesting roof runoff, permeable pavements and infiltration devices should be considered for the hard surfaces. Dealing with the water locally not only reduces the quantity that has to be managed at any one point, but also reduces the need for conveying the water off the site. Additionally, the reuse of roof water for on-site irrigation would reduce the requirement for mains water.

- Drainage interceptors, gravel filters, and manholes must be checked as part of the regular maintenance to remove accumulated debris. The annual maintenance of the open channel prior to the approach of the annual wet seasons should be considered a requirement for development and be incorporated within the permit document.

7.5 MONITORING PLAN AND MANAGEMENT PLAN

A draft Monitoring and Environmental Management plan is located in Appendix II and III.

8.0 ASSESSMENT OF ALTERNATIVES TO PROJECT

8.1 ALTERNATIVE 1: WITHOUT PROJECT SCENARIO

8.1.1 Ecology

From an ecological perspective, the without-project scenario holds its value in that the area retains the potential for remediation toward its former state through actions such as tree replanting and various wetland conservation and rehabilitation measures. The development site is part of a larger watershed area and its function remains critical to the health of the surrounding ecosystem. The wetland areas on the east and west boundaries of the property, although small in size, serve important and growing roles in terms of providing coastal protection from erosion and buffering coastal waters from excess sedimentation and nutrient loading. The present state of sedimentation levels in nearshore waters adjacent this site indicates the severity of this problem and the need for immediate amelioration. The most ecologically sensitive alternative to the current development proposal would call for remediating the area including measures to enhance the existing wetland areas, thereby maximizing the coastal functionality of the ecosystem. In the absence of remediation, the without project scenario does not provide ecological benefits to the area since it leaves the area vulnerable to uncontrolled clearing, sand mining and other similarly destructive activities which could further compromise the integrity of the ecosystem.

8.1.2 Socio-economics

Without the proposed development project, the site would continue to be undeveloped vacant land. New housing solutions would not be provided. Additionally, potential for employment during and after construction of the proposed development would also be lost. The without project scenario is therefore less favourable.

8.2 ALTERNATIVE 2: WITH PROJECT SCENARIO

8.2.1 Ecology

The Llandovery project represents an irreversible commitment of coastal resources. For the with-project scenario to be viewed in a positive light, it is essential that the most negative impacts are mitigated and that the project, as a whole is developed in a manner congruent with its environment.

Excessive clearing of vegetation along with inappropriate development of low lying areas which are part of a greater watershed, including small wetland areas, have the potential to compromise the capacity of the watershed ecosystem to buffer the terrestrial and marine environs from impacts of seasonal flash flooding and storm surges. The proposed high density development for the Llandovery will bring with it a number of negative impacts to the existing ecosystem. The long term negative impacts to the area could be mitigated by reducing the number of units and the associated impermeable surfaces in favour of keeping vegetated areas, especially the existing riparian vegetation along the seasonal stream paths and the wetland areas located near the beach.

Increasing the current setback distance of 31.25 to >45 m would serve to maintain the integrity of the wetland areas along the eastern and western boundaries of the property, while providing a vegetated buffer zone protecting the property during high wave events and at the same time reducing beach erosion and protecting coastal waters from excess sedimentation and runoff. According to UNESCO (1997) guidelines for construction setbacks, it is "recommended that the line of "permanent" vegetation be used as the baseline for measurement. This is the tree line or scrub line and can be easily defined and agreed by different observers. It also shows only slight change apart from the relatively rare tropical storms and hurricanes. Features such as high water mark vary according to the tidal cycle and are very subjective."

Habitat conservation is essential for mitigating habitat fragmentation and the decline in biodiversity due to development. Habitat conservation plans developed in Florida and California call for habitat conservation at ratios ranging from 1:1 to 3:1 (conserved/developed) depending on the ecological sensitivity, including the presence of endangered species, in the area under consideration. Reducing the footprint of the development would maximize conservation ratio which is a consideration in making the with-project scenario a more viable one. Incorporation of the water detention ponds in the development proposal is a key mitigative element to the acceptability of this proposal especially the loss of the degraded western wetland area is to be considered.

8.2.2 Socio-economics

The "with project" scenario of the proposed residential development would result in significant and long term positive impacts on the availability of housing and employment. This would then result in other economic gains (housing, increased incomes etc.). This alternative is most favourable.

9.0 LEGISLATIVE AND REGULATORY FRAMEWORK

9.1 Responsible Authorities

The responsibility for regulating and facilitating environmentally sound development lies with several authorities. The principal agency responsible for environmental matters is the National Environment and Planning Agency (NEPA) of the Ministry of Environment and Housing. This agency administers the Natural Resources Conservation Authority Act (1991), which allows the Authority, the Board to which NEPA reports, to request an environmental impact assessment in addition to the requirements of the Permit and Licensing System for development or construction considered likely to have an adverse effect on the environment. Failure or refusal to submit the documents is an offence under the law. This agency also administers the Beach Control Act under which a License is required for encroachment on the foreshore, such as the development of a pier.

The Environmental Health Division (ECD) of the Ministry of Health administers the Public Health Regulations (1976) developed under the **Public Health Act** of 1985, under which air; soil and water pollution control standards are established and monitored. A full application for approval of sewage treatment plans may be made to the EHD, which will input into the detailed application to be approved by the NRCA before authorizing any development. The EHD and local planning authorities monitor construction work to ensure that all development restrictions and requirements are properly adhered to.

In addition, there are Parish Acts and guidelines of local significance, including the Local Improvements Act (1944). However, whereas general approval under the Parish Councils Act is needed for building permits, the UDC Act supersedes all other legislation in the UDC designated areas. The construction of all buildings must comply with the Building Code. The Ministry of Environment and Housing (developed by ASCEND, 1996) and the Town Planning Department have manuals which provide guidelines and planning standards for housing developments. The national planning enforcement authority is the Town and Country Planning Authority (TCPA) which is now part of the NEPA.

9.2 Planning and Environmental Legislation

Natural Resources Conservation Authority (NRCA) Act

The Natural Resource Conservation Authority (NRCA) Act allows the Authority to request an environmental impact assessment for development or construction considered likely to have an adverse effect on the environment. A permit is required from the NRCA for the undertaking of any activity within certain prescribed categories. A permit to operate is required by any new development, construction or modification of any works enabling the discharge of trade or sewage effluent into the environment under Sections 9, 10 and 12 of the NRCA act. This Legislation referred to includes:

- The NRCA (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order.
- The NRCA (Permit and Licence) (Forms, Processing and Fees) Regulations

Failure or refusal to submit the required documentation shall constitute an offence. In general, planning permission must first be sought from the NRCA.

Public Health Act (Air, Soil, and Water Regulations)

The Public Health Act (1974) specifies that persons responsible for any construction, repair or alteration and grit removal facilities, treatment ponds, sludge handling and disposal, and outfalls have to seek the approval of the Ministry of Health. It also deals with issues such as emergency power facilities, fencing and appropriate signage around treatment ponds.

The Watershed Protection Act

The Watershed Protection Act (1963) was enacted to provide protection for watersheds and adjoining areas and by that means promote the conservation of water resources. The Ocean

Pointe development is located within the Martha Brae Watershed Management Unit, one such designated watershed area. The Watershed Protection Commission, established by the Act, can make relevant regulations restricting the planting of crops, the felling and destruction of trees, and the clearing of vegetation within watershed areas.

The Town and Country Planning Act

The TCPA formulates and coordinates strategic plans for area development in the form of Development Orders consistent with the Town and Country Planning Act (1975). This act is now administered by NEPA, and the NRCA board functions as the Town and Country Planning Authority

The Housing Act

The Housing Act (1973) requires that any proposal for the subdivision of land and the construction of houses thereon be accompanied by a plan of the area inclusive of, but not restrictive to, the following: the manner in which it is intended that the area shall be laid out, in particular, the land intended to be used for the provision respectively of houses, roads and open spaces for public and commercial purposes;

the approximate area of the land;

the approximate number and nature of the houses and other buildings to be provides;

the average number of houses to be constructed per acre;

Particulars relating to water supply, drainage and sewage disposal.

The Beach Control Act

The Beach Control Act (1956) states that no person shall be deemed to have any rights in or over the foreshore of the island or the floor of the sea and all rights over the foreshore of the island and the floor of the sea are declared to be vested in the Crown. Additionally, no person shall encroach on or use, or permit any encroachment on or use of, the foreshore or the floor of the sea for any public purpose or for or in connection with any trade or business, or commercial enterprise without a licence granted under this Act. This act is administered by NEPA.

The Tourist Board Act

This Act states that no person shall operate or maintain any tourism enterprise unless such person is the holder of a licence.

9.3 Other Significant Legislation and Policies

Other significant legislation includes the Tree Preservation Order which provides for the protection of all trees from destruction or mutilation of any kind, except with the express permission of the local planning authority. The Wildlife Protection Act (1981) and the Forestry Act (1983) are also relevant to the proposed undertaking.

National Land Policy (1996)

This policy establishes the framework to enhance the efficient planning, management, development and use of land. It is comprehensive in order to achieve complementary and compatible development which is in harmony with economic and socio-cultural factors.

Chapter 3 of the National Land Policy includes rural development and the protection of watershed and fragile areas, exploitation of mineral resources, and crop and livestock production.

Section 3.5.2 (Tourism) states that Government has adopted policies to:

#1 Improve physical planning and infrastructure development in resort areas;

#6 Ensure the preservation and or development as well as access by all to public open spaces and recreational areas.

Section 4.2.2 (Land Access) states that Government will seek to:

#1 Reduce the incidence of squatting by eviction, relocation, regularization and upgrading of infrastructure where necessary;

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11.0 APPENDICES

Appendix I – Terms Of Reference

Appendix II – Monitoring Plan

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APPENDIX I

TERMS OF REFERENCE

Terms of Reference

The Environmental Impact Assessment should include but not be limited to the following:

1) Objectives
2) Complete description of the existing site proposed for development.
3) Significant environmental issues of concern through the presentation of baseline data which should include social, cultural and heritage considerations. Assess public perception of the proposed development.
4) Policies, Legislation and Regulations relevant to the project.
5) Likely impacts of the development on the described environment, including direct, indirect and cumulative impacts, and their relative importance to the design of the development's facilities.
6) Mitigation action to be taken to minimise predicted adverse impacts and quantify associated costs.
7) Monitoring Plan which should ensure that the mitigation plan is adhered to.
8) Alternatives to the project that could be considered at that site or at any other location.
9) Conclusions

The following tasks to be undertaken:

Task #1: Description of the Project

Provide a comprehensive description of the project and its the surrounding environment specifying any information necessary to identify and assess the environmental effects of the project. This should include project objectives and information on the nature, location/ existing setting, timing, duration, frequency, general layout and size of facility including ancillary buildings, pre-construction activities, construction methods, works and duration, and post construction plans. A description of raw material inputs, technology and processes to be used as well as products and by-products generated, should be provided. Note areas to be reserved for construction and areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment.

