Report

Environmental Impact Assessment

Highway 2000: Phase 1B
Sandy Bay to Williamsfield
Km: 33+000 to 71+500

Submitted to:

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Introduction

The Highway 2000 Project (H2K) one of the Government of Jamaica's landmark Millennium Projects began in 2001, when the Prime Minister of Jamaica announced that Bouygues Travaux Publics of France was selected as the preferred Bidder for Phase I of the project. The first phase of the project was the upgrade of the Old Harbour Bypass, followed by the construction of the Kingston to Bushy Park segment, and then the Portmore Causeway segment. TransJamaican Highway Ltd., a specially created subsidiary of Bouygues Travaux Publics is the developer responsible for implementation of the project. The alignment from Sandy Bay to Williamsfield is currently in the design phase.

This document presents the findings of an Environmental Impact Assessment of the proposed Highway 2000 Phase IB: Sandy Bay to Williamsfield to be developed by TransJamaican Highway Limited. Environmental Solutions Ltd. was contracted by TransJamaican Highway Ltd. to carry out the Environmental Impact Assessment (EIA) as part of the permitting requirements stipulated by the regulatory agency, the National Environment and Planning Agency (NEPA) in respect of the proposed development.

The Alignment

The alignment begins at the western end of the existing tolled section of Old Harbour Bypass, passing through rolling terrain from KM 34 to KM 44, where the alignment crosses the Rio Minho, parallel to and just of where the existing A2 Road crosses the river. The design speed will be 110 kph.

Two Toll Plazas will be constructed, one at May Pen on the ramps of the interchange and one at Four Paths on the main alignment. The alignment continues in a westerly direction and passes just to the south of and parallel to the existing railway line, between KM 51 and KM 57. The alignment continues through hilly terrain and will have a design speed of 90 kph. A vertical gradient of 5.5% is required, between KM 58 and KM 59 to accommodate a change in ground level of almost 100 metres.

The existing Melrose Bypass will be incorporated into the new alignment (as this is a contractual agreement with the Government of Jamaica through the Grantor which is the National Roads Operating and Construction Company (NROCC)). The alignment will continue as a two lane, dual carriageway with a design speed of 90kph. The alignment will cross the railway line, before joining the existing roundabout at Williamsfield.

Twenty-nine (29) crossings have been identified and will be facilitated by overpasses and underpasses. These crossings include gullies, rivers, slip roads, local roads, railway and field connectors.

The project is scheduled to be concluded 34 months after the commencement certificate has been issued. The project will be divided into phases that will be defined by the construction requirements.

Permitting and Legislative Requirements

Under the Environmental Permit and Licence System an applicant for a development is required to complete an application form and Project Information for submission to NEPA. The submission of these forms constitutes the permit application and the permitting process for a project begins. Additionally, the Revised Guidelines for Conducting Environmental Impact Assessments (NEPA, 2005) and the Guide to Conducting Public Consultations (NRCA, 1997) specifies the requirements for the Terms of Reference for the EIA and the public consultation process. The Draft Terms of Reference for this EIA were submitted to NEPA for review by NEPA and its sister agencies.

This EIA report is in response to the requirements of NEPA and the TORs have incorporated the comments from NEPA. Several legislative instruments, standards and policies have been identified as relevant to the project including the Natural Resources Conservation Authority Act, The Quarries control Act, Air Quality Regulations, Noise Standards, The Natural Resources Conservation (Portland Bight Protected Area) Regulations, The National Solid Waste Management Authority Act, and The Land

Acquisition Act. The relevance of the legislation to the developer is given.

Methodology

A multi-disciplinary team of experienced and qualified environmental scientists and professionals was assembled to carry out the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. An iterative approach among the environmental team members and other project professionals was adopted, and was facilitated by fortnightly or weekly team meetings as required. The EIA team worked very closely with the other professional team members.

The team utilized the Charette-style approach to data gathering, analysis, and presentation whereby team members conducted the reconnaissance investigations together to determine the critical elements for analysis and the issues to be highlighted for the design and planning process. Team meetings were held to discuss the progress of investigations and analyses and facilitate integration of data toward an understanding of the systems at work in both the natural and built environment.

Baseline data for the study area was generated using a combination of field studies; aerial observation; analysis of maps, plans, aerial photos; review of reports and background documents; structured interviews and stakeholder meetings; public consultations; and laboratory analyses.

Data was collected and analyzed for the physical, biological and socio-economic aspects of the environment including topography, drainage, hydrogeology, climate and rainfall, water quality and quantity, air quality, noise, flora, fauna, habitats, endangered species, community structure, employment, demographics, traffic projections and public sentiment. Standard scientific methodologies were applied and are supported by references and documentation.

The Existing Environment

Physical Aspects

A definition of the study area was prepared, based on the drainage area of which the project site forms a part. These boundaries were demarcated based on a desktop review of available topographical maps and field reconnaissance along open and traversable access ways. Baseline data collection on the study area was conducted and included climate, hydrology, geology, hydrogeology and topography.

Information on rainfall, groundwater pollution incidents, flooding incidents, mains supply facilities and other critical facilities were reviewed within a 5 km radius of the site.

The highway starts at approximately 270000mE, 1983514mN (UTM) at the western end of Old Harbour Bypass, keeping south and roughly parallel to the existing A2 roadway. The proposed alignment travels to the north of Halse Hall, and crosses the Rio Minho parallel to the existing river crossing. It continues east across Denbigh and then north-westerly toward the existing railway line at around Belle Plain. It then runs parallel to the southern side of the railway until it crosses the railway at Clarendon Park. The highway then traverses hilly terrain of the limestone hills of Berry Dale continuing to the north-west keeping south of Old Porus before crossing the existing A2 roadway, the railway and the Milk River at a single point, just east of Porus. It then continues north-west incorporating the existing Melrose Bypass, and crossing the existing railway and before joining the main road just south of the Williamsfield roundabout at 242970mE, 1996008nN (UTM).

Local climate in the coastal plain is dry to very dry with average yearly precipitation of less than 1200 to 1800 mm. Although this area does not receive as much rainfall as the rest of the island, it still is an area prone to flooding because of the water flowing down the mountains that occupy the central part of the country. Poorly absorbent soils fail to retain any of the rainwater that flows down the gullies or disappears in sinkholes. Thus, despite the relatively low rainfall, where the corridor passes through alluvial plains and interior valleys such as the Rio Minho floodplains, there is high flood potential. From

Scott's Pass area to Williamsfield, the higher altitude affects the mean temperature range, which is 28^{o}C. Recorded rainfall shows an increase in this area, rising to 2100 mm yearly.

Topographically, Sandy Bay and Clarendon Park, is generally flat sloping gently to the south. The route beyond Clarendon Park is typified by rolling limestone hills. The geology is broken into four sections: Sandy Bay to Four Paths, Four Paths to Clarendon Park, Clarendon Park to Porus and Porus to Williamsfield.

Alluvium deposits, which are similar to these soils deposits, are derived from Cretaceous rocks found further north of the site and comprise coarse gravel, sand and clay. The Alluvium deposits generally occupy the ancient and extant, gully channels (Shutes/Webber gully) or river channels (Rio Minho) carved into the limestone. The Alluvium deposits of the Webbers Gully trending southwesterly represent one such fossil channel of the Rio Minho. There are two buried channels incised into the limestone, the deeper one runs in a NNE-SSW path from Jacobs Hut through Content carrying on to the sea at Marcarry Bay. The second lies along a NNW-SSE line just west of the Brazilletto Mountains. These superficial deposits overlie the Miocene Newport Limestone Formation, which is broadly sub-divided into three horizons: lower, middle and upper.

Landslide susceptibility of the upper catchment of the Rio Minho catchment shows areas of significant soil erosion coinciding with high landslide susceptibility zones. Though the study area is several kilometres north of the proposed route it demonstrates that significant soil material is potentially available for mobilization in the mountainous zones of the upper catchment during rainfall events. If mobilized, this sediment load in the Rio Minho will modify the viscosity of its discharge waters resulting in increased hydraulic forces being placed on any structure crossing the Rio Minho downstream.

Southern Clarendon and Manchester are flood prone areas due in large part to its geology and hydrogeology. Several significant flood incidents in the recent past have sensitized the residents including events such as those at Inverness/Shutes Gully (May 20, 1993),

Porus (May/June 2002) and Harmmons (September 2002).

Data obtained from the Flood Registry of the Office of Disaster Preparedness and Emergency Management (ODPEM) shows clearly that historic flooding events are an unfortunate, but pre-existing feature of south Clarendon and Manchester.

Two sets of data were collected to establish baseline air quality along the alignment. Respirable particulate levels obtained were well within the 150 $\mu g/m^3$ 24hr guideline at all twelve (12) stations tested. Total particulates include respirable particulates as well as those particulates above 10 microns in diameter.

Noise levels at all twelve (12) locations were within the perimeter guideline of 75.0 dBA set by NRCA. The Inverness and Four Paths stations are located along busy thoroughfares, which contributed to the increased noise levels in these areas.

Water quality was sampled at four (4) stations. The water quality data showed that pH and phosphate levels were 100% compliant with the NRCA Ambient Fresh Water Standards. The pH levels recorded for the Rio Minho water quality station indicated that the waters are somewhat alkaline.

With the exception of the June 5, 2007 result at the Rio Minho sampling station, all other stations yielded results above the 0.8-1.7 mg/L range. The same trend was observed for the nitrate levels. The Rio Minho water quality station was just in compliance recording 7.5 mg/L on both monitoring events. The elevated nitrate levels may be associated with farming activities for which these interior areas are noted.

The presence of bacterial coliform in surface water is an indication that pathogenic material from animal excreta is present in the water. Coliform levels varied significantly over the two monitoring occasions for the Milk River and Rio Minho stations. The results obtained at the Rock Halt and Spring Grove stations were highly comparable for both

monitoring events. Faecal coliform levels were consistently high at the Spring Grove (2400 MPN/100 ml) station.

Biological Aspects

Most of the study area was highly disturbed and influenced by the various human activities occurring along its length. The vegetation zones were influenced by gradients of elevation, rainfall and disturbance, as well as geology and drainage patterns. More than 170 species were encountered in the surveys, the majority of which were common and widespread. Few endemic species were found in any habitat at this stage.

The following habitats/vegetative categories were identified:

1. **Disturbed dry limestone woodland/ abandoned sisal plantation**

   The study area runs along the northern edge of Harris Savanna, through an area that was once sisal plantation, where the forest was totally cleared and cultivated for many years. Abandoned about 20 years ago, it is regenerating into woodland.

2. **Cane fields and pasture**

   From Harris Savanna to Clarendon Park the route runs across flat, alluvial agricultural land, including sugar cane, mixed agriculture and pasture with housing in subdivisions and along roads. There are also irrigation canals, fish ponds and some seasonally flooded pasture, characterized by the presence of wetland plants such as *Typha domingensis*. These plains are prone to flooding and are also known to retain standing water in shallow depressions for a considerable period after heavy rains. This area has been under intense cultivation for hundreds of years and few remnants of natural or semi-natural vegetation remain.

3. **Rural settlement and cultivation**

   As the elevation increases between Clarendon Park and Williamsfield, the route passes through some forest, then through the Upper Milk River Valley where Scotts Pass and Porus are located. In the past this area probably supported mesic limestone

forest on the hillsides and riparian forest along the valley bottom. However the entire route is very depauperate of species compared to less disturbed areas.

The banks of the upper Milk River are lined with highly disturbed riparian woodland, most of which has been replaced by food and timber forest and crops. Many large fruit trees are distributed through this area. This was probably once a distinct community, but so many trees and other crops have been planted that it is distinguishable from the surrounding area mainly be the size of the trees that grow there.

In Porus the survey corridor cuts though homes and gardens, which include typical fruiting and ornamental plants.

4. Roadside scrub

Above Porus the road corridor takes in and parallels the existing Melrose Bypass, running through 'restored' bauxite lands. The soils are very poor and the vegetation highly disturbed. The verges are characterized by common weedy species.

Seventy nine species of birds were observed or predicted, including eleven endemic species. However no threatened or rare species were observed or predicted.

Several anolis lizards were observed, mainly in the sub-urban gardens and limestone forests. The American Crocodile *Crocodylus acutus* is the only species of special concern in the Portland Bight Protected Area that might be found in the study area.

Portland Bight Protected Area

The Portland Bight Protected Area (PBPA) had been earmarked for special protection under the NRCA Act and was declared as a Protected Area under Section 5 of the Natural Resources Conservation Act (1991) on Earth Day, April 22, 1999. The propose alignment will be just within the northern boundary of the PBPA and will follow the existing railway line for the most part. The highway is not expected to impact on the dry

limestone habitat of the endemic and endangered Jamaican Iguana in Hellshire Hills, the Braziletto Mountains nor the caves at the southern end Portland Ridge which provide a habitat for endemic fauna.

Socio-economic Aspects

Collectively, the communities crossed by the alignment or close to it, define a zone within which immediate and cumulative project impacts will be first experienced. Impacts of the project will permeate well beyond this limited zone, particularly the travel time reduction impacts and the development generation effects.

The project is linear, and traverses two thirds of the length of Clarendon and almost half the length of Manchester as measured along the A1 main road. Four Sections of this corridor have therefore been defined and select issues are dealt with within each. The four areas identified for the socio-economic aspects are Sandy Bay to Rio Minho; Rio Minho to Parish Border; Parish Border to Redberry; and Melrose Hill and Bypass to Williamsfield.

The main issues identified are land use; demography and livelihoods; perception of flooding; attitudes to the project; land acquisition and displacement; transport sector; social rights-of-way; traffic flow and benefits; macro-economic benefits; archaeology and cultural heritage; social services; and public health.

Public Consultation Process

The Public Consultation Process for Phase 1B has included the following components:

1. Individual stakeholder meetings

2. Application of interview instruments to over three hundred (300) persons in twenty (20) communities in the zone of impact

3. Meeting with the GOJ regulatory agency, the National Environment and Planning Agency (NEPA) and presentation to the Technical Review Committee (TRC) of the Natural Resources Conservation Authority (NRCA)

4. Meetings with Government of Jamaica (GOJ) agencies (eg. National Works Agency, National Roads Operating and Construction Company (NROCC))

5. Requests to GOJ agencies for information (eg. Jamaica Bauxite Institute, Forestry Department, Water Resources Authority, Office of Disaster Preparedness and Emergency Management, Jamaica National Heritage Trust)

6. Information sharing with and requests to NGOs, in particular the Caribbean Coastal Area Management Foundation (CCAM) the co-managers of the Portland Bight Protected Area

7. Meetings with Parish Councils (Manchester and Clarendon)

8. Availability of the Terms of Reference for the EIA for public review and comment through distribution of hard copies to the Manchester and Clarendon Parish Libraries and Parish Council offices (Appendix V); posting of the electronic version on the ESL website; submission of the electronic version of the TORs to NEPA for posting on the NEPA website.

9. Public notification and presentation of the project (Advertisement in the Sunday Gleaner on June 24, 2007 and the staging of Public Consultation No. 1 held in May Pen on June 28, 2007)

10. NEPA's request to its sister agencies for review of the Terms of Reference and incorporation of the agencies' comments

11. Private sector companies and stakeholders (e.g. JAMALCO)

A Public Presentation of the Findings of the EIA will also be held and will be conducted according to the NRCA Guidelines for Public Consultations.

Issues Identified

Phase 1B Sandy Bay to Williamsfield will commence at Sandy Bay at the end of the existing Highway 2000 Kingston to Sandy Bay segment. Several issues have been identified in respect of the proposed alignment. These issues have been incorporated into design phase discussion with the developer to ensure that the relevant mitigation measures can be considered for the final stage.

Issues were identified according to the alignment; drainage and flooding; cut and fill and slope stability; air quality; noise; habitat modification; parks and protected area

management; location of toll plazas; access points, crossings and social-rights-of-way; solid waste management (construction spoil and vegetative waste); and land acquisition and relocation.

Positive Impacts

Several positive impacts are expected from the development of Phase 1B for Highway 2000: Sandy Bay to Williamsfield, as proposed. These are:

- ✓ Generation of Employment/Supply of Goods and Services in the Construction Phase
- ✓ Improved Transportation Network
- ✓ Land Use Planning
- ✓ Aesthetics/Scenic Values of the Highway Alignment
- ✓ Improved safety on the roads
- ✓ Good public sentiment

Cumulative Impacts

Cumulative impacts have also been identified as:

- ✓ Increased traffic flow (the new alignment with the highway design speed will significantly reduce travel time; result in increased efficiency of the movement of goods and services from Kingston through to Mandeville; and saving time and money for commuters.)
- ✓ Land use options (the alignment passes through agricultural lands, pasture, scrublands, residential communities and across existing transportation networks. The land use within these areas will be modified by the highway alignment.)
- ✓ Employment (the construction phase for Phase 1B is scheduled for 34 months. Various levels of skilled and unskilled labour will be required during the period as well as the provision of goods and services. The other phases of Highway 2000 have created job opportunities, and this would be continued over the sort to medium term.)

Consideration of Alternatives

The alignment for Phase 1B: Sandy Bay to Williamsfield is the alignment that was presented in the Strategic Environmental Assessment (SEA) (Dessau - Soprin Int., 2000).

Developing the preparation of the Outline Design for the entire Highway alignment 2000, several considerations were given to the alignment. For this section Phase 1B: Sandy Bay to Williamsfield four (4), alternatives were considered for specific areas along the alignment:

1. Rio Minho
2. Four Paths
3. Milk River
4. Porus/Melrose Pen

The preferred alignment from the alternatives presented in the Strategic Environmental Assessment is the alignment considered in this EIA. The exact location of the construction camp has not been determined.

The 'No Action Alternative' looks at the option of not constructing Phase 1B of the highway 2000 alignment. This would break the continuity of the alignment that has been completed from the Portmore Causeway through Bushy Park and to Sandy Bay, and which is now expected to be completed from Sandy Bay to Williamsfield and eventually to Montego Bay.

Potential Negative Impacts and Mitigation Measures

Several potential negative impacts have been identified for the physical, biological and socio-economic aspects of the environment. Mitigation measures have been identified and presented to minimize these negative impacts (See tables following):

Alignment - Potential Impacts and Mitigation Measures		
	Potential Impacts	***Mitigation Measures***
• **Over gullies**	The Highway results in five (5) gully crossings: the Shu Gully (1 and 2), Webbers Gully (1 and 2), and St. Ann's Gully. These are at chainage 34+650; 35+650; 39+200; 39+ 480 and 48+150, respectively.	Drainage structures will be designed to ensure continuous flow thus preventing ponding and flooding. A 100-year return period is recommended for major structures and the overall drainage system has been designed to accommodate flash floods and catastrophic events which characterize the area.
• **Over rivers**	The Highway results in two major river crossings. These are the Rio Minho at chainage 43+850 and the Milk River at chainage 61+250.	As for the gully crossings, the drainage structures will be designed to ensure continuous flow thus preventing ponding and flooding. A 100-year return period is recommended for major structures and the overall drainage system has been designed to accommodate flash floods and catastrophic events, which characterize the area.
• **Over railway lines**	The Highway results in four (4) crossings of the railway line. These are at Content at chainage 46+000; Clarendon Park at 57+500; at Porus at chainage 64+500 and at Williamsfield at chainage 70+400.	In the SEA of 2000, the recommendation was made that the Highway should not result in the sterilization of the railway at any point. These four crossing will maintain the railway alignment as underpasses of the highway.

• **Through existing vegetative stands**	Vegetative stands are all modified vegetation including four types of habitats. These are disturbed Dry Limestone Woodland/ Abondoned Sisal Plantation; Cane Fields and Pasture; Rural Settlement and Cultivation and Roadside Scrub. There are no stands of primary vegetation along the current alignment.	Landscaping could include trees, grasses and shrubs as appropriate in order to maintain airshed purification functions and soil stabilization.
• **Land Acquisition**	Land acquisition for the required acreage is the responsibility of the National Roads Operating and Constructing Company (NROCC).	The land required for the Phase 1B: Sandy Bay to Williamsfield alignment includes privately owned lands that are in residential, commercial and agricultural use, as well as Crown Lands.
• **Existing local roads and access**	Points have been identified where the Highway will cross or intersect with existing local roads. Underpasses and overpasses will facilitate these crossings. Fourteen (14) Local Road crossings have been identified. Three areas have been identified where agricultural field connectors are required.	Underpasses or Overpasses are provided at the following points: ❖ Sandy Bay ❖ Savannah Cross ❖ Hunts Pen ❖ May Pen Interchange ❖ Coates Pen ❖ Content ❖ Denbigh ❖ Four Paths ❖ Belle Plain ❖ Ludford Rocks ❖ Berry Dale ❖ Spring Grove ❖ Red Berry

		❖ Porus ❖ Trinity Field connectors are crossings designed to maintain the operation of existing agricultural facilities, particularly as relates to the movement of heavy machinery. The field connectors prevent the highway from dividing the property in terms of access and operations. Three field connectors will be provided at: ❖ Sheckles Pasture (45+100) ❖ Ebony Pen (48+700) ❖ Clarendon Park (59+950)
• **Archaeological and cultural resources**	The JNHT had identified areas of potential impact during the SEA (Dessau Soprin International, 2000), within a 1km wide corridor.	1. The Jamaica National Heritage Trust (JNHT) has already been contacted and made aware of the highway alignment. 2. The JNHT has been requested to indicate if there are any areas that are included on their Sites and Monuments List 3. The JNHT should be allowed to conduct a Watching Brief during the site preparation and construction phases, and to perform Rescue Archaeology if appropriate.

		4. The following areas are recommended for particular attention: • Free People • Halse Hall • Belle Plain
Toll Plazas	The Toll Plaza proposed at May Pen will include 8 lanes and 2 small buildings. At Four Paths the Toll Plaza will also be 8 lanes.	The May Pen Interchange will include eastbound and westbound entry and exit slips. At Four Paths there will be a Toll Plaza only with no entry points.

Natural Environment – Potential Impacts and Mitigation Measures		
Environmental Aspect	***Potential Impacts***	***Mitigation Measures***
Hydrology and Drainage	Impacts on hydrology and drainage are both direct and indirect. They relate to all phases of the development and to high volume events (major drainage) as well as to drainage requirements for run-off from more frequent events (minor drainage). Direct impacts involve : ➢ Storm channel outlets ➢ Ponding ➢ Siltation ➢ Pollution Indirect impacts involve: ➢ Pollution ***Site Preparation and Construction Impact***	1. Surface drainage design considers both the major and minor systems. The major system is the route followed when the minor system is exceeded. 2. The engineering design has used the 100-yr. event as design criterion for major drainage, including bridge openings, to accommodate flash floods and catastrophic events, which typify the area. 3. Storm water runoff (more frequent events) will be handled by curbs, channels, catch basin inlets, storm sewer\s, minor swales and roadside ditches. These have been designed to prevent ponding and flooding of the highway and adjacent properties. The guiding principles for the design of the highway in relation to drainage are: ➢ All bridges and culverts over 5.0 m in total opening width are designed to pass the 100 year storm with a minimum freeboard of 1.0 m between lowest point on bridge and high water

Groundwater	Groundwater flows can be significant and charged aquifers can result in rise in groundwater levels which can undermine the structural integrity of the highway.	level. ➢ Culverts under 5.0 m opening width are designed to pass 25-yr storm with minimum 600 mm freeboard between the edge of the road and high water level during 100-yr storm event.
Surface Water	Existing surface water, pathways (gullies, dry gullies and rivers) must be left unobstructed to allow for continuous flow of water and reduce the risk of flooding. The current design indicates fill areas on some surface water pathways (eg. Clarendon Park, Shu Gully, McGilchrist Pen).	➢ Scour protection will be provided where necessary. ➢ Highway profiles must be consistent with major drainage to enable free flow. The gullies that currently run under the road must be maintained, and design must ensure that there is no blockage of the existing channels. If these principles are adhered to, the potential for flooding, as a consequence of the highway construction, should be negligible. ➢ The engineering design should include under drains to allow free passage of water in the areas specified. ➢ It is recommended that all surface drainage features be kept unobstructed and not filled. Structures should be provided such as box

		culverts to ensure that these drainage pathways are kept. ***Operation Phase*** During the operation phase the mitigation measures incorporated in the engineering design should prevent problems of ponding on the Highway. Scheduled inspections and maintenance of drainage channels is critical.

Hazard Vulnerability	Impacts during site preparation or construction relate to the effect of flood events and storm-water run-off on the project. Flooding is a major natural hazard to be encountered by construction of the highway, and the major impact is derived from the effect of extreme runoff on the site and the low-lying nature of the topography, and flood history along several sections of the proposed alignment.	1. Design of bridges, culverts and drainage channels have taken account of the 100-year event and the channels are therefore expected to handle the flood flows. 2. Site preparation and construction schedules should take account of the traditional rainy season between May and October, and of the hurricane season from June to November, during which tropical systems sometimes cause flood rains. Extraordinary tropical systems have also caused problems of supersaturated soils, so that schedules should factor this eventuality.
Air Quality	***Site Preparation and Construction Phase*** Analysis of road construction activities indicates that the movement of trucks and heavy-duty equipment to and from the project area will be responsible for the greatest amount of dust emissions. Construction activities will also result in the removal of vegetation that will expose and loosen soil which can become airborne with medium to strong winds. This would add fugitive dust to the area, which is already dust prone because of previous land clearance. The transport of aggregate for road and drainage culvert construction will also contribute to the fugitive dust levels.	1. Watering of un-vegetated areas and stripped road surfaces along which construction vehicles and trucks travel will control dust emissions by up to 70%. A full-time watering truck should be maintained on site for watering road surfaces as needed to minimize fugitive dust emissions. Over-saturated conditions, which would cause outgoing trucks to track mud onto public streets, should be avoided. Watering would not be necessary on days when rainfall

	Construction vehicles will emit air contaminants such as nitrogen and sulphur oxides as well as particulates. ***Operation Phase*** The main air impacts during the operational phase will be an increase in the concentration of vehicular emissions as a consequence of the expected increased vehicular throughput. There are currently no vehicular emissions standards for Jamaica. However, improved traffic movement is expected to reduce idling time and therefore the level of carbon monoxide (CO) emissions.	exceeds 2.5 mm (0.01 inch). 2. Stock piling of earth materials for construction should be carried out within temporarily constructed enclosures to limit fugitive dust. Vehicles transporting earth materials should be covered en route. Mixing equipment should be sealed properly and vibrating equipment should be equipped with dust removing devices. Stockpiles of fines should be covered on windy days. 3. A monitoring programme for dust is recommended to assess the effectiveness of control measures in meeting ambient air quality standards. 4. Provide dust masks to operators in order to protect them from dust impacts.

Noise	***Site Preparation and Construction Phase*** The noise level is expected to increase during site preparation and construction with the use of heavy machinery and earth moving equipment. Existing noise levels are not significant along the rural areas and residential communities ***Operation Phase*** The toll plazas which will have 8 booths are expected to generate an increase in noise in this area.	***Site Preparation and Construction Phase*** 1. Noise impacting the public from construction activities can be a major impact although only for the short-term. Noise levels can be minimized by limiting noisy construction activities to the hours between 7 am and 6 pm, where construction is in close proximity to residential areas. 2. Service construction machinery and vehicles at regular intervals in order to keep noise to a minimum. ***Operation Phase*** 1. The toll plazas will be sited near May Pen and Four Paths which includes residential communities nearby.
Surface Water Quality	***Construction Phase*** The water quality data obtained from the present survey indicates some nutrient loading probably from animals using the two main rivers – the Rio Minho and the Milk River. Generally the water quality in these rivers is quite good.	***Construction Phase*** 1. Measures to control or limit sedimentation of streams and gullies during the construction phase will include storage of earth materials within containment berms

	The major water quality impacts likely due to the proposed road/bridge construction work are: • Increased suspended solid loading (sediments and garbage) to the surface waters (from earth moving activities and terrestrial run-off) • Increased bacterial levels due to indiscriminate disposal of human waste (particularly construction camp activities). • Oil and grease from heavy equipment and trucks. ***Operation Phase*** Of the likely impacts, the most important relate to contaminated storm drainage.	2. The deployment of silt screens as required at gullies and streams during the construction of bridges and culverts. 3. The deployment of sediment traps during filling in the coastal environment. 4. The engineering design has incorporated measures for slope stabilization and reinforcement at the approach to bridges. This serves to prevent slope failure, which not only undermines the bridge approach but also results in the wash down of soil into streams and gullies. 5. The proper removal and disposal of construction spoil, so as not to block drains and gullies. 6. Take all necessary measures to prevent refuse (solid waste) and wastewater produced in construction camps from entering into drains and water bodies. 7. Provision of portable chemical toilets at work sites, with appropriate sanitary arrangements for disposal of the contents.