Sewage treatment system including treated effluent disposal must be clearly outlined as well as solid waste disposal option. In addition, plans for storm water collection and disposal as well as plans for providing utilities and other services should be clearly stated. This should involve the use of maps at appropriate scales, site plans, aerial photographs and other graphic aids and images, as appropriate.

In terms of beach modification, the proposed works on the foreshore and the floor of the sea must be clearly described including but not limited to any seagrass or coral removal and replanting.
A storm surge analysis must be conducted to inform coastal setbacks of buildings and impact mitigation structures/measures.

For projects to be done on a phased basis it is expected that all phases clearly define the relevant time schedules provided and phased maps, diagrams and appropriate visual aids be included.

Task #2: Description of the Environment/Baseline Studies Data Collection and Interpretation

Describe study area/geographical boundaries, and methodology to be utilized for baseline and other data and the length of the study. This task involves the generation of baseline data which is used to describe the study area as follows:

i) Physical environment
ii) Biological environment
iii) Socio-economic and cultural constraints.

(A) Physical

i) A detailed description of the existing **soil and geology and geomorphology, landscape, aesthetic values** and **hydrology.** Special emphasis should be placed on storm water runoff, drainage patterns, aquifer characteristics, effect on groundwater and availability of potable water. Any slope stability issues that could arise should be thoroughly explored.

ii) **Water quality** of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of the development. Quality Indicators should include but not necessarily be limited to nitrates, phosphates, faecal coliform, and suspended solids.

iii) **Coastal and Marine** ecosystem, including but not limited to any wetlands including mangroves, seagrass and coral community with indication of its function and value in the project area.

iv) **Climatic conditions and air quality** in the area of influence including particulate emissions from stationary or mobile sources, NO_x, SO_x, wind speed and direction, precipitation, relative humidity and ambient temperatures,

v) **Noise levels** of undeveloped site and the ambient noise in the area of influence.

vii) Obvious sources of existing **pollution** and extent of contamination.

viii) Availability of **solid waste** management facilities.

(B) Biological

Present a detailed description of the flora and fauna (terrestrial and aquatic) of the area, with special emphasis on rare, threatened, endemic, protected, endangered species. Migratory species wild food crop plants and presence of invasive alien species should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment. Generally, species dependence, habitats/niche specificity, community structure and diversity ought to be considered.

(C) Socio-economic & cultural

Present and projected population; present and proposed land use; planned development activities; issues relating to squatting and relocation; (housing demand and supply) community structure; economic base /employment; distribution of income; goods and services; utilities; recreation; public health and safety; cultural peculiarities, aspirations and attitudes should be explored. The historical importance (heritage, archaeological sites and feature) and other material assets of the area should also be examined. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires/surveys.

Task #3: Policy, Legislative and Regulatory Considerations

Outline the pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation should include at minimum, legislation such as the NRCA Act, the Housing Act, the Town and Country Planning Act, Building Codes and Standards, Development Orders and Plans and the appropriate international convention/protocol/treaty where applicable.

Task #4: Identification and Assessment/Analysis of Potential Impacts

Identify the significant environmental and public health/safety issues of concern and indicate their relative importance.

Identify the nature, severity, size and extent of potential direct, indirect and cumulative impacts (for terrestrial and aquatic environments) during the pre-construction, construction and operational phases of the development as they relate to, (but are not restricted by) the following:

- change in drainage patterns
- flooding potential
- landscape impacts of excavation and construction
- loss of and damage to geological and palaeontological features
- loss of species and natural features
- habitat loss and fragmentation species
- biodiversity/ecosystem functions
- pollution of potable, coastal, marine, surface and ground water
- air pollution
- capacity and design parameters of proposed sewage treatment facility

- socio-economic and cultural impacts.
- Impact of flooding, loss of natural features, excavation and construction on the historic landscape, architecture and archaeology of the site.
- risk assessment
- noise
- solid waste
- soil
- access to resources such as beaches
- carrying capacity of the proposed site

Identify the interaction between different impacts and impacts of other projects should also be considered. In addition, the impacts that have occurred and those impacts which could still occur as a consequence of the clearing works that were conducted on the site prior to the preparation of the TORs should also be identified and analysed

Distinguish between significant positive and negative impacts, reversible or irreversible direct and indirect, long term and immediate impacts as well as avoidable and irreversible impacts.

Characterize the extent and quality of the available data, explaining significant information deficiencies, assumptions and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should be represented in matrix form with separate matrices for pre and post mitigation scenarios.

Task #5: Drainage Assessment

An assessment of Storm Water Drainage should be conducted. The
EIA Report should cover, but not limited to:

i. Drainage for the site during construction, to include mitigation for sedimentation to the aquatic environment

ii. Drainage for the site during operation, to include mitigation for sedimentation to the aquatic environment

iii. Drainage control for the gully traversing the property, to include impacts that this drain will have on the aesthetics, water quality and sedimentation of the beach area, etc.

Task #6: Mitigation

Prepare guidelines for avoiding or reducing (e.g. restoration and rehabilitation), as far as possible, any adverse impacts due to proposed usage of the site and utilising of existing environmental attributes for optimum development. Quantify and assign financial and economic values to mitigating methods.

Task #7: Environmental Management and Monitoring Plan

Design a plan for the management of the natural, historical and archaeological environments of the project to monitor implementation of mitigatory or compensatory measures and project impacts during construction and occupation/operation of the units/facility. An Environmental Management Plan and Historic Preservation Plan (if necessary) for the long term operations of the site should also be prepared.

An outline monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit and/or licence(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.

- The sites being monitored. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA

The Monitoring report should also include, at minimum:

- Raw data collected. Tables and graphs are to be used where appropriate
- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
- Recommendations
- Appendices of data and photographs if necessary.

Task #8: Project Alternatives

Examine alternatives to the project including the no-action alternative. This examination of project alternatives should incorporate the use history of the overall area in which the site is located and previous uses of the site itself. Refer to NEPA guidelines for EIA preparation.

Task #9: Public Participation/Consultation Programme

Conduct a public presentation on the findings of the EIA to inform, solicit and discuss comments from the public on the proposed development.

- Document the public participation programme for the project.
- Describe the public participation methods, timing, type of information to be provided to the public, and stakeholder target groups.
- Summarise the issues identified during the public participation process
- Discuss public input that has been incorporated into the proposed project design; and environmental management systems

All Findings must be presented in the **EIA report** and must reflect the headings in the body of the ToRs, as well as references. Ten hard copies and an electronic copy of the report should be submitted to the National Environment and Planning Agency.

The report should include an appendix with items such as maps, site plans, the study team, photographs, ToR and other relevant information.

APPENDIX II

MONITORING PLAN

SCOPE OF STUDY AND METHODOLOGY

The monitoring programme is designed to ensure that the requirements of the Permit granted by the NEPA are met. Monitoring and mitigation of impacts during the implementation of the project will also require coordinated scheduling of activities between Sagicor (Life of Jamaica) and the consultants, as well as regular reports required by the NEPA. Water quality and ecological parameters that may be affected by construction and operation of the development will be monitored with the necessary fieldwork component to provide the data as needed.

Field observations and measurements will be correlated simultaneously with weather prevailing conditions, so that any change in weather can be compensated for, and unwanted impacts can be avoided. In order to abide by the terms of the Permit set by the authorities, and certify satisfactory completion of the project, it will be necessary to perform the following:

a. **The monitoring of water quality parameters**, specifically, Turbidity, Total Suspended Solids (TSS), and Dissolved Oxygen (DO) during the implementation and post construction phases of the project. Samples will be collected at various locations (approved by the NEPA) twice during the first week of operation, weekly and then at fortnightly, depending on the nature of the activities being carried out at the time. Monitoring will be carried out more frequently as required if the results of initial monitoring suggest that there is a potential threat to the environment.

b. **Random photographs** (and aerial surveys) will be taken at regular intervals to determine whether the project is being carried out according to the stipulations of the Permit.

c. **A suite of ecological observations** would be required to observe any changes in the composition of marine, benthic and terrestrial flora and fauna If required, as above, monitoring will be carried out more frequently if the results of initial monitoring suggest that there is a potential threat to the environment.

d. Final monitoring will be carried out at least three weeks after the works are complete.

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OUTPUT

The information from the monitoring exercise will be used by the consultant to guide LOJ regarding the efficacy of the mitigation measures being implemented. Any changes required to enhance the effectiveness of existing mitigation actions would then be recommended. Monitoring reports will contain the results of water quality and ecological examinations, as well as photographic monitoring carried out, in the period preceding the report, as well as recommendations for action, if required, for improving the construction process from an Environmental perspective. Data will be presented in both tabular and spatial form on maps prepared for this purpose. The maps will carry background, average and current data on each site of monitoring as well as coordinates. Monitoring reports would be produced according to the following schedule, in hard copy and electronic format:

1. Monitoring Report No. 1 - within one week following commencement of construction.
2. Monitoring Reports No. 2 onwards - within one week following the monitoring period (fortnightly or monthly) as determined, unless there is an unforeseen situation which could negatively affect the environment.
3. Post Project Monitoring will take place three weeks after the works are complete and the Final Monitoring Report will be submitted within week four after completion of the post project monitoring.

Depending on the length of the construction process, the NEPA may require monitoring reports on a schedule different from the intervals proposed.

ENVIRONMENTAL CHEMISTRY

1.0 BACKGROUND

This plan is developed to satisfy the water quality monitoring component of the Sagicor (LOJ) construction project at the Llandovery. The water quality component is required to evaluate impacts on critical parameters as a result of the proposed construction. In order to evaluate immediate and short term effects of the project, the monitoring plan will be carried out in two parts as follows:

- Water quality monitoring during construction
- Post development monitoring

Rationale for Selection of Water Quality Indicators

Our experience in this area has allowed us to determine that parameters of significance to the monitoring programme are **Total Suspended Solids** (**TSS), Turbidity, Biological Oxygen Demand** (**BOD)**, and **Dissolved Oxygen** (**DO).**

2.0 METHODOLOGY

Initial sampling will be carried out prior to the commencement of construction, to compare current conditions with data previously collected in order to confirm the baseline water quality for comparison with data collected during the project. Sampling will be carried out twice during the first week of construction. If the results are satisfactory, then sampling will be done weekly thereafter. As the project progresses there may be the request to change the frequency to fortnightly. Sampling will be increased to three times per week if a potential threat to the environment is identified.

At least four sampling stations will be established to enable comparison with data collected for the targeting areas slated for development ·and the closest sensitive area(s) potentially affected by the development.

2.1 Sample Collection

Surface and sub-surface water samples will be collected at all sites established using a Van Dorn sampler or similar device. Sampling will be carried out on several occasions during the development project as follows: Twice in the first week after commencement of infrastructure construction and then weekly thereafter. Final monitoring will be three weeks after completion of the project.

2.2 Sample Analysis

Laboratory analyses will be carried out by local facilities in accordance with Standard Methods for the Analysis of Water and Wastewater to determine levels of TSS and BOD. Dissolved Oxygen (DO) will be determined in situ using portable instrumentation.