Restoration and Rehabilitation	Site Construction and preparation activities as well as establishment of the construction camp and associated facilities can result in scaring of the landscape and improper disposal of construction spoil.	1. All construction spoil should be properly disposed of at a site approved by the National Solid Waste Management Authority. 2. Scaring of the landscape must be avoided by landscaping of the Highway where appropriate and Confirming construction works within the right of Way. 3. A post permit condition should include the preparation of guidelines for avoiding adverse impacts due to usage of the corridor, restoration and rehabilitation of works site and utilizing environmental attributes within the development.

Earth Materials Sourcing and Transportation	Site construction activites will require the provision of large quantities of earth materials, of a specific grade. Supply of material from unapproved or illegal sources can result in scarring of the landscape, deleterious modification of the topography, alter drainage patterns and increase levels of fugitive dust.	1. Any quarries utilized for supply of earth materials should be approved and licensed entities. 2. As far as possible material cut should be used as fill. 3. Trucks transporting materials should be covered and adhere to maximum laden weights.
Vegetation	***Site Preparation and Construction Phase*** The vegetation identified along the alignment comprises, dry limestone forest, mid-level moist forest, riparian woodlands, cultivated fields, routhg pastures and suburban settlement (including small cultivated plots). No significant rare, threatened, endangered or endemic species are expected to occur in these areas. These areas provide green space, which assists in the purification of the air shed by removal of carbon dioxide and release of oxygen. Additionally, the areas provide host plants for species of insects, reptiles, amphibians, butterflies and birds. Site preparation and construction activities will remove several acres of these vegetative stands removing the airshed purification function and some habitat. Removal of the vegetation, at areas along the Dyke Road, will also expose top-soil which can be washed into streams and	1. Vegetation will have to be cleared to provide land for the proposed road works. Clearing of the vegetative stands should be carried out on a phased basis to reduce the amount of exposed top soil that can be washed down in rainfall events. 2. To continue to provide airshed functions of purification it is recommended that verges be replanted with trees and shrubs where appropriate. 3. Additionally, tree planting should be carried out to form shelter belts, windbreaks, noise buffers, slope stabilization bands, erosion control and for aesthetic appeal. 4. Selection of plants for landscaping should consider the following: habitat suitability, trees of national

	gullies during rainfall events.	interest, flowering trees and shrubs. ***Operation Phase*** 1. Vegetation planted for landscaping buffers and for aesthetic appeal should be maintained, and a maintenance programme should be established and implemented.

Fauna	***Site Preparation and Construction*** Birds located in the modified vegetative communities will relocate when their habitat is removed. Species along the proposed alignment such as reptiles are also highly mobile and should also relocate to adjacent similar habitats. Insects, snails and other groups with low mobility may suffer from loss of specimens, as a result of heavy machinery and the use of earth moving equipment. ***Operation Phase*** Once the highway is completed there is always the risk of increased access to rural areas resulting in poaching of wildlife	1. Landscaping could result in the replacement of some habitat for selected species. 2. Birds will relocate to adjacent suitable habitats. 3. Encroachment by squatters could result in degradation of areas. As a Toll Road, the highway will be limited access and will be enclosed by fencing thereby reducing the possibility of encroachment from the road way. 4. Plant and animal communities immediately outside the project corridor should not be at risk.

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
Land-use and Zoning	***Site Preparation and Construction Phases*** Relocation of residential communities will be required. ***Operation Phase*** During the operation phase the Highway is not expected to have any additional significant negative impacts on aspects of land use and zoning. The impacts identified in the construction phase will obtain for the operation of the highway.	***Site Preparation and Construction Phases*** 1. The relocation of communities, commercial and/or agricultural enterprises is the responsibility of NROCC.
Traffic, Transportation and Access Roads	***Site Preparation and Construction Phase*** Site preparation and construction activities will impinge on traffic flow in the areas where the Highway connects or crosses existing roads.	***Site Preparation and Construction Phase*** 1. Scheduling of construction work should seek to minimise disruption to traffic flow and allow for the movement of material and heavy equipment. 2. Arrangements for parking and storage of material should be made as far off-site as is feasible for efficient operations.

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
		3. Discussions should be held early with relevant stakeholders to determine their needs and requirements and to advise them of the construction schedule. 4. Public notices by the print and electronic media should also be posted in order to make the general public aware of the construction schedule and to provide construction updates. 5. Properly trained flag persons and road side signs should also alleviate discomfort to commuters.
	Site Preparation and Construction Phase The siting of the construction camp may have potential negative impacts related to traffic, transportation and access.	***Site Preparation and Construction Phase*** 1. The location of the construction site camp has not yet been finalized. 2. Proper signage and flag persons will be required to provide traffic management into and out of

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
		the camp site. 3. Public notification of the camp site location will be required . 4. Schedule of movement of heavy vehicles should be prepared and made available to the public.
	Operation Phase The operational phase of the highway will see the application of a toll. Application of a toll will be a minor, irreversible, long-term impact.	The previous section of Highway 2000, Kingston to Sandy Bay and Portmore Causeway currently operate with a toll.

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
Relocation/ Resettlement	The EIA Report has identified several communities and structures that will be directly impacted by the Highway Alignment. These include business enterprises, agricultural entities, private homeowners, informal residential areas.	1. Identification of all land acquisition and relocation requirements is the responsibility of the Grantor, the Government Agency, NROCC. 2. NROCC hasbegun the process of identifying lands to be acquired and persons to be relocated. 3. The Concession Agreement requires that the GOJ, represented by NROCC, own the lands with the ROW. NROCC will acquire the lands in accordance with the schedule set out in the concession agreement. 4. The GOJ does not have a Resettlement Plan. NROCC has indicated that it will not be involved in any relocation exercise (Appendix VI).

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
Business Enterprises	***Site Preparation and Construction Phase*** Some businesses have the potential to be affected by the Highway construction. These include: ❖ Clarendon Park Fish Farms ❖ Agricultural lands ***Operation Phase*** Impacts during the operation phase will include increased levels of traffic noise.	***Site Preparation and Construction Phase*** 1. Discussions have been held with relevant stakeholders. 2. Further discussions are to be held with NROCC to determine land acquisition plans. ***Operation Phase*** Mitigation measures as presented for noise should apply.

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
Social Rights –of- way	Several areas were identified for paths and tracks currently used by locals and communities. The 29 crossings provided in the engineering design have pedestrian access and generally meet the needs defined by the Social Rights of Way. However, there are three (3) areas (km 35+500; 40+000 and 60+000 to 61+000) where distances seem far.	➢ It is recommended that community consultations be on going and should include Stakeholders in these three (3) areas, the Social Development Commission and Community Based Organizations.

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
Employment	**Site Preparation and Construction Phase** Employment opportunities will be created during the site preparation and construction phases. This will mostly be unskilled labour for the duration of the construction activities. Additionally, economic opportunities will involve the sourcing of construction material and linkages created with local and regional suppliers and industries.	**Site Preparation and Construction Phase** 1. Casual labour will find employment and this is expected to be a positive impact for surrounding communities. 3. Workers should be briefed on traffic management, solid and liquid waste disposal, dust management, parking, idling of equipment and oil spill control. 4. Opportunities should include contractors and labourers from the parishes of Manchester and Clarendon.
Solid Waste Management	***Site Preparation and Construction Phase*** Solid waste generated from the site preparation and construction activities will include construction debris, vegetation, solid waste from beaches, the demolished bridge and solid waste generated from the construction camp.	***Site Preparation and Construction Phase*** 1. Construction sites generate considerable waste and provision must be made for suitable separation and storage of waste in designated and labelled areas on the site and site camp. 2. Collection of waste by certified contractors and

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
		disposal at an approved site, as recommended and approved by the National Solid Waste Management Authority. 3. Any hazardous waste should be separated and stored in areas clearly designated and labeled, for future entombing and disposal as directed by the National Solid Waste Management Authority. 4. Worker training should include instructions on how to dispose of food and drink containers. 5. Construction camps and work areas along the proposed alignment must be adequately equipped with portable chemical toilets. 6. Portable chemical toilets must be provided, maintained and removed by a certified contractor.
Proposed Developments	There are no major proposed developments along the Highway alignment. However, the NHDC has indicated a proposed development at Unity Farms/ Mid Island	1. Discussions should be held with the NHDC to determine the exact location of the proposed development and status of the project approvals.

Socio-economic – Potential Impacts and Mitigation Measures		
Environmental Aspect	**Potential Impacts**	**Mitigation Measures**
	Estates that may be on the alignment. The exact location and status of approvals could not be ascertained.	

Public Health and Safety	***Site Preparation and Construction Phase*** Increased levels of fugitive dust and construction noise are also public health issues as the air quality is already deteriorated in this region and noise and activity levels are high. The risk of forest fires affecting visibility on the highway is expected to be minimal. Animals crossing the Highway Alignment can pose a safety risk for commuters.	***Mitigation Measures*** 1. To minimise risk to the public the construction activities which will directly affect the movement of traffic and pedestrians, should be properly scheduled and standard construction techniques for sign–posting and flagging should be adhered to. 2. Dust control by wetting is essential to prevent aggravation of the already poor air quality. 3. Unnecessary idling of construction related vehicles should be discouraged. 4. Proper sign posting of speed limits and entrances and exits. 5. The Highway Developer/Operator should contact the nearest fire department and report any fires that may affect visibility to motorists. 6. The entire highway corridor will be fenced on both the Southern and Northern perimeters and this will prevent stray animals from crossing the right of way.

	Operation Phase Improper use of Highway ramps, exits and interchanges can result in traffic accidents. Additionally, malfunctions along the Highway such as inoperable tollbooths or structural changes in the road surface could result in project related accidents.	***Operation Phase*** 1. An extensive Highway Public Education Programme should be designed and implemented to make commuters aware of proper procedures on the Highway. This should include aspects related to tolling, lane changing, use of ramps, and access and exits. Enforcement of Highway legislation and procedures will be required. 2. The risk of structural malfunction is minimal as the engineering design has considered the highest standards and drawings will have to be approved by the relevant agencies. The highway is equipped with telephone services and offices at Toll Plazas for emergency response. In extreme events and large accidents Emergency Response Units (such as police, fire and ambulance) will be able to utilize the highway to get to the emergency.

Pollution Prevention	It is possible that during the construction and/or the operation phase spill of hazardous materials (eg. Petroleum products, paints, explosives) could occur, although not the fault of the developer. These materials could result in the contamination of adjacent water bodies or water supply systems (domestic irrigation). Sites currently contaminated could be disturbed by project related activities.	1. A detailed Emergency Response Plan (ERP) should be prepared as a post permit condition, to include prevention of contamination of water bodies, irrigation supply and domestic water supply, if these are disrupted as a direct result of the project. 2. No contaminated sites such as hazardous waste disposal sites have been identified along the alignment.
Risk Assessment	With respect to man-made/technological hazards, and malfunctions, accidents can occur as a result of construction activities directly on-site and as a result of activities off-site, such as transportation of equipment and materials. Health and safety aspects must be considered related to workers during the Construction Phase and the motoring public during the Operation Phase.	1. A safety management plan including traffic handling and equipment management procedures should be developed as part of the construction scheduling. 2. A Public Education Programme specifically on highway use should be developed for the general public. 3. The Explicit Safety Review (BYPTJ, 2007c, Appendix I) indicates those aspects of the Design for Approval which may give rise to potential safety or operational hazards. These include aspects such as cross sections, drainage, landscaping, Lay-Bys, visibility, vertical alignment and junctions. BYTPJ (2007c) concludes that

	Operation Phase During the operation phase the mitigation measures incorporated in the engineering design should prevent problems associated with hazards. Safety is a major consideration and it is strongly recommended that a targeted driver education campaign be mounted to ensure acceptable driving practices, and to meet the requirements of the toll road.	the Design for Approval has been checked and the Highway and related works have been designed in accordance with good safety practices.
Archaeological and Cultural heritage	No direct heritage threats were reported during the preparation of the EIA report.	Although no direct heritage threats were discovered it is recommended that the JNHT be allowed to perform a watching brief during site preparation activities, if they so require. The following areas are recommended: 1. The alignment as it crosses north of the existing Halse Hall property in May Pen which was once much more extensive sugar plantation, than its current boundaries or land use would suggests. 2. Curatoe Hill just north of the alignment as it passes through south of the community of Curatoe, is reported to have been a Taino settlement.

1. Introduction

The Highway 2000 Project (H2K) one of the Government of Jamaica's landmark Millennium Projects began in 2001, when the Prime Minister of Jamaica announced that Bouygues Travaux Publics of France was selected as the preferred Bidder for Phase I of the project. The first phase of the project was the upgrade of the Old Harbour Bypass, followed by the construction of the Kingston to Bushy Park segment, and then the Portmore Causeway segment. Transjamaican Highway Ltd., a specially created subsidiary of Bouygues Travaux Publics is the developer responsible for implementation of the project. The alignment form Sandy Bay to Williamsfield is currently in the design phase.

This document presents the findings of an Environmental Impact Assessment of the proposed Highway 2000 Phase IB: Sandy Bay to Williamsfield (chainage 33 + 000 to 71 + 400) to be developed by TransJamaican Highway Limited. Environmental Solutions Ltd. was contracted by TransJamaican Highway Ltd. to carry out the Environmental Impact Assessment (EIA) as part of the permitting requirements stipulated by the regulatory agency, the National Environment and Planning Agency (NEPA) in respect of the proposed development.

1.1. The Alignment, Crossings and Toll Plaza

1.1.1. The Alignment

The Sandy Bay to Williamsfield segment of Highway 2000 requires the construction of a two lane, dual carriage, with a design speed of between 90 to 110 kph. The alignment is shown in Figure 1.0. Information on the alignment is provided by Bouygues Travaux Publics Jamaica Branch, 2007a and 2007b and is given in detail in Appendix I, with excerpts as below:

Sandy Bay to Four Paths (km 33+000 to 50+000)

The alignment begins at the western end of the existing tolled section of Old Harbour Bypass, passing through rolling terrain from KM 34 to KM 44, where the alignment crosses the Rio Minho, parallel to and just of where the existing A2 Road crosses the river.

An interchange will be constructed to the north of Halse Hall, at KM 41 to provide access to May Pen by means of the existing B-3 Road. Tollbooths will be installed on the entry and the exit slip roads for both the east and west bound mainline carriageways.

West of the Rio Minho, the alignment, will be constructed approximately two metres above existing ground for drainage purposes, passing through sugarcane fields, crossing several gullies and has grade separations where it will cross local roads, field connectors and the existing railway (KM46).

At KM 50, the alignment passes under the existing A2 Road at Four Paths.

Four Paths to Clarendon Park (KM 50+000 to KM 58+ 000)

A toll plaza building together with tollbooths will be provided just north of the existing A2 road at Four Paths. There will be no junction here with the existing A2 road.

After the toll plaza, the alignment continues in a westerly direction and passes just to the south of and parallel to the existing railway line, between KM 51 and KM 57. In this area, there are two crossings of existing roads and the alignment will impact on several properties as well as an existing irrigation aqueduct.

Clarendon Park to Porus (KM 58+ 000 to KM 66+500)

The alignment continues through hilly terrain .A vertical gradient of 5.5% is required, between KM 58 and KM 59 to accommodate a change in ground level of almost 100 metres.

Between KM 59 and KM 66.5, the alignment passes through rolling terrain and crosses the existing A2 road, Milk River and the railway at a single location, just east of Porus.

There will be an Interchange at Milk River crossing at 61 + 250.

Porus to Williamsfield/Melrose Bypass (km 66+500 to km 71+400)

In accordance with the Illustrative Solution prepared by the Grantor (NROCC), the existing Melrose Bypass has been incorporated into the new alignment.

The alignment will continue as a two lane, dual carriageway with a design speed of 90kph. In addition, between KM 66 and KM 70, the existing westbound carriageway will be extended to provide a 3-lane west bound carriageway; the eastbound carriageway will remain as 2-lanes.

The alignment will cross the existing railway at KM 71.4, before joining the existing roundabout at Williamsfield.

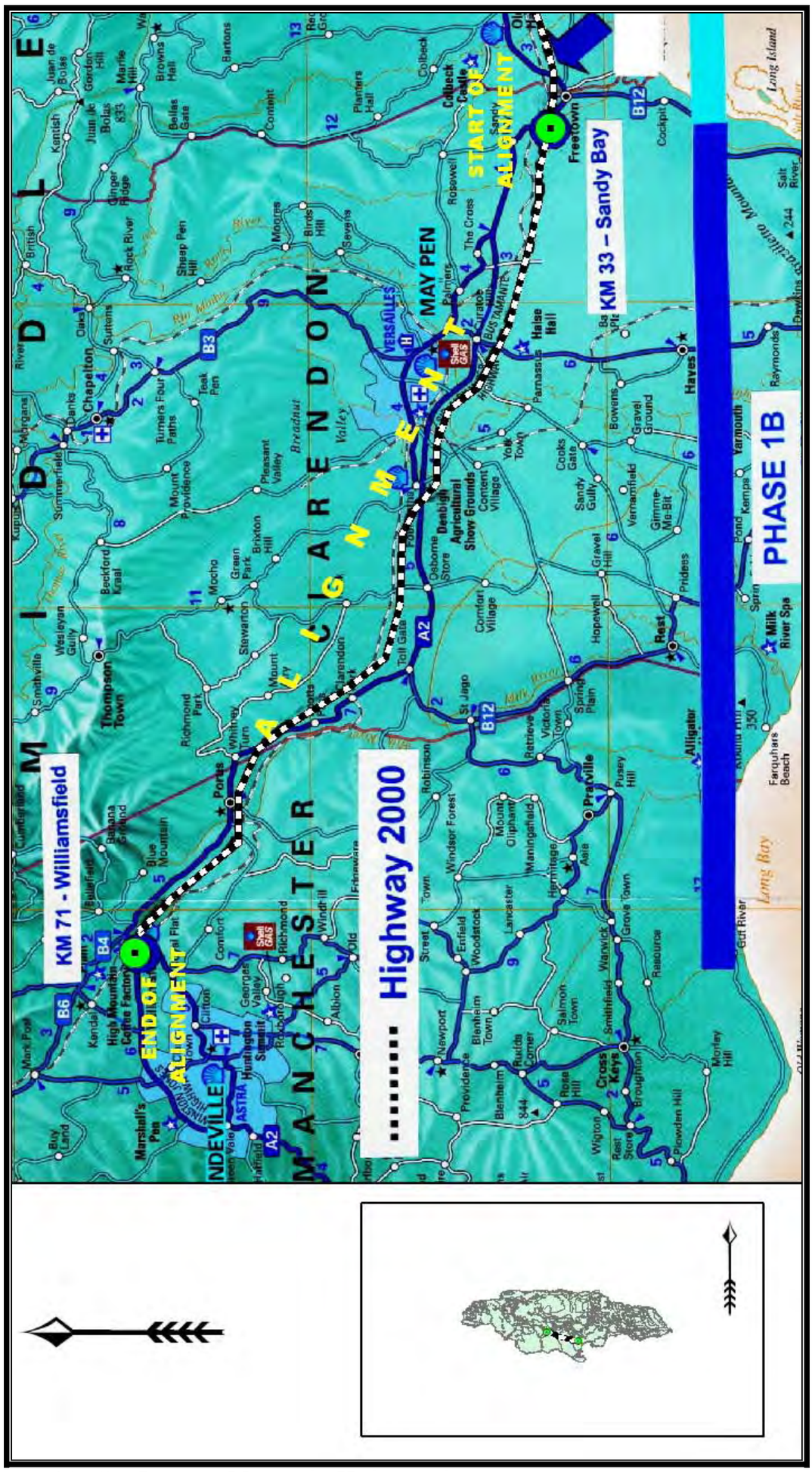


Figure 1.0 : Site Location Map of the Highway Alignment

1.1.2. Crossings

Twenty-nine (29) crossings have been identified and will be facilitated by overpasses and underpasses. These crossings include gullies, rivers, slip roads, local roads, railway and field connectors. The following list gives details of the proposed road crossings (BYTPJ, 2007a).

Table 1.1.2 Types and Locations of Crossings and Structures along the Alignment

Chainage	Local Name	Overpass/ Underpass	Bridge Type	Structure Type
33+900	Sandy Bay	Overpass	Slip Road	Concrete Frame-2 span
34+650	Shu Gully 1	Underpass	Gully	CMP or concrete culvert
35+650	Shu Gully 2	Underpass	Gully	CMP or concrete culvert
37+600	Savannah Cross	Overpass	Local Road	Concrete Frame-2 span
39+200	Webbers Gully 1	Underpass	Gully	
39+300	Hunts Pen	Underpass	Local Road	Concrete Frame
39+480	Webbers Gully 2	Underpass	Gully	CMP or concrete culvert
41+080	May Pen Interchange	Overpass	Local Road	Concrete Frame- 2 span
42+650	Coates Pen	Underpass	Local Road	Concrete Frame
43+850	Rio Minho	Underpass	River	Composite
45+100	Sheckles Pasture	Underpass	Field Connector	Concrete Frame
46+100	Content	Underpass	Railway	Concrete Frame
46+200	Content	Underpass	Local Road	Concrete Frame
47+150	Denbigh	Overpass	Local Road	Concrete Frame
48+150	St. Ann's Gully	Underpass	River	Concrete box-3 cell
48+700	Ebony Pen	Underpass	Field Connector	Concrete Frame
49+950	Four Paths	Overpass	Local Road (A2)	Concrete Frame- 2 span
51+700	Belle Plain	Underpass	Local Road	Concrete Frame
53+000	Ludford Rocks	Underpass	Local Road	Concrete Frame
57+500	Clarendon Park	Underpass	Railway	Concrete Frame
57+950	Clarendon Park	Underpass	Field Connector	Concrete Frame
59+850	Berry Dale	Underpass	Local Road	Concrete Frame
61+250	Milk River	Underpass	River	Composite
62+450	Spring Grove	Underpass	Local Road	Concrete Frame
64+100	Redberry	Underpass	Local Road	Concrete Frame
64+500	Porus	Underpass	Railway	Concrete Frame
64+700	Porus	Underpass	Local Road	Concrete Frame
65+600	Trinity	Overpass	Local Road	Concrete Frame
70+400	Williamsfield	Underpass	Railway	Concrete Frame

1.1.3. Toll Plazas and Equipment

An interchange including Toll Plazas is proposed for May Pen. This will include a 4 lane plaza on each ramp with canopy, with four (4) operational lanes (2 ETC, one manual, one mixed). Two buildings (each 100m^2) to accommodate technical rooms (located 41 +080).

At Four Paths there will be another Toll Plaza with provision for an access road to the plaza from the existing A2 road (located at 52 + 000). This plaza will be eight (8) lanes with operational centre of 250 sq m.

1.1.4. Rest Stop

Sanitary facilities will be provided at the Four Paths Toll Plaza and Melrose Rest Stop.

1.2. Phasing and Timetable

The project is scheduled to be concluded 34 months after the commencement certificate has been issued. The project will be divided into phases that will be defined by the construction requirements.

1.3. Construction Camp/Site Yard

The location of the construction camp/site yard has not yet been determined. It is anticipated, however, that the camp will be approximately 200m x 200m and will take into consideration storm water and surface water drainage requirements, location of interceptors, as well as wastewater and sewage requirements. All necessary approvals for the construction camp/site yard will be obtained prior to establishment of the site.

The construction works will be implemented by Bouygues Travaux Publics (Jamaican Branch), the contractor.

Although the exact location of the site construction camp has not been identified, the previous experience of the Highway 2000 project should be taken into account. The contractor has

displayed good housekeeping habits, conformance to permitting requirements and adherence to audit procedures.

1.4. Cut and Fill

All fill materials will be obtained mainly for the cut and transported by trucks to the designated fill areas.

Quarries will be identified based on the following criteria:

1. Proximity to project
2. Type of material required
3. Nature of approval from authorities

If the project requires the establishment of a quarry, the necessary licenses/approvals will be sought.

1.4.1. Transportation Requirements

All motorized vehicles within the site, excluding those on public roads, shall be restricted to maximum speed of 20 km per hour (in site yard) and 50 km per hour (on the alignment). Speed limit signs will be erected as appropriate.

Haulage and delivery vehicles will be confined to designated roadways inside the site.

The production team will ensure that vehicles transporting earth materials and fines are fitted with side and tailboards. Materials transported by vehicles shall be covered, with the cover properly secured and extended over the edges of the side and tailboards. Dusty materials will be dampened before transportation.

2. Terms of Reference

The Terms of Reference for conducting the EIA are based on the Generic Terms of Reference provided by NEPA for the Construction of Roads, Railways, Cables and Bridges (NEPA 2005) and the Minimum Standard Requirements for TORs for EIA's prepared by NEPA (received April 2007). The TORs have been modified to include project-specific issues, and have incorporated issues raised by NEPA in their letter of April 19, 2007. The TORs were submitted to NEPA for review on April 30, and a response was received on July 27, 2007 (dated July, 23). The comments from NEPA were incorporated in the TORs and re-submitted to NEPA on August 3, 2007 (Appendix III).

The Environmental Impact Assessment will include but not necessarily be limited to:

1) Objectives
2) Provide a complete description of the corridor proposed for development. This should include a description of the main elements of the development, highlighting areas to be reserved for construction, the creation of verges and other green areas.
3) Identify the significant environmental and health issues of concern through the presentation of baseline data which should include physical, biological, socio-economic, cultural and heritage considerations. Assess public perception of the proposed development.
4) Outline the Policies, Legislation and Regulations relevant to the project.
5) Predict the likely impacts of the development on the described environment, including direct, indirect and cumulative impacts, and indicate their relative importance to the design of the development's facilities.
6) Identify mitigation action to be taken to minimize adverse impacts and quantify associated costs.
7) Design a Monitoring Plan which should ensure that the mitigation plan is adhered to.
8) Describe the alternatives to the project that could be considered at that site or other locations.
9) Conclusions

To ensure that a thorough Environmental Impact Assessment is carried out, it is expected that the following tasks will be undertaken:

Task #1 Description of the Project

Provide a comprehensive description of the project, noting areas to be reserved for construction and verges. The description of the project will give the total length of the alignment, the width of the right-of-way, width of verges, drainage requirements, bridges and crossings and the location of toll plazas. This will also include an account of activities and features, which will introduce risks or generate impacts (negative and positive) on the environment. This will involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate, and include information on location, general layout and size, as well as pre-construction, construction, and post construction plans. For projects to be done on a phased basis it is expected that all phases be clearly defined, the relevant time schedules provided, and phased maps, diagrams and appropriate visual aids be included.

A description will also be given of:

i) The impact that the modification of the current use of the roads will have on the street system adjacent to the project
ii) Methods and location of construction surplus material disposal
iii) Any changes to associated water diversion management system
iv) Total quality management of modifications, vehicular traffic, equipment, waste etc
v) The proposed off-site facilities such as construction camps and infrastructure service
vi) Proposed decommissioning and abandonment of works and/or facilities
vii) Possible source of suitable material for road fill and the likely impacts the quarry operation will have on the physical, biological and socio-economic environment.

Task #2 Description of the Environment

Baseline data will be generated in order to give an overall evaluation of the existing environmental conditions, values and functions of the area, as follows:

i) physical environment
ii) biological environment

iii) socio-economic and cultural constraints.

It is expected that methodologies employed to obtain baseline and other data be clearly detailed.