Total Suspended Solids will be determined by filtration and gravimetry.

Biological oxygen demand (BOD) will be determined by the bottle dilution method.

Dissolved oxygen (DO), will be determined using the YSI Model 51B Oxygen meter, and Model 5739 Field Probe. The probe uses a Clark-type gas permeable membrane that covers polarographic electrode sensors. The system has a built in thermistor for temperature compensation, and temperature measurement. Measurement range of the instrument is 0-15mg/l, and accuracy is better than .2mg/l when calibrated within +/- 5^{o}C of actual sample temperature. Readability is better than 0.1mg/l.

3.0 OUTPUT

Monitoring reports will be produced according to the following schedule:

1. Monitoring Report No. 1 - within one week after commencement of construction
2. Monitoring Reports No. 2 onwards - within one week after the monitoring period (fortnightly or monthly) as determined, unless there is an unforeseen situation which could negatively affect the environment.

3. Post Project Monitoring will take place three weeks after the works are complete and the Final Monitoring Report will be submitted within week four after completion of the post project monitoring.

ECOLOGY

1.0 BACKGROUND

The ecology component of the monitoring of the LOJ Llandovery development calls for the evaluation of the impacts of the proposed construction on the overall flora and fauna of the area of influence of the project. The general objective will be to inspect, assess and characterise specific areas of the marine and terrestrial environment examined prior to, during; and immediately after the construction activities to be carried out.

The location of indicator species would be such as to render them directly or indirectly impacted by the development. Acute impacts resulting from the project will be evaluated by habitat monitoring during the construction and by post project monitoring.

Rationale for selection of ecological parameters

Particular emphasis will be placed on possible impacts to near shore mangrove stands, coral reefs, seagrass beds as well as other flora and fauna that may be affected (fall within the predetermined area of influence). The indicator parameters considered relevant to the assessment of significant impacts to the ecosystems include physical environmental data and the species composition and density of individuals comprising particular stands or habitats as well as mobile species that may inhabit them. The parameters of significance are considered to be ambient light levels, suspended sediments and the density of occurrence of reef building corals, seagrass shoots and the extent of these habitats located in close juxtaposition to site modification activities.

2.0 METHODOLOGY

An examination of the ecology of the area of influence of the project will be carried out at sites previously established to define baseline conditions before construction commences. Sampling will then be carried out initially, at two week intervals. Maintenance of or deviations from the status quo regarding the parameters being investigated would determine whether or not the sampling period would be increased or decreased. At least six sampling stations will be established in concert with the water quality monitoring stations if possible or appropriate so as to allow comparison with data collected from the ecological assessments made in previous studies

2.1 Sample collection and analysis

Sampling of the habitat component species will be carried out by direct visual count (using chain or quadrat transects of appropriate length; by use of grab samplers for benthic infauna or by videotaping of the substrate for later analysis (random dot matrix analysis) in the laboratory - as appropriate.

Sediment rates & levels will be measured with appropriately sized and positioned sediment samplers while light levels will be evaluated with the aid of a secchi disc Initial sampling exercises are expected to occur at the commencement of the project; two weeks after commencement then at two week intervals. Final monitoring will be three weeks after completion.

Random aerial photography re. influence of project on the overall environment will take place at monthly intervals if appropriate.

3.0 OUTPUTS

Monitoring reports will be produced according to the following schedule:

Monitoring Report No. 1 - One week after commencement of the project. Subsequent reports every two weeks. Post Project Monitoring will take place three weeks after construction is complete and the Final Monitoring Report will be submitted three weeks after completion of the post project monitoring.

HYDROGEOLOGY

The aqueous environment should be monitored both during and post construction to ensure that national water quality objectives for beaches and freshwater are achieved and demonstrated to be achieved. Sites for monitoring shall include the main open channel and the sea.

- **During the Construction Phase:** precautionary engineering measures (outlined above) should be implemented to reduce run-off and prevent it from reaching existing drains and the coast. Nothing which could cause pollution, including sediment-laden water, should be allowed to enter any such watercourse.

- All temporary fuel, oil and chemical storage must be sited on an impervious base within a bund and secured. The base and bund walls must be impermeable to the material stored and of an adequate capacity. Storage at or above roof level should be avoided.

- Leaking or empty oil drums must be removed from the site immediately and disposed of via a licensed waste disposal contractor or in conjunction with the local authority.

- Washings from concrete mixers, paint or paint utensils should not be allowed to flow into any drain or watercourse.

- **Post construction:** General monitoring of the open channel and debris removal.

APPENDIX III

ENVIRONMENTAL MANAGEMENT PLAN

ENVIRONMENTAL MANAGEMENT PLAN

This plan has been prepared in accordance with the requirements of the National Environment and Planning Agency as it pertains to the LOJ Llandovery development... This plan is being prepared to ensure effective management of the environment during the operational phase of this project.

This plan aims to provide:

- An integrated plan for the comprehensive monitoring and control of impacts.
- Auditable commitments displaying practical, achievable strategies for management to ensure that environmental requirements are specified and complied with

The Environmental Management Plan (EMP) defines a process wherein the managers of the LOJ Llandovery development will:

1) Establish its commitment to improving the environment

To this end an Environmental Management policy must be laid out by the management

Suggested Policy:

The management of Sagicor (Life of Jamaica) will work towards protecting the environment by ensuring that its activities do not contribute to its degradation. We will seek to lead by example in the national imperative of maintaining a healthy environment. To this end, The Sagicor will strive to operate in a safe, responsible manner within the country's environmental standards to secure a healthy environment for employees, visitors, and the wider society.

All employees are expected to understand, promote and assist in the implementation of this policy. This can be done by scheduling lectures, preparation of printed material etc to assist the decision makers of the management team as well as ordinary employees to be sensitive to the environmental character and vulnerabilities if the Llandovery Site, and the potential of their routine activities to impact on the environment.

2) Review its activities and identify those that have a significant impact on the environment.

This would involve a familiarity with the provisions of the NEPA Environmental Permit and Licences, particularly with the mitigation required and NRCA/NEPA Standards. Activities for the monitoring of the coral reef health and turtle nesting areas would be paramount.

3) Put programmes in place to eliminate or reduce these impacts.

A monitoring programme should be in place for the sewage effluent management as well as the quality of the coastal waters to identify changes from the background, baseline conditions.

The environmental monitoring plan must clearly identify the mitigating actions to be taken, including ecological surveys of the reef, development of drainage systems, dust control and waste disposal. Retaining the services of a third party monitor to carry out regularly scheduled sampling (e.g. on a monthly basis) of the area during the various phases of the development would ensure that negative impacts are identified and addressed in the earliest stages, thus preventing further deterioration of the environment.

A monitoring programme designed for the construction phase of the project should focus on:

- Collecting data and providing ongoing feedback on the state of the environment in the affected area
- Monitoring the state of the reefs, the nearshore area, the state of trees marked for protection and other landscape activities
- Looking for signs of soil erosion and runoff especially after significant rainfall
- Monitoring the marine community, as well as sedimentation rates and water quality in the nearshore
- Assessing transportation, storage and disposal of construction materials
- Assessing waste management practices

The Products of the EMP will be:

- Specific targets and actions to reduce the impact of the development's activities on the environment;
- The establishment of a system of monitoring the activities of the development identified above.
- A data base, preferably digital, of the development's activities and data collected to track the effect of the management programme
- An increase the awareness and knowledge of the staff at all levels of the environmental impacts of the decisions and activities that they undertake, and of the standards requited by NEPA.
- A communications programme to encourage environmental stewardship among the residents.

The outcome of the EMP will be an improvement of the environment in and around the development.

APPENDIX IV

IMPACT MATRICES

WEIGHTING FOR IMPACT MATRIX

+10
] Positive, Long term, New, Very significant, Direct
+8
] Indirect, Positive, Very significant, New, Long term
+6
] Positive, Direct, Short term, Very significant, Incremental
+4
] Indirect, Positive, Short term, Very significant, Incremental
+2
] Positive, Direct/Indirect, Insignificant, Short term, Incremental
0
] Indirect, Negative, Short term, Incremental, Insignificant, Mitigatable
-2
] Indirect, Negative, Short term, Very significant, Mitigatable, Incremental
-4
] Direct, Negative, Long term, Very significant, Mitigatable, Incremental
-6
] Indirect, Negative, Long term, Very significant, New, Immitigable
-8
] Direct, Negative, Long term, Very significant, New, Immitigable
-10

Environmental Chemistry

PRE-MITIGATION						
Coastal Water Quality						
Organic Pollution indicators						
INDICATOR	**TYPE**	**EXTENT**	**MAGNITUDE**	**MITIGATIVE MEASURES**	**COMMENTS**	**WEIGHT**
BOD	Negative	Long Term	Significant		Due to sewage discharge	-6
Nitrogen	Negative	Long Term	Significant		Due to sewage discharge	-6
Pesticides	Negative	Long Term	Significant		Use in Maintenance of Landscape	-6
TSS	Negative	Short Term	Significant		Due to sewage discharge	-6
Oil and Grease	Negative	Long Term	Significant		Deposition of oil contaminated soil	-6
Coliform	Negative	Long Term	Significant		Mainly from sewage	-4
D.O.	Negative	Long Term	Significant		Due to high level of BOD in sewage	-4
Inorganic Pollution Indicators:						
Phosphate	Negative	Long Term	Significant		From fertilisers used in maintenance of landscape	-4
Nitrate	Negative	Long Term	Significant		Due to break down of sewage and use of fertilisers	-4
Salinity	Negative	Long Term	Significant		Reduced salinity of coastal water due to increased fresh water run off	-6
TSS	Negative	Long Term	Significant		Due to sewage discharge, erosion	-6

Ground Water Quality						
Organic Pollution indicators						
INDICATOR	**TYPE**	**EXTENT**	**MAGNITUDE**	**MITIGATIVE MEASURES**	**COMMENTS**	**WEIGHT**
BOD	Negative	Long Term	Significant		Discharge of sewage to aquifer	-6
Nitrogen	Negative	Long Term	Significant		Discharge of sewage to aquifer, seepage of nutrient rich irrigation return water	-6
Pesticides	None	N/A	N/A		Use of pesticides in maintenance of landscaped areas, seepage of nutrient rich irrigation return water	0
TSS	Negative	Long Term	Significant		Discharge of sewage to aquifer, seepage of nutrient rich irrigation return water	-6
Coliform	Negative	Long Term	Significant		Discharge of sewage to aquifer, seepage of nutrient rich irrigation return water	-4
D.O.	Negative	Long Term	Significant		Due to high level of BOD in sewage	-6
Inorganic Pollution Indicators:						
Phosphate	Negative	Long Term	Significant		Seepage of nutrient rich irrigation return water	-6
Nitrate	Negative	Long Term	Significant		Discharge of sewage to aquifer, seepage of nutrient rich irrigation return water	-6
Salinity	Negative	Long Term	Significant		Abstraction of ground water	-6
Conductivity	Negative	Long Term	Significant		Abstraction of ground water	-6
TSS	Negative	Long Term	Significant		Discharge of sewage to aquifer	-6

Air Quality						
INDICATOR	**TYPE**	**EXTENT**	**MAGNITUDE**	**MITIGATIVE MEASURES**	**COMMENTS**	**WEIGHT**
SO_x	None					
NO_x	None					
CO	None					
CO_2	None					
PM_{10}	Negative	Short Term	Significant		Land clearing vehicle movement on haul roads	-4
Noise	Negative	Short Term	Significant		Vehicle movement through community, horns, defective vehicles, engine compression noise	-4

POST-MITIGATION						
Coastal Water Quality						
Organic Pollution indicators						
INDICATOR	**TYPE**	**EXTENT**	**MAGNITUDE**	**MITIGATIVE MEASURES**	**COMMENTS**	**WEIGHT**
BOD	Negative	Short Term	Insignificant	Treatment of sewage to ensure compliance with trade effluent standards		-1
Nitrogen	Negative	Short Term	Insignificant	Treatment of sewage to ensure compliance with trade effluent standards. Containment of surface run off	Overflow may occur in extreme events	-2
Pesticides	None	N/A	N/A	Containment of surface run off and irrigation return water	Overflow may occur in extreme events	-2
TSS	Negative	Short Term	Insignificant	Containment of surface run off and Treatment of sewage to ensure compliance with trade effluent standards	Overflow may occur in extreme events	-2
Coliform	None			Treatment of sewage to ensure compliance with trade effluent standards		0
D.O.	None			Treatment of sewage to ensure compliance with trade effluent standards		0
Inorganic Pollution Indicators:						
Phosphate	Negative	Short Term	Insignificant	Containment of surface run off	Overflow may occur in extreme events	-2
Nitrate	Negative	Short Term	Insignificant	Treatment of sewage to ensure compliance with trade effluent standards and Containment of surface run off	Overflow may occur in extreme events	-2
Salinity	Negative	Short Term	Insignificant	Containment of surface run off	Overflow may occur in extreme events	-2
conductivity	Negative	Short Term	Insignificant	Containment of surface run off	Overflow may occur in extreme events	-2
TSS	Negative	Short Term	Insignificant	Containment of surface run off	Overflow may occur in extreme events	-2

Ground Water Quality						
Organic Pollution indicators						
INDICATOR	**TYPE**	**EXTENT**	**MAGNITUDE**	**MITIGATIVE MEASURES**	**COMMENTS**	**WEIGHT**
BOD	None			Use of appropriate liner in containment area		0
Nitrogen	None					0
Pesticides	None			Use of appropriate liner in containment area		0
TSS	None			Use of appropriate liner in containment area		0
Coliform	None			Use of appropriate liner in containment area		0
Inorganic Pollution Indicators						
Phosphate	None			Use of appropriate liner in containment area		0
Nitrate	None			Use of appropriate liner in containment area		0
conductivity	None			Avoid use of ground water for irrigation		0
TSS	None			Use of appropriate liner in containment area		0
Air Quality						
SO_x	None					
NO_x	None					
CO	None					
CO_2	None					
PM_{10}	Negative	Short Term	Insignificant	Sprinkling of haul roads and other areas as appropriate to minimise dust hazards, appropriate covering of haul vehicles		-2
Noise	Negative	Short Term	Insignificant	Regulation of traffic, Planning of routes, use of only vehicles satisfying traffic regulations		-2

ECOLOGY

	LLANDOVERY ECOLOGICAL IMPACT INDICATOR	Impact Type	Significant	Not significant	Direct	Indirect	Short-term	Long-term	Unavoidable	Irreversible	Cumulative	Mitigation Required	Comments	Weight
During Construction	Loss and fragmentation of natural habitat:	NEG	x		x			x	x	x	x	x	The clearing of the site in preparation for the construction phase represents an immediate and most negative environmental impact to the area. The removal of trees and shrubs would reduce and fragment the existing forest cover, resulting in irreversible loss of natural habitat for flora and associated fauna in the area.	-9
	Decreased biodiversity	NEG	x		x			x	x	x	x	x	Development activities will have a negative impact on bird populations (indicator species for biodiversity) using the habitat. Keeping/replanting food trees for birds & using feeders would encourage avifauna to remain in the area.	-9
	Loss or Alteration of Turtle Nesting Grounds	NEG	x		x			x		x	x	x	Coastal development near beaches used by hawksbills can alter the beach, introduce light pollution and destroy the vegetation and other conditions needed for successful reproduction. Measures must be taken to ensure that the natural state of the beach is not directly or indirectly compromised in a manner that could deter turtles from nesting on the beach.	-8
	Impact on the beach and wetland areas.	NEG	x		x			x		x	x	x	Altering the wetland areas, in part or in full, will compromise the ability of wetlands to act as a physical buffer against storm surges, reducing coastal erosion, reducing runoff and flood waters, filtering out sediment, protecting coral reefs and serving as a habitat for flora and fauna.	-8
	Change in drainage patterns and soil erosion	NEG	x			x		x	x		x	x	Removal of vegetation, excavation and construction activities will impact the existing drainage patterns in the area. Removal of riparian vegetation along the east and west borders of the property, along the seasonal waterways which receive waters from the watershed via culverts located along the highway will lead to soil erosion and excess run-off. Soil erosion and excessive runoff into the lagoon present a significant impact with long term implications.	-6

	LLANDOVERY ECOLOGICAL IMPACT INDICATOR	Impact Type	Significant	Not significant	Direct	Indirect	Short-term	Long-term	Unavoidable	Irreversible	Cumulative	Mitigation Required	Comments	Weight
	Degradation of marine environment	NEG	x			x		x			x	x	Excessive runoff, especially during heavy rains, could also lead to elevated nutrient loading into the lagoon. The compounded effect of turbidity and sedimentation would negatively impact the inshore water quality and the seagrass beds in the lagoon.	-8
	Transportation and Storage of Construction Materials	NEG		x		x	x					x	Transportation of building supplies as well as improper storage of building materials could have a negative impact on the coastal waters. Improper storage or handling of hazardous or flammable materials, including fuel, paints and solvents) could result in soil contamination.	-4
	Noise and dust pollution	NEG		x	x		x		x			x	Noise barriers. Restricting construction to daylight hours. Proper transportation and storage of building materials on site.	-4
	Disposal of construction debris	NEG		x		x	x		x			x	Need for comprehensive construction site disposal plan.	-2
	Sewage and Garbage Disposal	NEG		x		x	x		x			x	Provision of appropriate sanitation for workers.	-2
Post- Construction	Setback line	POS	x		x			x					Increasing the setback distance of 31.25 to >45 m would serve to maintain the integrity of the wetland areas along the eastern and western boundaries of the property, while providing a vegetated buffer zone protecting the property during high wave events and at the same time reducing beach erosion and protecting coastal waters from excess sedimentation and runoff.	8
	Wetland conservation	POS	x		x			x			x		The most effective mitigation measure for the beach and wetland areas would be to avoid the construction of permanent structures on or immediately near the beach. Maintaining or enhancing the wetland areas on either side of the property is essential to mitigating the loss of habitat and maintaining biological diversity in the area. The alternative to use the western wetland for development purposes and mitigate its loss by the creation of water retention ponds within the development designed to function as self sustaining wetland areas has great merit	10
	Landscaping and replanting	POS	x		x			x			x		Landscaping plan to use local species in green areas to maintain species diversity of flora. Keeping food trees for birds & using feeders would encourage them to remain in the area.	7
	Protection of turtle nesting ground	POS	x		x			x			x		Providing long-term protection to turtle nesting beaches is paramount to protecting the species. Eliminating threats such as beachfront development, beach erosion resulting from sand mining. Monitoring is essential during and upon completion of development.	7
	Construction site management plan	POS		x		x		x					Construction site plan to deal with proper transportation. storage and disposal of materials. The plan would entail proper rubbish and sewage disposal for the construction site.	2
	Cumulative impact weight													**-27**

SOCIO-ECONOMICS ASSESSMENT IMPACT MATRIX

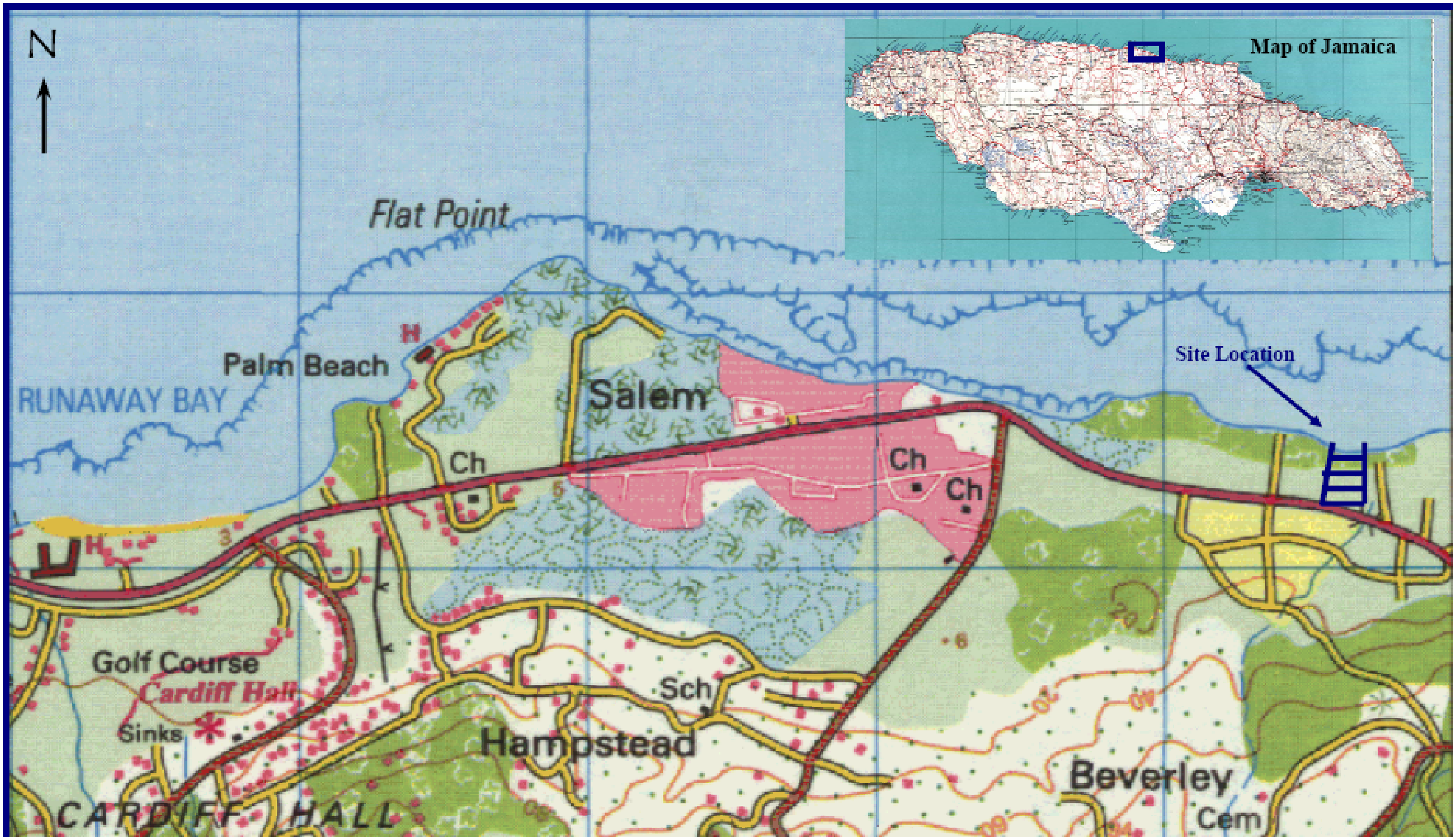
Factor	Indicator	Type	Extent	Magnitude	Mitigative Measures	Comments	Weight
Socio-economic Construction (Micro)	Land Use	a) Positive, direct	Long-term	Very Significant	N/A	The site will be developed with residential units	+10
	Employment and Income	a) Positive, direct	Short-term	Significant	N/A	Employment creation during construction activities	+6
	Transportation	a) Negative, indirect	Short-term	Insignificant	Proper planning and scheduling of transportation activities on and off site.	Increased vehicular traffic	-1
	Community Development	N/A	N/A	N/A	N/A	Lands within 0.5 km of the site are undeveloped vacant land. As such community activities will not be significantly impacted by the proposed development	0
Socio-economic Post-Construction (Macro)	National/Regional	a) Positive, direct	Long-term	Very Significant	N/A	Increased housing stock for the nation	+10
		b) Positive, direct/indirect	Short and Long-term	Very Significant	N/A	Contribute to employment/ reducing unemployment	+10