Baseline data will include:

(A) Physical

i) A detailed description of the existing geology and hydrology with emphasis on the existing and long term storm water runoff requirements. Reference will be made to future development of lands. Special emphasis should be placed on storm water run-off, and drainage patterns. Any slope stability issues that could arise will be thoroughly explored.

ii) Water quality and quantity of any existing rivers, ponds, or streams in the vicinity of the development, and particularly to be crossed by the highway. Quality Indicators should include but not necessarily be limited to suspended solids, turbidity, oil and grease.

iii) Climatic conditions and air quality in the area of influence including particulate matter, NO_x, SO_x, wind speed and direction, precipitation, relative humidity and ambient temperatures,

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

v) Obvious sources of pollution existing and extent of contamination.

vi) Availability of solid waste management facilities.

vii) Availability of public sanitary facilities (rest stops) along the corridor

viii) Identify and assess the impact of the project on potential wells, ground water pre, during and post construction phases and its associated effect on water supplies to the adjacent communities.

ix) Assess the potential impact on the air quality during construction and operation to include baseline air quality information

x) Assess the potential residual air quality impact.

xi) A section will be included called “Issues of Natural Hazard and Geotechnical Stability”.

(B) Biological

Present a detailed description of the flora and fauna (terrestrial and aquatic) of the area, with special emphasis on rare, endemic, protected or endangered species. Migratory species will also be considered. Information will be presented on existing vegetation, proposed vegetation loss and resulting loss and/or fragmentation of habitat for fauna. Generally, species dependence, niche specificity, community structure and diversity will be considered. The location of the alignment within the Portland Bight Protected Area will be detailed.

A description will be given of:

i) Different ecosystem types including cave and sinkholes and their species, if present
ii) Nocturnal species within the project site
iii) Habitat of flora
iv) Biological diversity importance of the area
v) Invasive and economically important species
vi) Mitigation measures to avoid or minimize negative impacts on wildlife, wildlife habitat, and vegetation communities/ecosystems.

(C) Socioeconomic & cultural

A Socioeconomic Evaluation will be prepared and will include present and projected population; present and proposed land use; planned development activities, issues relating to squatting and relocation, community structure, employment, distribution of income, goods and services; recreation; public health and safety; community health, health facilities and medical services; cultural peculiarities, aspirations and attitudes should be explored. The historical importance of the area should also be examined. While this analysis is being conducted, an assessment of public perception of the proposed development will be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings, interviews with key stakeholders or the distribution of interview instruments (questionnaires). Targeted communities will include Sandy Bay, May Pen, Toll Gate, Clarendon Park and Scotts's

Pass in the parish of Clarendon; and Porus and Williamsfield in the parish of Manchester and any other community affected by the proposed alignment.

The following will also be identified:

i) Private land acquisition needs

ii) Tenure issues during pre-application consultations and how they will address them

iii) Local economic benefits and cost overall and on an individual community bias

iv) Implications of the project during the construction phase for resident commuter travel and travel times; accommodation for construction workers; access to and delivery of health, educational and social services and emergency support to local communities

v) Correlation between highway upgrade and possible traffic congestion for the adjoining communities

vi) Impact on future transit opportunities

vii) Economic impact of the construction phase on local economic benefit on the project and in the adjacent communities, road closures, delays and detours a well as quality of experience for visitors (tourists)

viii) Implications during the construction and operation phase on:

- Emergency support to local communities
- Resident commuter travel and travel time
- Access to and delivery of health and other social amenities.

Task #3 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 Public Health Act, the Town and Country Planning Act, the Toll Roads Act, the Main Roads Act, and the appropriate international convention/protocol/treaty where applicable.

Task #4 Identification of Potential Impacts

Identify the major environmental and public health issues of concern and indicate their relative importance to the development project. Identify potential impacts as they relate to, (but are not restricted by) the following:

- flooding potential and change in drainage pattern
- landscape impacts of excavation and construction
- loss of and damage to geological and palaeontological features
- landscape impacts of excavation and construction
- slope stability
- loss of species and natural features
- habitat loss and/or fragmentation
- biodiversity/ecosystem functions
- pollution of potable, surface or ground water
- air pollution
- socio-economic and cultural impacts
- maintenance of any alternative routes idenitified
- impact on private and commercial property owners and recreational facilities
- impact of flooding, loss of natural features, excavation and construction on the historic landscape, architecture and archaeology of the site
- risk assessment and hazard management (slope stability, flooding, debris torrents and seismic activity
- technological hazards
- noise
- solid waste disposal
- soil
- change in land use

The following will be addressed:

i) A detailed emergency plan to be implemented if water bodies become contaminated as well as if irrigation and domestic water supply are disrupted due to the project (to be addressed in mitigation measures).

ii) Mitigation measures for erosion and sediment control management for each construction section.

iii) Aesthetics/scenic values of the highway alignment; include an evaluation of opportunities to provide viewpoints or scenic lay-by along the corridor.

iv) Access to, from and across the highway- including bicycle/pedestrian access requirements for corridor communities; a description of how emergency access requirements (fire, police, ambulance) will be addressed during construction.

v) Traffic management and road safety; consider the risk of forest fire impacts on safety in use of the highway as well as animals intruding onto the highway.

vi) Identification of any known contamination sites that would be disturbed as a result of project-related actions, and propose mitigation measures to deal with any contamination material.

vii) Effects of the environment on the project (in particular, identify and describe any potential geotechnical and weather related factors on the Project, and proposed mitigation measures

viii) Cumulative environmental impacts- identify and describe any residual environmental impacts that are likely to result from the project in combination with other projects or activities that have been or likely to be carried out.

The assessment will identify relevant significant positive and negative impacts, direct and indirect, long term and immediate impacts. Identify avoidable as well as irreversible impacts. Characterize the extent and quality of the available data, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts will be represented in matrix form.

Cumulative impacts of this and other proposed and/or existing developments will be explored.

Task #5 Drainage Assessment

An assessment of Storm Water Drainage should be conducted. The EIA Report will cover but not be 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 crossings of rivers and/or gullies, to include impacts that drainage control features could have on aesthetics, water quality and sedimentation of rivers and/or gullies.

iv) Assessment of the impact of draining the site on adjacent communities and on future developments (north of the highway) including mitigation measures. This should be calculated and designed to facilitate the storm runoff without causing flooding of these development. Underpasses for the highway should be designed to accommodate the volume and velocity of storm water post construction.

v) Identify other effects of storm water such as the input of oil and grease into the aquatic environment.

Task #6 Mitigation

Prepare guidelines for avoiding, as far as possible, (eg restoration and rehabilitation) any adverse impacts due to proposed usage of the corridor and utilising of existing environmental attributes for optimum development. Quantify and assign financial and economic values to mitigating methods. Guidelines should include the issues of restoration and rehabilitation.

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 highway. An Environmental Management Plan and Historic Preservation Plan (if necessary) for the long term operations of the site will also be prepared.

An outline Environmental Monitoring Programme (EMP) for the construction phase will be prepared, indicating the parameters to be monitored, and the recommended frequency of monitoring. A detailed version of the EMP will be 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 license(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.

Consideration will be given to the development of a Resettlement Action Plan.

Task #8 Project Alternatives

Examine alternatives to the project including the no-action alternative. This examination of project alternatives will incorporate the use history of the overall area in which the site is located and previous uses of the area itself.

Task #9 Public Participation/Consultation Programme

A Public Presentation on the findings of the EIA will be conducted to inform, solicit and discuss comments from the public, on the proposed. Considering the geographical scope of the project, two consultations are recommended, one for each of the parishes of Clarendon and Manchester.

All Findings will be presented in the **EIA report** and will reflect the headings in the body of the TORs. Information and data presented will be supported by references. Ten hard copies and an electronic copy of the report will be submitted to NEPA. The report will include an

appendix with items such as maps, site plans, the study team, Terms of Reference, photographs, and other relevant information.

Key Stakeholders to be consulted will be identified and the mechanisms for consultation and disclosure of the project, from the project design to the operational phase will be given.

All Findings will be presented in the **EIA report** and will reflect the headings in the body of the TORs. Information and data presented will be supported by references. Ten hard copies and an electronic copy of the report will be submitted to NEPA. The report will include an appendix with items such as maps, site plans, the study team, Terms of Reference, photographs, and other relevant information.

3. Legislative and Regulatory Requirements

Under the Environmental Permit and Licence System an applicant is required to complete an application form and Project Information for submission to NEPA. The submission of these forms constitutes the permit application and the permitting process for a project begins. Additionally, the Revised Guidelines for Conducting Environmental Impact Assessments (NEPA, 2005) and the Guide to Conducting Public Consultations (NRCA, 1997) specifies the requirements for the Terms of Reference for the EIA and the public consultation process. The following table lists the significant milestones in the permitting and EIA processes for this development.

Table 3.1: Significant Milestones for the Permitting Process

Milestones	Date
Submission of Permit Application to NEPA	March 2, 2007
Acknowledgement from NEPA on receipt of Application	March 12, 2007
Response from NEPA (with guidelines for conducting EIA, Minimum required Standard for TORs for EIA and request for TORs)	April 19, 2007
Submission of Draft TOR to NEPA for review	April 30, 2007
Site visit with NEPA	May 4, 2007
TORs submitted to Parish Council and Parish Libraries for public review	May 24, 2007
Alignment sent to Forestry Department and Jamaica Bauxite Institute with request for identification of reserves	May 24, 2007
Comments from FD	Pending
Comments from JBI	Pending
Alignment sent to Jamaica National Heritage Trust	May 24, 2007
Comments from JNHT	Pending
Site reconnaissance, aerial observations and field studies for EIA	May to August, 2007
Advertisement for Public Consultation No.1 (Presentation of the Project and TORs)	June 24, 2007
Presentation to TRC	June 26, 2007
Public Consultation No. 1 (Presentation of Project and TORs)	June 28, 2007
Response from NEPA to Draft TORs (dated July 23, 2007)	July 27, 2007
Submission of revised TORs to NEPA for approval	August 3, 2007
Response from NEPA on still awaiting comments	August 13, 2007
Response from NEPA to finalize Report	September, 2007
PROPOSED SUBMISSION DATES	
Submission of EIA to NEPA	September, 2007
Advertisement for review of EIA and Consultation No. 2	September, 2007
Public Hearing of EIA	September, 2007
Submission of Verbatim Report to NEPA	September, 2007

3.1. National Legislation – Natural Environment

3.1.1. Natural Resources Conservation Authority Act (1991)

The Natural Resources Conservation Authority Act was passed in the Jamaican Parliament in 1991 and provided the basis for the establishment of the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development in Jamaica through the protection and management of Jamaica's natural resources and control of pollution. Sections 9 and 10 of the NRCA Act stipulate that an Environmental Impact Assessment (EIA) is required for new projects and existing projects undergoing expansion.

The body is also responsible for investigating the effect on the environment of any activity that may cause pollution or which involves waste management. Sections of the Act that relate specifically to pollution control state that:

(i) No person shall discharge on or cause or permit the entry into waters, on the ground or into the ground, of any sewage or trade effluent or any poisonous noxious or polluting matter.

(ii) No person is allowed to construct or reconstruct or alter any works designed for the discharge of any effluent.

The Act also empowers the authority to require of any owner or operator of a pollution control facility information on the performance of the facility, the quantity and condition of effluent discharged and the area affected by the discharge of such effluent.

The Authority has the right to consult with any agency or department of Government having functions in relation to water or water resources to carry out operations to:

(a) Prevent pollutants from reaching water bodies.

(b) Remove and dispose of any polluting matter or remedy or mitigate any polluted water body in order to restore it.

3.1.2. Environmental Review and Permitting Process (1997)

The Environmental Permit and License System (P&L), introduced in 1997, is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L System is administered by NEPA, through the Applications

Section (formerly the Permit and License Secretariat). Permits are required by persons undertaking new development which fall within a prescribed category. Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of approval stipulated. An applicant for a Permit or License must complete an application form as well as a Project Information Form (PIF) for submission to the NRCA.

TransJamaican Highway Ltd. has applied for a permit for the construction of the highway. This EIA Report and supporting appendices are a part of the regulatory agency requirements.

3.1.3. Wildlife Protection Act (1945)

The Wildlife Protection Act of 1945 prohibits removal, sale or possession of protected animals, use of dynamite, poisons or other noxious material to kill or injure fish, prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries and streams, and authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act are six species of sea turtle, one land mammal, one butterfly, three reptiles and several species of birds including rare and endangered species and game birds.

Construction of the highway must take into account the protected species and no protected animal should be endangered as a result of the construction works.

3.1.4. The Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000)

This Act deals with restriction on trade in endangered species, regulation of trade in species specified in the schedule, suspension and revocation of permits or certificates, offences and penalties, and enforcement. Many species of reptile, amphibian and birds that are endemic to Jamaica but not previously listed under national protective legislation, or under international legislation, are listed in the Appendices of this Act.

3.1.5. The Natural Resources (Prescribed Areas)(Prohibition of Categories of Enterprise, Construction and Development) Order (1996)

The island of Jamaica and the Territorial Sea of Jamaica have been declared a Prescribed Area. No person can undertake any enterprise, construction or development of a prescribed description or category except under and in accordance with a permit. The Natural Resources Conservation (Permits and Licenses) Regulations (1996) give effect to the provisions of the Prescribed Areas Order.

Application for a permit for the construction of the highway has been submitted to NEPA. Subsequent application for required permits and licenses in respect of the proposed development will be submitted as required.

3.1.6. Water Resources Act (1995)

The Water Resources Act of 1995 established the Water Resources Authority (WRA). This Authority is authorized to regulate, allocate, conserve and manage the water resources of the island. The Authority is also responsible for water quality control and is required under Section 4 of the Act to provide upon request to any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources.

It is the responsibility of the WRA as outlined in Section 16 to prepare, for the approval of the Minister, a draft National Water Resources Master Plan for Jamaica. Areas to be covered in this Draft Master Plan of 1990 included objectives for the development, conservation and use of water resources in Jamaica with consideration being given to the protection and encouragement of economic activity, and the protection of the environment and the enhancement of environmental values.

Section 25 advises that the proposed user will still have to obtain planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, Section 21 of the Act stipulates that if the water to be used will result in the discharge of effluents, an application for

a license to discharge effluents will have to be made to the Natural Resources Conservation Authority or any other relevant body as indicated by the Minister.

With regard to underground water, Section 37 states that it is unlawful to allow this water to go to waste. However, if the underground water "interferes or threatens to interfere with the execution or operation of any underground works", it will not be unlawful to allow the water to go to waste in order to carry out the required works provided that there is no other reasonable method of disposing of the water. The Authority also has the power to determine the safe yield of aquifers (Section 38).

The Water Resources Authority, a sister agency of NEPA, should be asked to comment on the TORs, the project in general and the EIA Report. Prevention of contamination of water resources, both surface and ground, are important. The data gathering process for the EIA Report has included data request to the WRA in respect of surface and groundwater data, hydrostratigraphy maps, locations of wells and lakes and other relevant parameters.

3.1.7. Quarries Control Act (1983)

The Quarries Control Act of 1983 established the Quarries Advisory Committee, which advises the Minister on general policy relating to quarries as well as on applications for licenses. The Act provides for the establishment of quarry zones, and controls licensing and operations of all quarries. The Minister may on the recommendation of the Quarries Advisory Committee declare as a specified area any area, in which quarry zones are to be established and establish quarry zones within any such specified area.

Section 5 of the Act states that a license is required for establishing or operating a quarry though this requirement may be waived by the Minister if the mineral to be extracted is less than 100 cubic metres. Application procedures are outlined in Section 8. The prescribed form is to be filed with the Minister along with the prescribed fee and relevant particulars. The applicant is also required to place a notice in a prominent place at the proposed site for a period of at least 21 days starting from the date on which it was filed.

Any quarries used to provide material for the project should be licensed.

3.1.8. The Pesticides (Amendment) Act (1996)

The Pesticides (Amendment) Act of 1996 amended sections of the principal act, which came into effect in 1975 and established the Pesticides Control Authority. This Act gives the Authority the responsibility of controlling the importation, manufacture, packaging, sale, use and disposal of pesticides. Section 11 states that the Authority is required to keep a register or record of all relevant information such as registered pesticides, restricted pesticides, pest control operators and persons licensed to import or manufacture pesticides. Under Section 16 of the Act, the Authority may also, with the approval of the Minister, make regulations which relate to areas such as:

- Aerial application of pesticides;
- Supervision required for the use of pesticides, the prescribed protective clothing to be worn and other precautionary measures;
- The permissible levels of pesticides to be used;
- The periods during which particular pesticides may or may not be used on certain agricultural crops;
- The disposal of pesticides and packages.

The use of pesticides should be approved by the relevant regulatory agencies..

3.1.9. Clean Air Act (1964)

This act refers to premises on which there are industrial works, the operation of which is in the opinion of an inspector likely to result in the discharge of smoke or fumes or gases or dust in the air. An inspector may enter any affected premise to examine, make enquiries, make tests and take samples of any substance, smoke, fumes, gas or dust as he considers necessary or proper for the performance of his duties.

3.1.10. Air Quality Regulations (2002)

Part I of the Act stipulates license requirements and states that every owner of a major facility or a significant facility shall apply for an air pollutant discharge license. Part II speaks to the stack emission targets, standards and guidelines.

The Act states that no person shall emit or cause to be emitted from any air pollutant source at a new facility, any visible air pollutants the opacity or pollutant amount of which exceeds the standards.

Every owner of a facility with one or more air pollutant source or activity shall employ such control measures and operating procedures as are necessary to minimize fugitive emissions into the atmosphere, and such owner shall use available practical methods which are technologically feasible and economically reasonable and which j reduce, prevent or control fugitive emissions so as to facilitate the achievement of the maximum practical degree or air purity.

Under this Act a "major facility" is described as any facility having air pollutant source with the potential to emit:

a) One hundred or more tones/y of any one of total suspended particulate matter (TSP);
b) Particulate matter with a diameter less than ten micrometers (PM10);
c) Sulphur oxides measured as sulphur dioxide (SO_2);
d) Carbon monoxide (CO);
e) Nitrogen oxides (NOx) measures as equivalent nitrogen dioxide;
f) Five or more tones/y lead;
g) Ten or more tones per year of any single priority air pollutant; or
h) Twenty five or more tonnes per year of any combination or priority air pollutants.

Any facilities to be installed by the developer or contractor that will have stack emissions will require a pollutant discharge license. Monitoring of air quality parameters may be required by the regulatory agencies. Baseline air quality data including suplhur and nitrogen oxides are presented in Section 5.1 of this report.

3.1.11. Noise Standards

Jamaica has no national legislation for noise, but World Bank guidelines have been adopted by the National Environment and Planning Agency (NEPA) and are used for benchmarking purposes along with the draft National Noise Standard that is being prepared. The guidelines for daytime perimeter noise is 75 decibels and 70 decibels for nighttime noise.

The highway will pass through noise sensitive receivers (NSR) such as the communities of Porus, Clarendon Park and Scott's Pass. Noise monitoring may be required as an aspect of construction monitoring. Baseline noise data are presented in Section 5.1 of this report.

3.1.12. Trade Effluent and Sewage Regulations (1996) (Draft)

Jamaica has draft regulations governing the quality of the effluent discharged from facilities to public sewers and surface water systems. These draft regulations should be gazetted sometime in 2006. The draft guidelines require the facility to meet certain basic water quality standards for trade effluent including sewage. The requisite permits and licenses are required to install and operate sewage treatment facilities.

If the developer is interested in releasing any effluent into the environment a license for discharge of trade effluent or sewage effluent will be required.

3.1.13. The Natural Resources Conservation (Portland Bight Protected Area) Regulations (1999)

These regulations apply within the area declared to be the Portland Bight Protected Area as described in the Schedule of the Natural Resources Conservation (Portland Bight Protected Area) Declaration Order 1999, and in addition to any other regulation relating to said Protected Area. The regulations give the activities that can be undertaken within the protected area, activities that can be undertaken with a license/permit, activities that can be undertaken with the written permission of the Protected Area Manager, enforcement and exemptions.

The alignment begin in the Portland Bight Protected Area (PBPA) at the end of the existing Bushy Park to Sandy Bay segment. In this area the railway line forms the northern

boundary of the PBPA and the proposed highway traverse a small section of the PBPA before the alignment varies northward outside the project boundary. Information on the PBPA is presented in Section 5.2 of this report.

3.1.14. Forest Act (1996)

Jamaica's first Forest Act, passed in 1937, created the Forest Branch of the Lands Department. During 1938 the Forest Branch was transferred to the Department of Agriculture as the Forest Division and in 1942 an independent Forest Department was created.

During the period 1937-42 the framework of an island-wide forestry service was built up. The country's system of forest reserves was set up in those early years - during 1938 the Forest Branch gazetted some 78,800 hectares of Crown Lands as forest reserves - representing more than three-quarters of the present day extent of forest reserves. In subsequent years, these areas were added to by purchase, lease and other arrangements.

The 1996 Forest Act replaced the 1937 legislation and created the actual Forestry Department, defining its functions and mission.

The Forestry Department is the lead agency responsible for the management and conservation of Jamaica's forests. Its functions are aimed at managing forests on a sustainable basis to maintain and increase the environmental services and economic benefits they provide. Its mission is to: "*Provide efficient technical and professional leadership in the conservation, protection, management and development of the forest resources of Jamaica*".

The soil conservation mandate held by the previous Department of Forestry and Soil Conservation was given over to the Rural Agriculture Development Authority of the Ministry of Agriculture in 1996, following the passing of the new Forest Act.

A request was sent to the Forestry Department to determine if the alignment crosses any Forest Reserves. The Forestry Department has indicated that the proposed Highway, as outlined, does not seem to threaten any of the forest reserves of forest management areas

between Sandy Bay and Williamsfield (Appendix V).

3.2. National Legislation – Socio-economic Environment

3.2.1. Town and Country Planning Act (1958)

Section 5 of the Town and Country Planning Act authorizes the Town and Country Planning Authority to prepare, after consultation with any local authority, the provisional development orders required for any land in the urban or rural areas, so as to control the development of land in the prescribed area. In this manner, the Authority will be able to coordinate the development of roads and public services and conserve and develop the resources in the area.

Any person may, under Section 6 of the Act, object to any development order on the grounds that it is:

- impractical and unnecessary;
- against the interests of the economic welfare of the locality.

However, if the Minister is satisfied that the implementation of the provisional development order is likely to be in the public interest, he may, under Section 7 (2) of the Act, confirm it with or without modification by publishing a notice in the Gazette. Section 8 of the Act also gives the Minister the authority to amend a confirmed development order.

Section 10 of the Act states that a development order must include:

- clearly defined details of the area to be developed;
- regulations regarding the development of the land in the area specified;
- formal granting of permission for the development of land in the area.

If the provisions of section 9A of the Natural Resources Conservation Authority (NRCA) Act apply to the development, the application can only be approved by the Planning Authority after the NRCA has granted a permit for the development. (Section 11 (1A). The Authority may impose a "tree preservation order" under Section 25 of the Act if it considers it important to make provision for the preservation of trees and woodlands in the area of the development.

This order may:

- prohibit the cutting down, topping, lopping or willful destruction of trees;
- secure the replanting of any section of the woodland area in which trees were felled during the forestry operations permitted under the order.

The tree preservation order is not applicable to the cutting down of trees which were already dead, dying or had become dangerous and the order can take effect only after it has been confirmed by the Minister.

The Minister can, under Section 26 of the Act, make regulations to restrict and regulate the display of advertisements in any area to be developed if he considers this to be in the interest of public safety. Section 28 of the Act empowers the local authority to require the owner or occupier of land in the development area to take the steps necessary to ensure its proper maintenance.

3.2.2. Land Development and Utilization Act (1966)

Under Section 3 of the Land Development and Utilization Act (1966), the Land Development and Utilization Commission is authorized to designate as agricultural land, any land which because of its "situation, character and other relevant circumstances" should be brought into use for agriculture. However, this order is not applicable to land, which has been approved under the Town and Country Planning Act for development purposes other than that of agriculture. Among the duties of the Commission outlined in Section 14 of the Act is its responsibility to ensure that agricultural land is "as far as possible, properly developed and utilized".

3.2.3. Public Health Act (1976)

The Public Health (Air, Soil and Water Pollution) Regulations 1976, aim at controlling, reducing, removing or preventing air, soil and water pollution in all possible forms. Under the regulations given:

i. No individual or corporation is allowed to emit, deposit, issue or discharge into the environment from any source.

ii. Whoever is responsible for the accidental presence in the environment of a contaminant must advise the Environmental Control Division of the Ministry of Health and Environmental Control, without delay.

iii. Any person or organization that conducts activities which release air contaminants such as dust and other particulates is required to institute measures to reduce or eliminate the presence of such contaminants.

iv. No industrial waste should be discharged into any water body which will result in the deterioration of the quality of the water.

The construction works will routinely require the use of some hazardous materials including petro- chemicals will generate fugitive dust and use heavy machinery and equipment. Proper care and standard best practices for the construction industry should be applied to minimize public health risks. Relevant permits and licenses for use and storage of hazardous materials must be obtained.

3.2.4. Country Fires Act (1942)

Section 4 of the Country Fires Act of 1942 prohibits the setting of fire to trash without prior notice being given to the nearest police station and the occupiers of all adjoining lands. In addition, a space of at least fifteen feet in width must be cleared around all trash to be burnt and all inflammable material removed from the area. Section 6 of the Act empowers the Minister to prohibit, as may be necessary, the setting of fire to trash without a permit.

Offences against this Act include:

- Setting fire to trash between the hours of 6.00 p.m. and 6.00 a.m. (Section 5a);
- Leaving open-air fires unattended before they have been completely extinguished (Section 5b);
- Setting fires without a permit and contrary to the provisions outlined in Section 6 (Section 8);
- Negligent use or management of a fire which could result in damage to property (Section 13a);
- Smoking a pipe, cigar or cigarette on the grounds of a plantation which could result in damage to property (Section 13b).

Vegetation clearance will be required and the developer will not utilize burning as a method for vegetation removal.

3.2.5. The National Solid Waste Management Authority Act (2001)

The National Solid Waste Management Authority Act (2001) is "an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority and for matters connected therewith or incidental thereto". The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste. The SWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.

Solid waste management will be essential in the construction phase and will require the removal and proper disposal of vegetative matter, soil and construction rubble. The NSWMA should be contacted regarding an approved disposal site.

3.2.6. Jamaica National Heritage Trust Act (1985)

The Jamaica National Heritage Trust Act of 1985 established the Jamaica National Heritage Trust (JNHT). The Trust's functions outlined in Section 4 include the following responsibilities:

- To promote the preservation of national monuments and anything designated as protected national heritage for the benefit of the Island;
- To carry out such development as it considers necessary for the preservation of any national monument or anything designated as protected national heritage;
- To record any precious objects or works of art to be preserved and to identify and record any species of botanical or animal life to be protected.

Section 17 further states that it is an offence for any individual to:

- willfully deface, damage or destroy any national monument or protected national heritage or to deface, damage, destroy, conceal or remove any mark affixed to a national monument or protected national heritage;
- alter any national monument or mark without the written permission of the Trust;
- remove or cause to be removed any national monument or protected national heritage to a place outside of Jamaica.

The JNHT has been contacted officially to advise them of the project with a map of the alignment in order to determine if there are any relevant listings on their Sites and Monuments Records.

3.2.7. Land Acquisition Act (1947)

Section 3 of the Land Acquisition Act (1947) empowers any officer authorized by the Minister to enter and survey land in any locality that may be needed for any public purpose. This may also involve:

- Digging or boring into the sub-soil;
- Cutting down and clearing away any standing crop, fence, bush or woodland;
- Carrying out other acts necessary to ascertain that the land is suitable for the required purpose.

The Minister is authorized under Section 5 of the Act to make a public declaration under his signature if land is required for a public purpose provided that the compensation to be awarded for the land is to be paid out of the:

- Consolidated Fund or loan funds of the Government;
- Funds of any Parish Council, the Kingston and St. Andrew Corporation or the National Water Commission.

Once the Commissioner enters into possession of any land under the provisions of this Act, the land is vested in the Commissioner of Lands and is held in trust for the Government of Jamaica in keeping with the details outlined in Section 16. The Commissioner shall provide the Registrar of Titles with a copy of every notice published as well as a plan of the land. The

Commissioner will also make an application to the Registrar of Titles in order to bring the title of the land under the operation of the Registration of Titles Act.

The National Roads Operating and Construction Company (NROCC) has responsibility for land acquisition along the alignment. This legislation will be applied as deemed necessary.