Factor	Indicator	Type	Extent	Magnitude	Mitigative Measures	Comments	Weight
(Micro)	Land Use	a) Positive, indirect	Long-term	Very Significant	N/A	Post-construction land use will be residential	+8
	Employment	a) Positive, indirect	Long-term	Significant	N/A	Employment opportunities	+8
	Transportation	a) Negative direct	Long-term	Insignificant	The proposed development is located along the North Coast Highway which is adequate to accommodate the expected increased activity.	Increased vehicular traffic with movement of visitors and cargo via land transportation	-1
	Community Development/ Recreation	a) Positive, direct	Long-term	Very Significant	N/A	Increased employment opportunities may result in increased economic activities in the area. Increased employment will lead to increase incomes, which will affect other economic activities such as shopping facilities for the population with increased residual incomes to spend on consumer goods. The proposed development will also increase the availability of recreation facilities within the community.	+6
		b) Negative, indirect	Long-term	Significant	Expand access to social services for current and future residents of the community and visitors	Existing social services such as schools and waste disposal systems) may not be able to facilitate the increased population within the SIA study area	-4

APPENDIX V

MAPS

Site location map for proposed development, Llandovery, Jamaica



Aerial view of proposed development site with site plan overlay.

APPENDIX VI

HYDROGEOLOGY

APPENDIX A

Figure 1 – Site location plan. Blue lines are the rivers. Image adapted from Google Earth

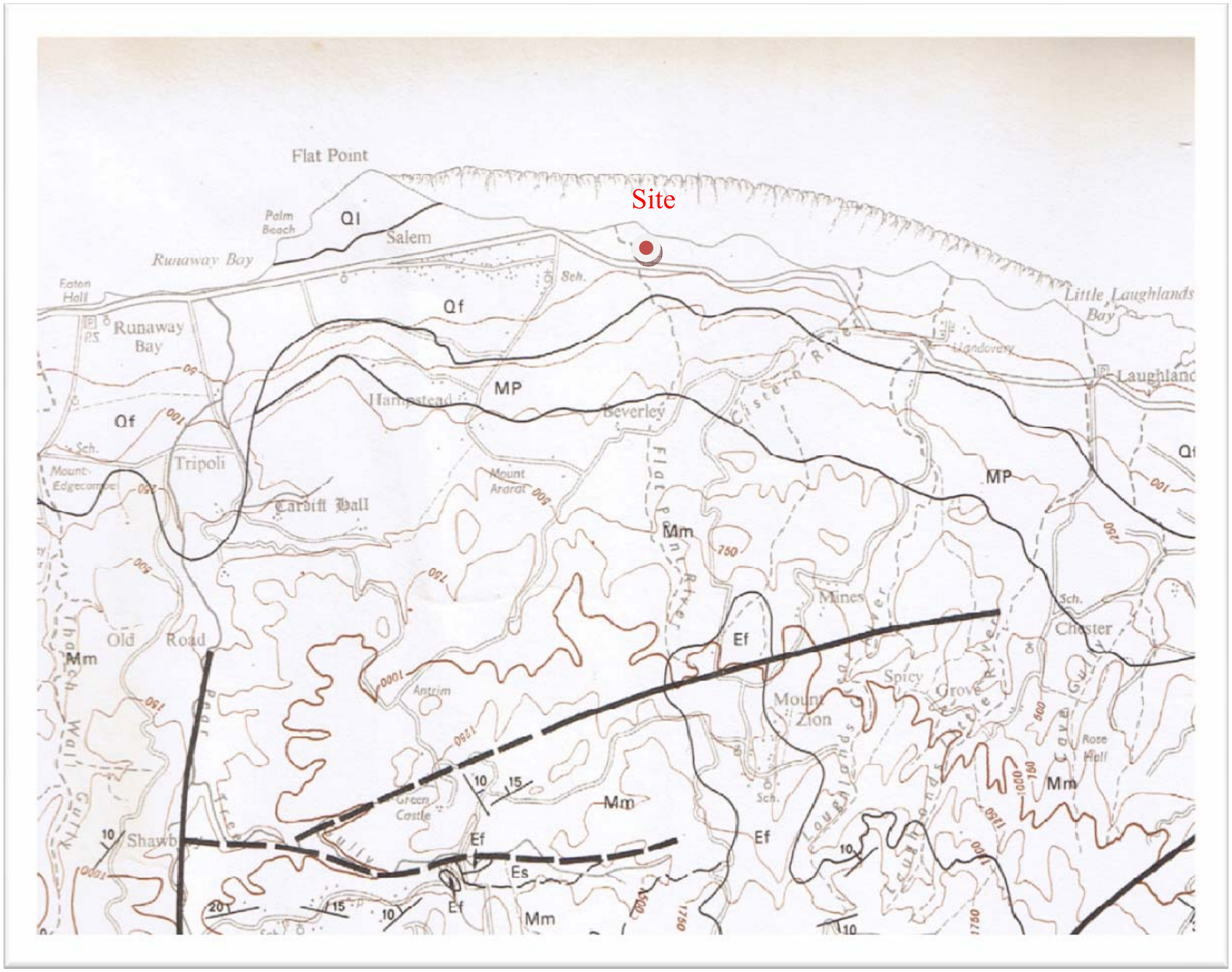


Figure 2 – Site regional geology (taken from Sheet 14, 1:50,000 Series, Imperial) Not to scale. North to top of page.