3.2.8. Registration of Titles Act (1989)

The Registration of Titles Act of 1989 is the legal basis for land registration in Jamaica, which is carried out using a modified Torrens System (Centre for Property Studies, 1998). Under this system, land registration is not compulsory, although once a property is entered in the registry system the title is continued through any transfer of ownership.

This legislation should help to facilitate the job of NROCC identifying ownership of land along the alignment.

3.2.9. The Mining Act Regulations (1947)

The Mines and Quarries Division of the Ministry of Mining and Energy is responsible for administering the Mining Act and Regulations. The Mining Act requires that the directions of the Conservator of Forests must be obtained before any trees are cut or removed on lands leased for mining. The Mining Regulations require restoration of mined land to pre-disturbance productivity and use, and make specific provisions for afforestation.

Any quarries to be used for supply of aggregate must be licensed.

3.2.10. The Main Roads Act (1932)

The Main Roads Act gives power to the minister to declare other roads to be main roads. The director can from time to time add or remove from the Schedule any other road. The director is to manage main roads and the funds thereof. The director may grant permission for works across, above and under main roads.

3.2.11. The Toll Roads Act (2002)

This is an Act to provide for the designation of specified roads as toll roads, the establishment of the Toll Authority, the operation and maintenance of toll roads, the collection and retention of toll, and for other connected matters. (1) The Minister may, by order- (a) subject to subsection (2) designate any road as a toll road for purposes of this Act; and (b) authorize any person, in return for undertaking such obligations as may be specified in an agreement with respect to the design, construction, maintenance, operation, improvement or financing of a toll road, to enjoy the rights conferred in the order, including the right to levy, collect and retain toll in respect of the use of the toll road. (2) No road shall be designated as a toll road under subsection (1) (a) unless in the area which the toll road is to be established there is an alternative route accessible to the public by ferry, vehicular or other traffic.

3.3. International Legislative and Regulatory Considerations

3.3.1. Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region) (1983)

Adopted in March 1983 in Cartagena, Colombia, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, also known as the Cartagena Convention, is the only legally binding environmental treaty for the Wider Caribbean. The Convention came into force in October 1996 as a legal instrument for the implementation of the Caribbean Action Plan and represents a commitment by the participating governments to protect, develop and manage their common waters individually and jointly.

Ratified by twenty countries, the Cartagena Convention is a framework agreement which sets out the political and legal foundations for actions to be developed. The operational Protocols, which direct these actions, are designed to address special issues and to initiate concrete actions. The Convention is currently supported by three Protocols. These are:

- *The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region* (The Oil Spills Protocol), which was adopted and entered into force at the same time as the Cartagena Convention;
- *The Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region* (The SPAW Protocol), which was adopted in two stages, the text in January, 1990 and its Annexes in June, 1991. The Protocol entered into force in 2000;
- *The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region* (LBS Protocol), which was adopted in October, 1999.

3.3.2. Convention on Biological Diversity

The objectives of the Convention on Biological Diversity are "the conservation of biological diversity, sustainable use of its components and the fair equitable sharing of the benefits arising out of the utilization of genetic resources". This is the first global, comprehensive agreement which has as its focus all aspects of biological diversity: genetic resources, species and ecosystems. The Convention acknowledges that the "conservation of biological diversity is a common concern of humankind and an integral part of the development process". In order to achieve its goals, the signatories are required to:

- Develop plans for protecting habitat and species.
- Provide funds and technology to help developing countries provide protection.
- Ensure commercial access to biological resources for development.
- Share revenues fairly among source countries and developers.
- Establish safe regulations and liability for risks associated with biotechnology development.

Jamaica's Green Paper Number 3/01, entitled *Towards a National Strategy and Action Plan on Biological Diversity in Jamaica,* speaks to Jamaica's continuing commitment to its obligations as a signatory to the Convention.

3.4. Summary of Legislation

TransJamaican Highway Ltd. has applied for a permit for the construction of the highway. This EIA Report and supporting appendices are a part of the regulatory agency requirements. Subsequent applications for required permits and licenses in respect of the proposed development will be submitted as required.

Construction of the highway must take into account the protected species and no protected animal should be endangered as a result of the construction works.

Prevention of contamination of water resources, both surface and ground, are important. The data gathering process for the EIA Report has included data request to the WRA in respect of surface and groundwater data, hydrostratigraphy maps, locations of wells and lakes and other relevant parameters.

Any quarries used to provide material for the project should be licensed.

The use of any pesticides should be approved by the relevant regulatory agencies. Any facilities to be installed by the developer or contractor that will have stack emissions will require a pollutant

discharge license. Monitoring of air quality parameters during the construction phase may be required by the regulatory agencies. The highway will pass through noise sensitive receivers (NSR) such as the communities of Porus, Clarendon Park and Scott's Pass. Noise monitoring may be required as an aspect of construction monitoring.

The alignment begins in the Portland Bight Protected Area (PBPA) at the end of the existing Bushy Park to Sandy Bay segment. In this area the railway line forms the northern boundary of the PBPA and the proposed highway traverse a small section of the PBPA before the alignment varies northward outside the project boundary. The developer will not be using any fires for clearing of vegetation.

The construction works will routinely require the use of some hazardous materials including petro-chemicals will generate fugitive dust and use heavy machinery and equipment. Proper care and standard best practices for the construction industry should be applied to minimize public health risks. Relevant permits and licenses for use and storage of hazardous materials must be obtained.

Solid waste management will be essential in the construction phase and will require the removal and proper disposal of vegetative matter, soil and construction rubble. The NSWMA should be contacted regarding an approved disposal site.

The JNHT has been contacted officially to advise them of the project with a map of the alignment in order to determine if there are any relevant listings on their Sites and Monuments Records. The National Roads Operating and Construction Company (NROCC) has responsibility for land acquisition along the alignment. This legislation will be applied as deemed necessary.

Under the Main Roads Act, the director can add to or remove roads from the Schedule, and the director is to manage the main roads and the funds thereof. The Toll Roads Act is to provide for the designation of specified roads as toll roads, the establishment of the Toll Authority, the operation and maintenance of toll roads, the collection and retention of toll, and for other connected matters.

4. Methodology and Approach

4.1. General Approach

A multi-disciplinary team of experienced scientists and environmental professionals was assembled to carry out the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. The EIA professional team is given in Appendix IV. An iterative approach among the environmental team members and other project professionals was adopted, and was facilitated by fortnightly or weekly team meetings as required. The EIA team worked very closely with the other professional team members.

The team utilized the Charette-style approach to data gathering, analysis, and presentation whereby team members conducted the reconnaissance investigations together to determine the critical elements for analysis and the issues to be highlighted for the design and planning process. Team meetings were held to discuss the progress of investigations and analyses and facilitate integration of data toward an understanding of the systems at work in both the natural and built environment.

Baseline data for the study area was generated using a combination of:

- Field studies
- Aerial observation
- Analysis of maps, plans, aerial photos
- Review of reports and background documents
- Structured Interviews and Public Consultation
- Laboratory analyses

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

4.2. Physical Environment

A desktop survey was conducted on the physical environment aspects including baseline geological and hydrological components of the proposed Highway 2000, Phase 1B, Sandy Bay to Williamsfield. This was supported by field investigations and ground truthing.

4.2.1. Site and Situation

1. A definition of the study area was prepared, based on the drainage area of which the project site forms a part. These boundaries were demarcated based on a desktop review of available topographical maps and field reconnaissance along open and traversable access ways. Baseline data collection on the study area was conducted and included climate, hydrology, geology, hydrogeology and topography.

2.

3. Information on rainfall, groundwater pollution incidents, flooding incidents, mains supply facilities and other critical facilities were reviewed within a 5 km radius of the site. Information was obtained from the Office of Disaster Preparedness and Emergency Management (ODPEM), the Water Resources Authority (WRA), the National Water Commission (NWC) and internet searches.

Information was garnered from field reconnaissance, aerial photographs, previous site and intrusive site reports done and current public domain reports held within various governmental and non-governmental organizations. A summary of internet searches for baseline data is given in Appendix VI.

4.2.2. Climate and Rainfall

Climate data including rainfall was collected from the National Meteorological Services.

4.2.3. Topography, Hydrogeology and Drainage

A definition of the study area, based on the drainage areas traversed by the highway alignment was created.

1. Baseline data was collected on the study area (hydrology, geology, soils, hydrogeology, geomorphology, etc) and a review conducted of available existing reports and other published information relevant to the study area.

2. The Review of the collected data collected was done to:

1) Provide an assessment of natural hazard risk(s) particularly as it relates to flooding, landslides and seismicity.

2) Provide analysis of the change in drainage patterns, issues related to potential ponding, and any history of flooding on the site. This will include a) Drainage for the site during construction to include mitigation for sedimentation to the aquatic environment, b) Drainage for the site during operation, to include mitigation for sedimentation to the aquatic environment, c) Drainage control for crossings of rivers and/or gullies, to include impacts that drainage control features could have on aesthetics, water quality and sedimentation of rivers and/or gullies

3) Discuss the suitability of the conceptual Storm Water Drainage Plan for the highway.

4) Comment on the potential for increased changes to flows, channel shifting, bedload movement and stream banks to the coastal environment as the available data provides. Other effects of storm water, such as the input of oil and grease into the aquatic environment will be discussed and mitigation measures to reduce same.

5) Identify any major potential impacts, including cumulative impacts that the proposed development may have on the components of the physical environment described in the baseline survey.

The hydrological assessment was made using a combination of the Rational Equation for highway sections and catchments beneath 5 km^2 and WinTR-55 for medium catchments (>5km^2). For larger catchments, such as the Shutes Gully, Rio Minho, Milk River etc, the calculations from the June 2000 SEA will be used and revised as the information allows. The Rational Method was coupled with Crystal Ball v7 a simulation program that helps you analyze the risks and uncertainties associated with any Excel spreadsheet models. Crystal Ball generates thousands of possible outcomes using Monte Carlo simulation[1]. WinTR-55 is a single-event, rainfall-runoff small watershed hydrologic model. The model generates

[1] The Monte Carlo simulation is a type of spreadsheet based simulation which randomly generates values for chosen uncertain variables over and over to simulate a model outcome as the inputs vary. Results are presented using a probability distribution frequency curve (PDF).

hydrographs from both urban and agricultural areas and at selected points along the stream system. Rainfall intensity values were obtained from regression equations developed in the June 2000 SEA for segments along the alignment.

3. Existing reports and data were reviewed with a view to determining the following:
    1) Water demand based on population and consumption rate for the proposed site.
    2) Pre and post project runoff rates for 25 yr return period
    3) Possibility for contamination of the water courses as a result of the proposed project.

4.2.4. Natural Hazard Risk

Assessment of natural hazard risk was accomplished through a review of relevant literature pertaining to history of flood events, seismicity and hurricane impacts. Anecdotal reports on historical events were recorded from residents in the surrounding communities. The storm-water runoff analysis provided a basis for evaluating flood risk, and canals and gullies in the project area were examined in terms of level of maintenance and historical performance. The WRA Report is given in Appendix VI.

4.2.5. Air Quality

Particulate matter (PM) refers to discrete particles in ambient air that exist either as solid particles, or as liquid droplets. The sources of PM are: natural, e.g. pollen; a combination of natural and man-made in variable proportions, e.g. dust in a park, roadside dust, smoke from vegetation and wood burning; and wholly man-made, either: - naturally, e.g. household dust from skin shedding; or - activity-related, e.g. smoking, cooking and barbecuing, vehicle use, industrial activities, etc.

A baseline air quality survey was conducted to ascertain the concentration of respirable particulates in the project area prior to the construction and operation of the proposed Sandy Bay to Williamsfield leg of Highway 2000. Twelve sampling locations (Figure 4.2.5a) were selected at sites upwind and downwind of key environmental health receptors. It is a known fact that construction of highways can produce significant increases in fugitive dust emissions,

which may have health implications.

Particulate measurements (PM 10 - non-settleable dust smaller than 10 microns in diameter) were taken at the thirteen stations over two (2) twenty - four hour sampling periods. SKC Air lite and SKC DSP portable air monitors were used to collect the respirable particulates. These pumps were calibrated to a suction rate of approximately 2.5 litres/minute using a SKC Primary Flow Calibrator. The calibrated pumps were attached to pre-weighed filters fitted to cyclones. The cyclones separate the respirable from the non-respirable particulates by centrifugal forces

The pumps with the cyclones were placed at the respiratory height of pedestrians for approximately twenty-four (24) hours after which they were turned off, the filters removed, stabilized and re-weighed to determine a Time Weighted Average (TWA) value for the particulates. Respiratory height is the approximate height at which someone conducting his normal daily activity breathes. Weighing of the filters was done at the Jamaica Bureau of Standards, Kingston.

Twelve (12) stations for air quality monitoring were selected. Site selection was primarily based on the proximity to of the proposed alignment to human receptors, existing sources for ambient air emissions, and fugitive dust sources such as quarries, traffic, etc. A dispersion model was not required under the Terms of Reference for the EIA.

Table 4.2.5: Location of sampling stations

Location/Chainage	Air Quality	Noise	GPS Position
Inverness/CH 37+000	☑	☑	N 17°55.658 W077°10.282
Savannah Cross/ CH 38+000	☑	☑	N 17°55.88 W077°12.507
Webber's Gully B35/ CH 39+000-40+000	☑	☑	N 17°56.121 W077°13.526
Mineral Heights 1/ CH 40+000	☑	☑	N 17°56.241 W077°14.017
Mineral Heights 2/ CH 41+500	☑	☑	N 17°56.327 W077°14.511
Rio Minho/ CH 43+000	☑	☑	N 17°57.417 W077°15.392
Four Paths/ CH 50+000	☑	☑	N 17°58.099 W077°18.421
Rock Halt/ CH 53+000	☑	☑	N 17°58.842 W077°19.915
Scott's Pass/ CH 59+000	☑	☑	N 18°00.817 W077°22.844
Spring Grove/ CH 63+000	☑	☑	N 18°01.648 W077°24.053
Red Berry/ CH 64+000	☑	☑	N 18°01.894 W077°24.954
Porus / CH 64+000	☑	☑	N 18°02.102 W077°25.186
Total	**12**	**12**	

The ambient sulphur and nitrogen dioxide measurements conducted at the twelve stations located along the proposed Sandy Bay to Williamsfield alignment are presented in Table 4.2.5b below. The results recorded are well within the limits established in the National Ambient Air Quality Standard for nitrogen and sulphur dioxide.