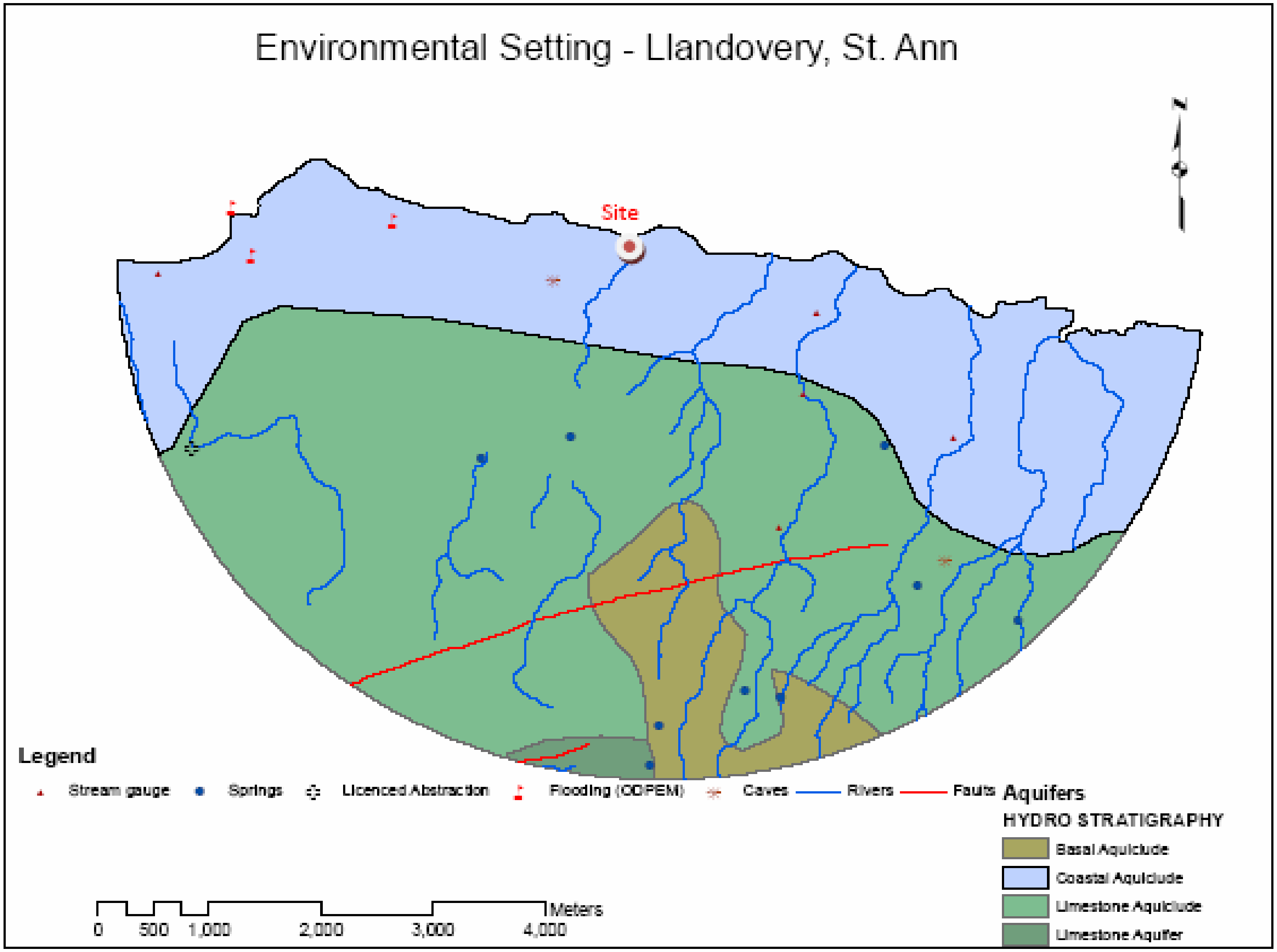
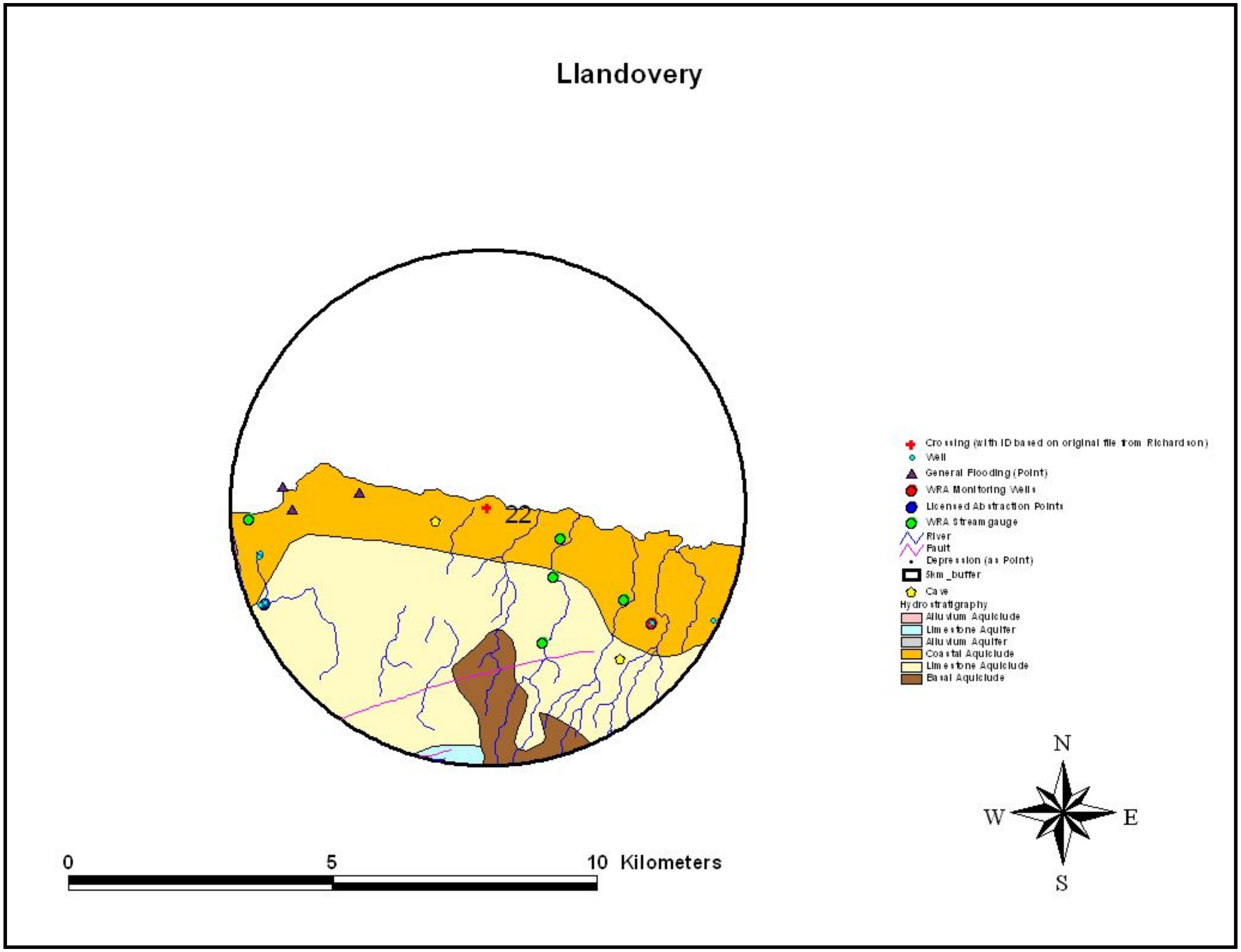


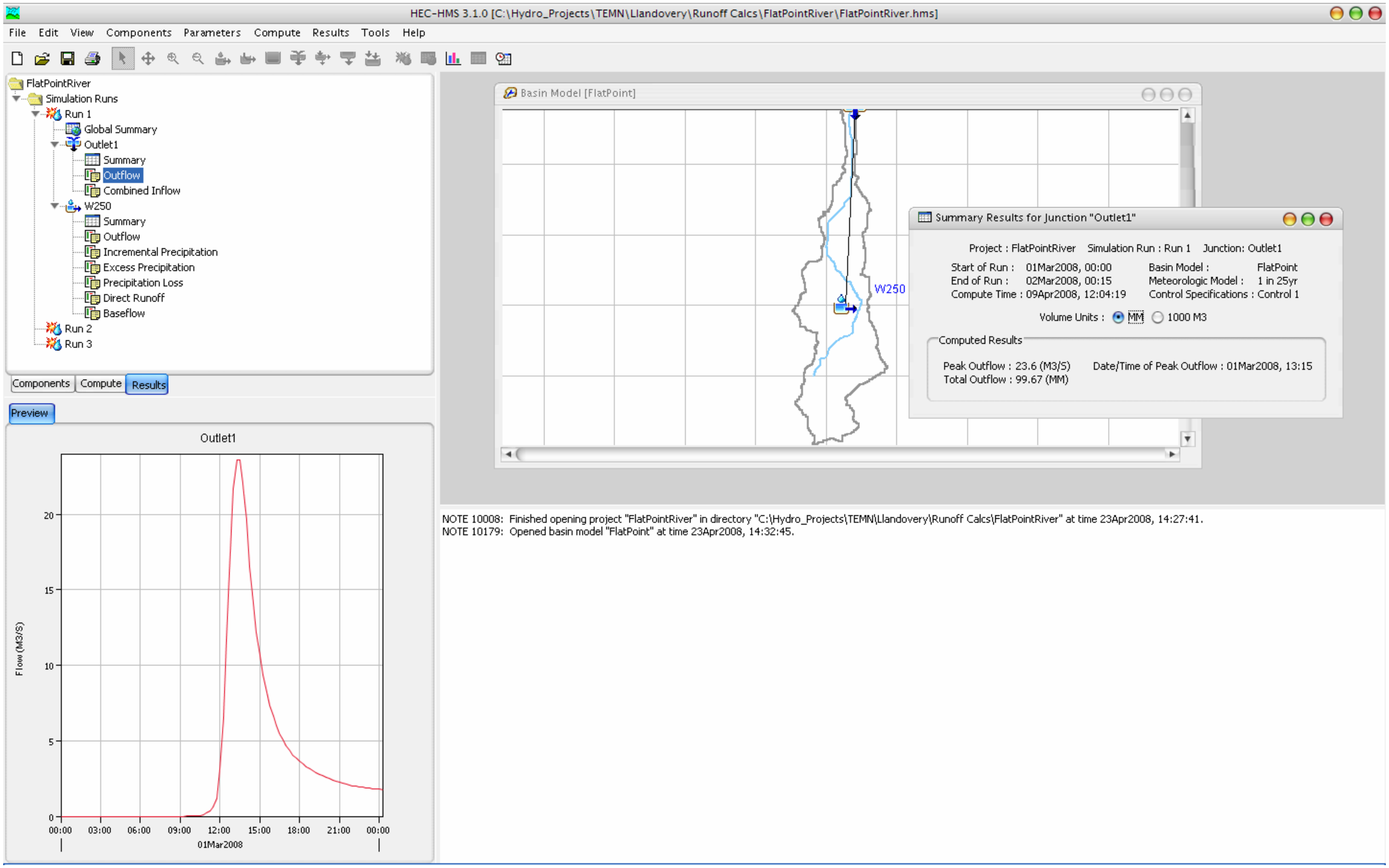
Figure 3 – Environmental setting within 5km showing the hydrostratigraphy, springs, licensed abstractions, geological features and flood events. (Compiled from WRA data)

APPENDIX B

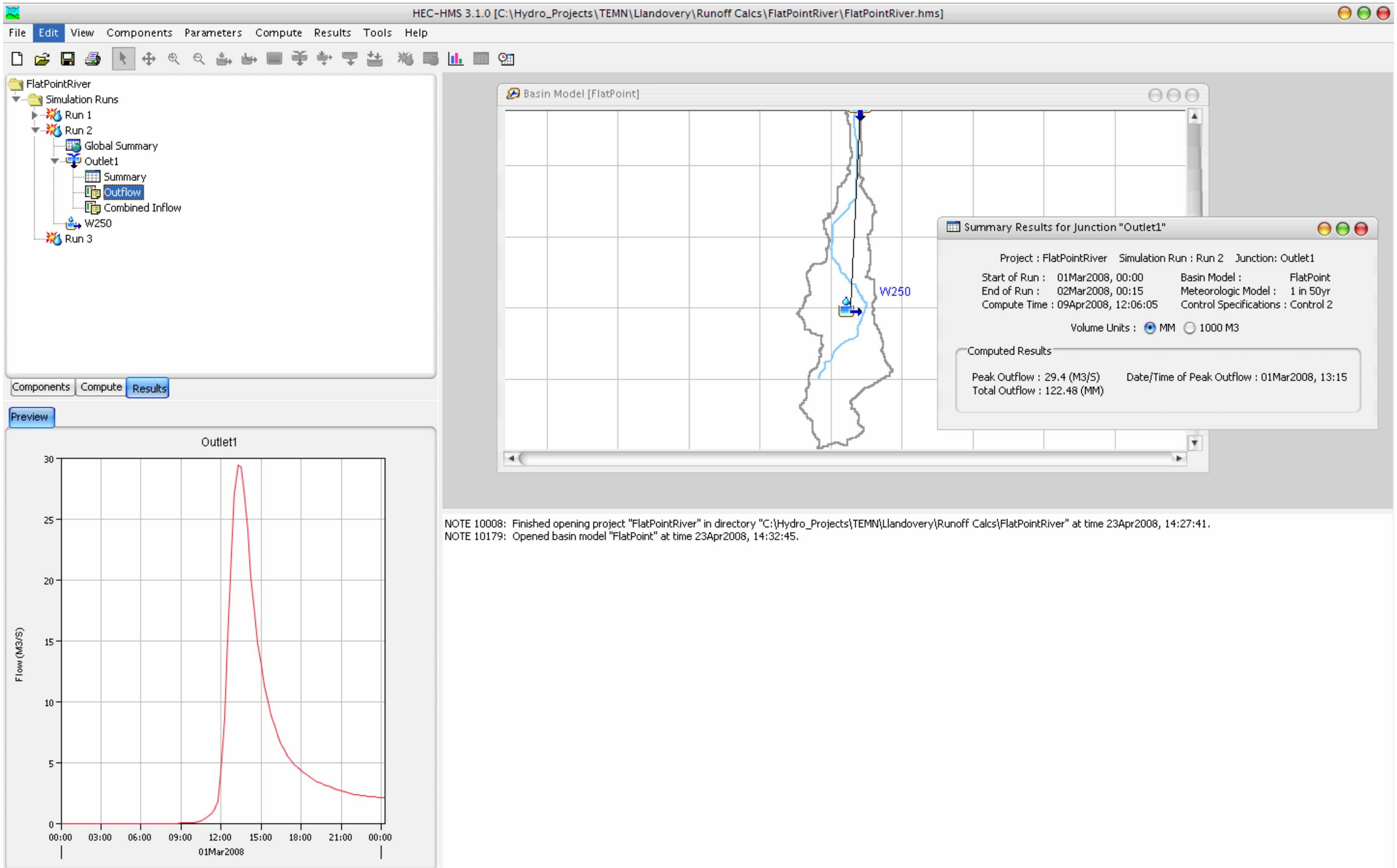


WRA – Llandovery data summary

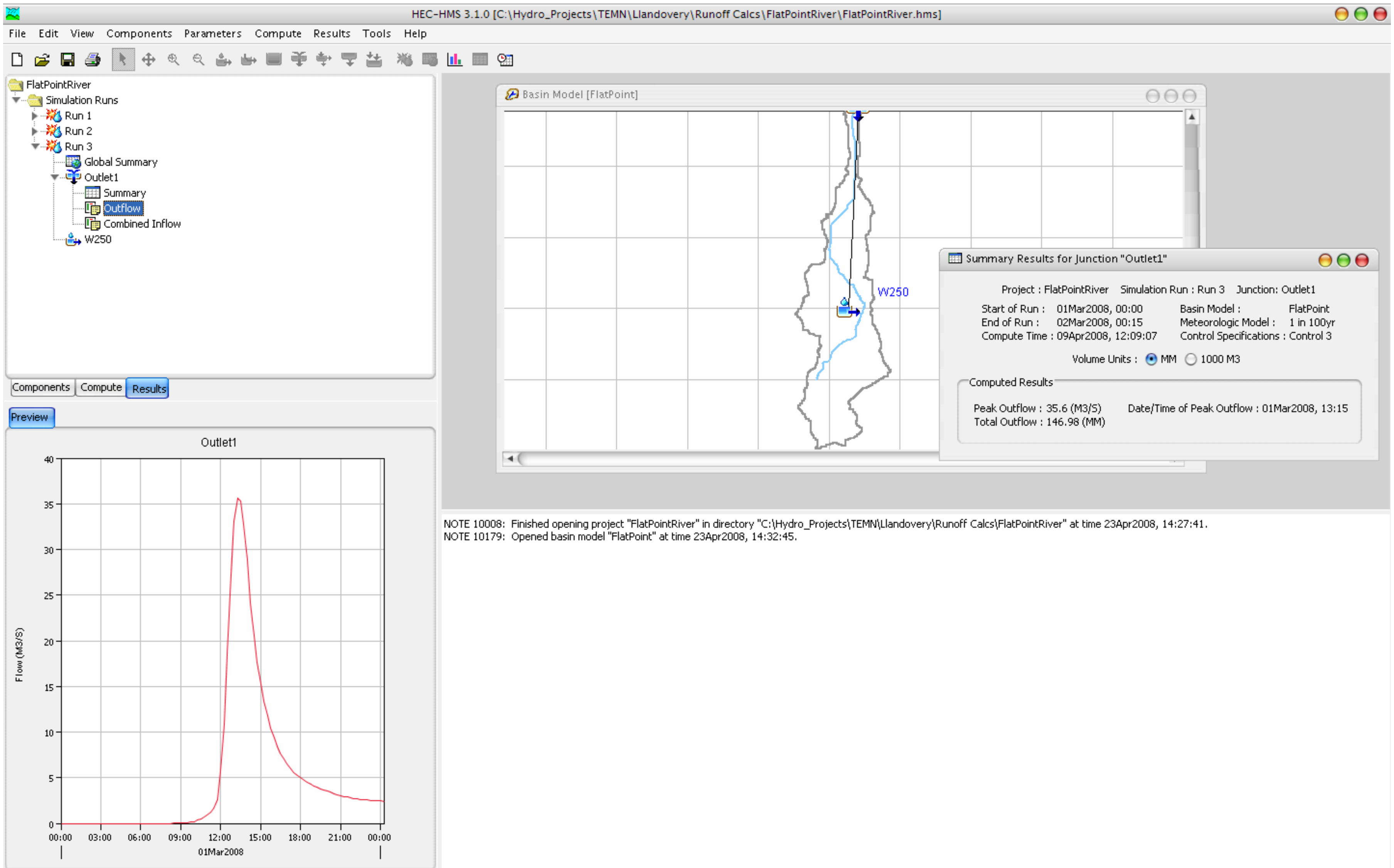
APPENDIX C



Flat Point Peak Discharge 1 in 25yr hydrologic event – HEC-HMS



Flat Point Peak Discharge 1 in 50yr hydrologic event – HEC-HMS



Flat Point Peak Discharge 1 in 100yr hydrologic event – HEC-HMS

Project: Llandovery Development
Location: Llandovery, St. Ann
Client: TEMN

Date: April 2008

Rational Equation

Q=0.00278 CIA	Metric units	
Q=1.008 CIA	SI units	

Where,

Q = peak runoff rate (cfs, m^3/s)		
C = runoff Coefficient from Table in Sheet 2	0.3	unitless
I = average rainfall intensity (in/hr, mm/hr)	123	mm/hr
A = the drainage area (acres, hectares)	4.2	hectares

Pre-development	**Shrubland**	
C	0.3	unitless
I*	123.3	mm/hr
A**	4.2	hectares
Conversion factor	0.00278	
Calculated Peak Discharge, Q	0.43	m^3/s
TOTAL	0.4	m^3/s

Post-development	**Hardsurfaced Areas** est. 90% of total area	**Green Areas** est. 10% of total area	
C	0.85	0.35	unitless
I*	123.3	123.3	mm/hr
A**	3.8	0.4	hectares
Conversion factor	0.00278	0.00278	
Calculated Peak Discharge, Q	1.10	0.05	m^3/s
TOTAL	1.15	m^3/s	

* Taken from the Preliminary Drainage Aug 2007
**est. from Llandovery Site Plan; undated

Percentage change 167%

Global site pre- and post- site runoff using Rational Method for a 1 in 5yr event

WIN TR55

BFR

Llandovery
LOJ Llandovery Condominium Development
St. Ann, Jamaica County,

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (mm)	5-Yr (mm)	10-Yr (mm)	25-Yr (mm)	50-Yr (mm)	100-Yr (mm)	1-Yr (mm)
119.0	166.0	199.0	239.0	269.0	300.0	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

BFR

Llandovery
LOJ Llandovery Condominium Development
St. Ann, Jamaica County,

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cms) (hr)	5-Yr (cms) (hr)	10-Yr (cms) (hr)	25-Yr (cms) (hr)	50-Yr (cms) (hr)	100-Yr (cms) (hr)
SUBAREAS						
FltPoint	6.81	16.83	25.30	36.43	45.29	54.72
	12.83	12.83	12.76	12.77	12.72	12.71
REACHES						
OUTLET	6.81	16.83	25.30	36.43	45.29	54.72

BFR

Llandovery
LOJ Llandovery Condominium Development
St. Ann, Jamaica County,

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (km²)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Descriptio
FltPoint	3.00	1.360	57	Outlet	

Total Area: 3 (km²)

```
BFR                              Llandovery
                    LOJ Llandovery Condominium Development
                           St. Ann, Jamaica County,

                    Sub-Area Time of Concentration Details


 Sub-Area      Flow             Mannings's    End      Wetted                 Travel
Identifier/   Length    Slope       n         Area    Perimeter   Velocity     Time
                (m)     (m/m)                (sq m)      (m)      (m/sec)      (hr)
--------------------------------------------------------------------------------
FltPoint
  User-provided                                                                1.360

                                                  Time of Concentration        1.360
                                                                            ========
```

```
BFR                              Llandovery
                    LOJ Llandovery Condominium Development
                           St. Ann, Jamaica County,

                  Sub-Area Land Use and Curve Number Details


 Sub-Area                                          Hydrologic   Sub-Area    Curve
Identifier             Land Use                      Soil         Area      Number
                                                     Group        (km²)
------------------------------------------------------------------------------
FltPoint  CN directly entered by user                  -            3         57

          Total Area / Weighted Curve Number                          3         57
                                                                      =         ==
```

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APPENDIX VII

ENVIRONMENTAL CHEMISTRY

Tables showing weather and wind data available for the Llandovery area (as close as possible) obtained from the Meteorological Division

Daily Meteorological Observation at Discovery Bay Marine Lab.

May 2007	RAIN	TEMPERATURE(°C)						RELATIVE		VAPOUR	
DATE	FALL			0800EST		1400EST		PRESSURE (hPa)		PRESSURE (hPa)	
	(mm)	Max	Min	Dry	Wet	0800E ST	1400EST	1400EST	1400EST	0800EST	1400EST
1		31.4	24.5	28.0	25.0	29.6	29.6	78	78	29.6	29.6
2		29.8	23.5	28.5	25.2	29.8	29.8	77	80	29.8	29.8
3		30.3	23.5	27.6	24.4	28.4	30.6	77	79	28.4	30.6
4		30.0	23.0	27.6	24.5	28.6	30.6	77	79	28.6	30.6
5		31.2	23.5	28.0	25.0	29.6	28.9	78	72	29.6	28.9
6		31.0	23.5	28.0	24.5	28.4	28.9	75	72	28.4	28.9
7		31.0	23.8	28.6	24.1	26.9	27.2	69	71	26.9	27.2
8		31.2	23.5	28.3	24.1	27.2	28.3	71	67	27.2	28.3
9		31.4	23.6	29.0	24.6	27.9	30.9	70	73	27.9	30.9
10	8.4	32.0	23.7	27.8	24.5	28.5	29.6	76	70	28.5	29.6
11		31.6	24.0	28.4	25.3	30.1	26.4	78	66	30.1	26.4
12	0.5	30.5	24.5	29.0	25.5	30.2	31.2	75	76	30.2	31.2
13		31.5	24.0	28.6	25.0	29.2	30.9	75	81	29.2	30.9
14		31.7	23.0	27.2	24.0	27.7	29.2	77	75	27.7	29.2
15	9.0	29.5	23.5	28.0	25.0	29.6	28.2	78	84	29.6	28.2
16	15.2	30.6	23.5	28.0	25.5	30.9	28.9	82	72	30.9	28.9
17		30.0	24.2	26.5	25.1	30.9	28.3	89	67	30.9	28.3
18	1.0	32.5	25.0	27.0	25.2	30.8	29.3	86	75	30.8	29.3
19	1.0	31.0	24.0	27.5	24.5	28.7	28.4	78	75	28.7	28.4
20	17.0	30.0	22.5	27.0	25.5	31.6	30.3	89	85	31.6	30.3
21	12.1	30.0	24.0	26.0	24.5	29.7	31.2	88	76	29.7	31.2
22		30.2	23.5	28.0	24.0	27.1	28.9	72	72	27.1	28.9
23		30.0	24.0	29.0	25.0	28.9	28.9	72	72	28.9	28.9
24	83.8	29.0	22.2	27.3	24.6	29.1	29.6	80	78	29.1	29.6
25	2.0	29.3	23.5	28.2	24.2	27.5	28.7	72	78	27.5	28.7
26	39.2	30.4	23.0	27.5	25.0	30.0	26.4	82	81	30.0	26.4
27	4.5	30.0	23.0	25.5	24.0	28.8	30.1	88	92	28.8	30.1
28	13.8	29.3	23.0	27.0	24.5	29.0	29.3	81	84	29.0	29.3
29	23.4	29.0	22.8	26.0	25.0	31.0	31.0	92	92	31.0	31.0
30	1.2	29.5	23.5	28.0	25.0	29.6	30.7	78	85	29.6	30.7
31	11.2	29.8	23.6	27.5	24.6	29.0	31.2	79	76	29.0	31.2
Total	243.3	944.7	730.4	858.6	766.9	904.7	911.7	2440	2381	904.7	911.7
Mean	15.2	30.5	23.6	27.7	24.7	29.2	29.4	79	77	29.2	29.4

June 2007 DATE	RAIN FALL (mm)	TEMPERATURE(°C) Max	Min	0800EST Dry	Wet	1400EST 0800EST	1400EST	RELATIVE PRESSURE (hPa) 1400EST	1400EST	VAPOUR PRESSURE (hPa) 0800EST	1400EST
1	1.3	31.4	23.5	25.5	25.0	26.8	25.0	96	86	31.4	30.5
2	9.5	30.0	24.5	27.0	25.0	27.0	25.0	85	85	30.3	30.3
3	0.1	31.0	23.5	27.5	25.5	29.0	26.5	85	82	31.3	32.9
4		32.0	24.5	29.0	26.0	30.0	27.0	79	79	31.6	33.6
5		33.0	24.5	29.5	26.0	30.4	27.2	76	78	31.2	33.9
6		33.4	24.4	28.5	24.8	31.0	25.5	74	64	28.8	28.9
7		32.9	24.0	28.6	25.7	30.0	26.0	79	73	31.0	30.9
8	2.0	31.5	24.5	28.0	26.0	30.5	25.0	85	64	32.3	27.9
9		32.0	24.0	29.0	25.5	29.7	25.5	75	71	30.2	29.8
10		29.5	23.2	26.2	24.3	27.8	25.0	85	80	29.1	29.8
11	1.2	31.6	23.0	28.0	24.5	27.1	24.5	75	81	28.4	29.0
12	16.6	31.3	22.8	27.0	25.5	29.5	27.0	89	82	31.6	34.0
13	5.1	30.7	22.6	27.0	24.7	29.5	26.0	83	76	29.6	31.2
14		31.5	23.5	28.1	24.6	30.8	27.0	75	74	28.5	33.1
15		32.5	24.5	29.5	26.0	31.0	27.5	76	76	31.2	34.3
16		33.9	25.5	30.0	25.5	31.0	27.3	70	75	29.6	33.8
17		33.0	24.5	29.0	25.5	30.5	25.5	75	67	30.2	29.2
18		32.5	25.0	29.5	26.0	30.5	26.5	76	73	31.2	31.9
19		32.8	24.2	29.3	25.5	30.7	27.5	74	78	30.0	34.5
20		33.5	23.7	28.0	25.3	31.0	26.0	80	67	30.4	30.2
21		33.0	25.5	29.0	26.0	29.9	27.0	79	80	31.6	33.7
22		33.5	24.8	30.0	25.1	31.0	27.0	67	73	28.5	32.9
23		33.9	24.6	30.0	25.0	31.7	26.5	67	66	28.3	31.1
24		33.5	25.0	30.4	26.0	31.3	27.0	70	72	30.6	32.7
25	6.0	32.1	26.0	29.1	26.0	29.0	26.0	78	79	31.5	31.6
26		32.7	25.0	28.8	25.0	31.3	26.8	73	70	29.1	32.2
27	1.2	32.0	24.5	29.5	25.0	29.6	26.5	69	78	28.6	32.5
28	8.2	31.6	24.0	29.2	25.5	29.5	26.2	74	77	30.1	31.8
29		33.1	24.5	29.5	24.5	30.6	26.5	66	72	27.3	31.8
30	2.5	33.4	23.5	28.9	25.0	30.5	26.5	73	73	29.0	31.9
31										6.1	6.1
Total	53.7	968.8	727.3	858.6	760.0	898.2	788.5	2309	2253	908.6	957.7
Mean	4.9	32.3	24.2	28.6	25.3	29.9	26.3	77	75	29.3	30.9

STATION: Norman Manley Int'l Airport
MONTH:MAY YEAR: 2007

HOUR: 1:00 am					HOUR: 1:00 pm		
DATE	WIND		Km/Hr		WIND		Km/Hr
1	35	03	06		14	13	24
2	32	03	06		14	16	30
3	30	04	07		13	18	33
4	50	05	09		14	16	30
5	36	05	09		14	14	26
6	40	02	04		14	13	24
7	33	04	07		17	09	17
8	29	02	04		15	10	19
9	36	05	09		13	14	26
10	13	16	30		15	13	24
11	30	05	09		14	17	31
12	30	05	09		12	16	30
13	29	02	04		14	17	31
14	35	03	06		13	18	33
15	40	03	06		14	18	33
16	12	12	22		14	20	37
17	13	10	19		14	17	31
18	11	09	17		15	15	28
19	14	10	19		14	13	24
20	11	05	09		15	14	26
21	15	10	19		14	17	31
22	13	08	15		15	16	30
23	20	02	04		14	11	20
24	10	03	06		14	10	19
25	00	00	00		16	15	28
26	00	00	00		11	15	28
27	36	07	13		11	14	26
28	35	03	06		25	10	19
29	33	03	06		25	12	22
30	34	04	07		25	15	28
31	06	01	02		12	13	24
Total	761	154	285.21		464	449	831.55
Mean	25	5	9		15	14	27
Maximum		16	30		25	20	37
Minimum		0	0		11	9	17

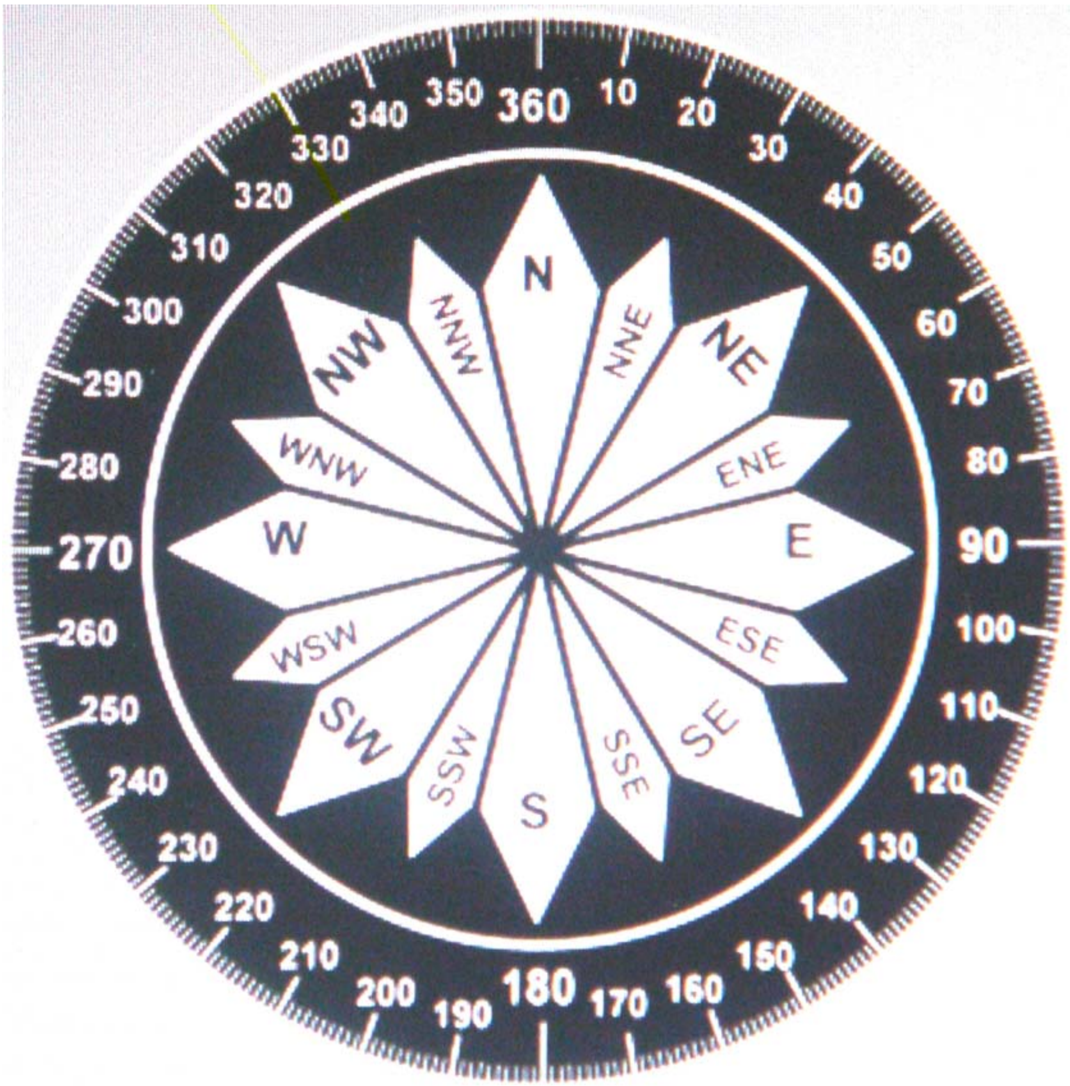

Illustration of a Compass Rose used in the interpretation of wind data.

APPENDIX VIII

PROJECT PERSONNEL

The following persons were involved in the study:

Donovan Rose *M.Sc*. - Project Coordinator, Impact Assessment
Peter Gayle *B.Sc.* - Ecology
Paul Carroll *M.Sc*. - Environmental Chemistry
Allison Richards *M.Sc*. - Socio- Economics
Brian Richardson *M.Sc.* - Hydrogeology
Pierre Diaz *B.Sc.* - Oceanography/Coastal Dynamics
Michelle McNaught *B.Sc.* - Project Research Assistant

Sub Contractor - Smith Warner International Ltd.

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[i] Synopsis of the Geology of Jamaica, Bulletin No. 4, Geol. Sur. Dept., JA, 1962
[ii] http://www.oas.org/CDMP/document/seismap/jamaica.htm, accessed April 27, 2007
[iii] CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Jamaica is a signatory to CITES as of July 22, 1997 (http://www.cites.org/index.html).