4.2.5.1. SOx and NOx Methodology

Sulphur oxides and nitrogen oxides form part of the gaseous emissions from industrial and vehicular sources. Their presence in excessive amounts in the atmosphere can result in

deleterious effects to ecology and social welfare. The gases are reactive and form nitrates and phosphates and other secondary pollutants in the atmosphere over a short time. One such pollutant is the formation of acid rain for which sulphur oxides are responsible. Sulphur oxides and nitrogen oxides are included as criteria pollutants for ambient air quality monitoring in the NRCA Air Quality Regulations, 2006.

To get an understanding of the current occurrences of these gases in the air along the project area, instantaneous *in situ* measurements for SOx and NOx were conducted at eleven sampling stations. These stations are coincident with the respirable particulate sampling locations. A pre-calibrated Quest AQ 5000 air quality monitor was used to measure the concentrations of the gases in the air. The meter was zeroed in an atmosphere free from the analyte of interest and then after the equipment achieved stability, SOx and NOx averaged readings were recorded. Measurements were taken on two different sampling occasions and the results recorded in mg/L or parts per million.

4.2.6. Water Quality

Two sets of data were collected for the Environmental Baseline Study conducted along the alignment for the proposed Sandy Bay to Williamsfield leg of Highway 2000. The monitoring events were carried out on June 5-6 and 7-8, 2007.

The major objectives of the baseline water quality assessment were:

- ◊ To assess land use practices prior to the construction of the proposed toll road between Sandy Bay and Williamsfield.
- ◊ To establish baseline water quality conditions of the surface water systems that will be traversed by the proposed alignment.
- ◊ To determine the nature and extent of existing land use impacts,

Four water-quality sampling stations were selected based on their location relative to the proposed bridge crossings and their proximity to National Irrigation Commissions (NIC) canal and other surface water systems. All point and potential non-point sources of contamination to

surface waters were identified. Each sampling station was geo-referenced for trace-ability and future monitoring requirements.

Water quality tests quantified the concentration and distribution of the following chemical and biological parameters:

- Ph
- Salinity
- Dissolved Oxygen
- Turbidity Total Suspended Solids;
- Nitrate
- Phosphate
- Biochemical Oxygen Demand BOD_5
- Oil and Grease
- Total and Faecal Coliform

Field observations and *in situ* measurements were made with respect to pH, dissolved oxygen, electrical conductivity/salinity and temperature at each site. Salinity, temperature, and dissolved oxygen were measured using an YSI Model 57 Salinity/Conductivity/Temperature (SCT) meter and YSI Model 33 oxygen meter respectively.

Each source was sampled three or more times over a period of one week (samples will only be taken in the dry season). Samples collected were kept at 4°C and transported to the lab within 12 hours of sampling. Environmental Solutions Limited Laboratory performed or supervised the analysis of all parameters using standard methodology.

A quality assurance (QA) and quality control (QC) plan involved all aspects of the project. A QA/QC plan was an essential first step to generating data of the highest quality and reliability. This programme included the care and calibration of field equipment and the collection and preservation of samples including archival samples.

The quality control procedures in the laboratory included duplicate and control samples as well as the utilisation of standard analytical methods. In all cases, appropriate chain-of-custody records were prepared and maintained for all analytical samples. All containers were properly labelled, individually packaged, stored and transported in cooler, packed with ice. Field assistance was provided with written procedures to ensure standard practices.

The ESL Laboratory located at 20 West Kings House Road in Kingston, Jamaica, recently completed a national accreditation programme conducted by the Swedish Board for Accreditation and Conformity Assessment (SWEDAC) and sponsored by the Government of Jamaica. The ISO 17025 Laboratory Quality System is implemented in the operations of the ESL Lab, which is now awaiting the scheduled certification audit by the National Accreditation Body.

Four water quality stations were identified and monitored. The stations are as presented in the table below.

Table 4.2.6 : Water Quality Stations

Location/Chainage	Water Quality
Rio Minho/ CH 43+000	☑
Rock Halt/ CH 53+000	☑
Milk River/ CH 61+000	☑
Spring Grove/ CH 63+000	☑
Total	**4**

4.2.7. Noise

Twelve (12) noise-monitoring sites were selected and coincided with the air quality sampling stations. Noise level readings, wind direction and any unusual local noise sources were recorded. The same rationale employed in locating the air quality stations was used in

establishing the noise measuring stations

4.3. Biological Environment

The vegetation and habitat types were classified using the aerial photographs combined with information gathered during the field visits.

4.3.1. Flora

All species of flora and fauna encountered at anytime during the fieldwork have been added to the total species list. However given the lack of homogeneity and the linear layout of the site a stratified random sampling regime was utilized. The habitat types were sampled independently using randomly placed point counts for birds and small belt transects for plants. Belt transects will be 5m wide (i.e. 2.5 m to each side of the centre line) and 20m long giving a total of $100m^3$. The actual number of transects in each zone were determined by using a species area curve to determine the optimum number for each habitat type. Abundance of each species were determined by frequency of occurrence in the sample plots and were classified into abundance classes using a **DAFOR** (Dominant, Abundant, Frequent, Occasional or Rare) scale.

4.3.2. Fauna

Surveys of the flora and selected faunal groups of the proposed site were conducted in June, July and August 2007. Bird surveys were carried out at 13 representative points throughout the study area, on 1-2 August 2007. The standard point count methodology was used. All birds heard and seen were counted over a 6 minute period at each point. The points are listed in Table 4.3.2. A species area curve was used to determine the adequacy of the number of sample points. Night birds were surveyed on 1st August 2007. For the night bird surveys, ten minutes were spent at each point. Sound playback was used to increase detectability of Northern Potoo and Jamaican Owl.

Since bird sampling only occurred during the months of June, July and August no neotropical migratory species were expected to be found. This could potentially exclude more than fifty percent of the total were species that utilize the habitats and as such a separate table of the most likely migratory species for the various habitat types has been generated based on species lists

collected from similar habitat types in the general area of the study site. Point counts were distributed randomly along the length of the route using a set of random numbers between 400 and 2000 to determine the distance to the next point. The numbers represented metres on the ground and started at 400 to ensure that no two points are closer than 400m apart. This would minimize the possibility of counting the same individual at more than one point. The methodology may have been modified slightly in the field where problems of access to certain points were prohibitive. Point counts were six minutes long and all species and the numbers detected (seen or heard) were recorded. Special playback or pre-recorded bird calls were used to assist with the detection of selected rare or nocturnal birds. The methodology followed recommendations contained in (Wunderle, 1994.) for sampling birds in the Caribbean.

Sampling of the invertebrate and fish life occurring in the various waterways traversing the routes were conducted at specific points where possible.

Fish and shrimp samples were done using dip nets. Local people were also interviewed.

Table 4.3.2: Bird Survey Points

#	NAME	HABITAT TYPE	DESCRIPTION	TIME	N	W	Elevation
1	MELROSE BYPASS 2	Roadside scrub	Secondary scrub and pasture	640	18 24.0116	77 99.008	
2	MELROSE BYPASS 2	Roadside scrub	Secondary scrub and pasture	655	18 03.007	77 26.479	882
3	MELROSE BYPASS 3	Roadside scrub	Restored bauxite, scrub and pasture	704	18 02.300	77 22.836	652
4	PORUS 1	Rural settlement and cultivation	Food forest, pasture and houses	717	18 02.101	77 25.171	466
5	PORUS 2	Rural settlement and cultivation	Food forest, pasture and houses	729	18 01.805	77 24.927	451
6	PORUS 3	Rural settlement and cultivation	River corridor and fruit trees	742	18 01.608	77 24.048	430
7	SCOTTS PASS	Rural settlement and cultivation	Secondary scrub and pasture	805	18 00.882	77 22.807	495
8	CLARENDON PARK 1	Pasture and canefields	Canal, trees and pasture	827	17 59.365	77 21.685	193
9	CLARENDON PARK 2	Pasture and canefields	Pasture	839	17 58.924	77 29.632	198
10	SWEET AND JUICY	Pasture and canefields	Sugar Cane and pasture	855	17 58.003	77 18.405	178
11	CURATOE HILL	Disturbed dry limestone woodland	Secondary dry limestone woodland	919	17 56.821	77 15.144	265
12	MINERAL HEIGHTS	Disturbed dry limestone woodland	Secondary dry limestone woodland	936	17 56.157	77 13.859	295
13	SAVANNA CROSS	Disturbed dry limestone woodland	Secondary dry limestone woodland	956	17 58.174	77 12.386	188

4.3.3. Portland Bight Protected Area (PBPA)

A small portion of the highway, at the beginning of the alignment at Sandy Bay traverses the Portland Bight Protected Area (PBPA). Information on the PBPA in the vicinity of the alignment is presented. The Caribbean Coastal Area Management Foundation (CCAM) are the co-managers of the Park, along with NEPA. CCAM has been contacted with regard to the Alignment and the TORs sent to them for review (Appendix V). The relevant legislation for the PBPA has also been reviewed for the EIA.

4.4. Socio-economic Environment

Information on land-use, employment and livelihoods, economic enterprise, demography, social/community structures, and traffic and transportation were collected from secondary sources and field investigations.

Field investigations involved a community rapid appraisal and in depth interviews with key informants and community members in the communities mentioned below.

The methodological approach for the baseline data involved the following methodological approaches:

Desk Research

1. Rapid Appraisal
    a. Rapid Appraisal
    b. Key Stakeholders' Interviews
2. Assessment

4.4.1. Desktop Research

The desk research reviewed and analyzed all the relevant socio-economic data available from both recommended sources and other national sources that would help to put the project into its local, industry and national context.

Included in desktop research was project specific documentation. For example any pre feasibility or feasibility reports on the proposed expansion, community related social or economic reports by government agencies, and traffic studies.

Reference, where necessary, is made to topographical and cadastral mapping and GIS where available.

4.4.2. Rapid Appraisal

The rapid appraisal involved established techniques to get a quick, but in-depth orientation to the project area and its constituent communities and to identify key issues for the project to consider.

a) Rapid Appraisal, including reconnaissance;

b) Key Stakeholders' Interviews.

a) Rapid Appraisal

The appraisal began with the Reconnaissance, where the study team drove through the project area to familiarize themselves with the locations and landmarks. The opportunity was taken at the same time to meet key persons who might be strategic in relation to the socio economic assessment and to note any features or establishments or activities that might warrant further investigation, such as: heritage elements, social capital, informal or unplanned settlements (including squatting) obvious forms of environmental degradation, other related activity and business activity of significance.

The project zone of immediate influence was defined based on the socio economic impact of the project in the local context, which would include the near communities (residential or industrial/commercial) that will directly experience the highway.

The communities included in the project zone of immediate impacts are:

1. Sandy Bay
2. Savannah Cross
3. Hunts Pen
4. Mineral Heights
5. Halse Hall
6. Curatoe
7. May Pen
8. May Pen Bypass
9. Foga Road
10. Four Paths
11. Swansea
12. Belle Plain and Rock Road
13. Osborne Store
14. Rock Halt
15. McGilchrist Pen, Toll Gate and Clarendon Park

16. Scotts Pass Village
17. Scotts Pass along Main Road
18. Spring Grove District
19. Porus
20. Redberry
21. Melrose Hill
22. Melrose Hill Bypass
23. Williamsfield Area

Only those communities and neighborhoods with discernable direct project impacts were investigated using the rapid appraisal approach.

Once the preliminary scoping was accomplished, the techniques of rapid urban appraisal were applied and can best be understood as encompassing the following methodologies.

b) Key Stakeholder Interviews

In-depth structured interviews as well as non-structured *ad hoc* discussions with non targeted individuals and groups of individuals were held within the defined communities. Similarly in-depth structured interviews as well as non-structured interviews were conducted with targeted key informants. By untargeted is meant those respondents who are approached more or less on a random basis, but in selected locations. Whereas targeted individuals are those key informants, pre selected for interviewing, whether by appointment or otherwise.

The total number of interviews conducted 306 persons. This is considered to be more than sufficient to bring into focus those positive or negative impacts that the communities and stakeholders are likely to perceive.

4.4.3. Assessment

The main themes addressed in the report are:

- typology (urban, rural, unplanned residential, housing scheme, etc.)
- land uses and livelihoods

- developments underway
- community facilities
- social infrastructure
- heritage
- intersections and social right of ways
- flooding experience
- community attitude

4.4.4. Archaeological and Cultural Heritage

A letter was sent to the Jamaican National Heritage Trust (JNHT) to determine if the proposed alignment crossed any areas on the National Sites and Monuments List (Appendix V). Additionally, desktop research was conducted and information presented in the Strategic Environmental Assessment (Dessau- Soprin, 2000) was reviewed and relevant portions included in this report.

4.4.5. Public Consultation

Public Consultation was conducted as part of the data gathering exercise during the Environmental Impact Assessment. Public Consultation took the form of structured interviews with targeted stakeholders and key informants; ad hoc interviews within the zone of impact of the project and community interviews. This Public Consultation serves the purpose of information gathering, information sharing, and to ascertain public perception on the proposed project.

In addition to the Public Consultations during the EIA preparation, the National Environment and Planning Agency (NEPA) usually requests a Public Meeting to present the findings of the EIA. This takes the form of a large community meeting which must be preceded by a requisite twenty-one day notification period in the media, letters of invitation to stakeholders, Non Governmental Organizations (NGO's); Government agencies and the community. During the notification period, copies of the EIA Report were made available for public review at the Parish Council Office, the Parish Library, the Documentation Centre at NEPA and the office of the project proponent. The meeting is recorded verbatim and a separate report is prepared for

submission to NEPA. This report contains relevant information on the proof of notification of the meeting (such as newspaper advertisements); the list of invitees; the agenda; any presentations made; and the question and answer session. At the end of the Public Meeting the public is given a thirty (30) day period in which to send comments to NEPA. In addition to the EIA Report, NEPA and its sister agencies will review the Report of the Public Meeting and any comments received before making a decision on issuing a permit.

Public Consultation Number 1 was held on Thursday June 28, in May Pen. This consultation was not a requirement by NEPA but served as a presentation of the project to the public, presentation of the Draft TORs for the EIA, to determine public sentiment and for information gathering (Appendix VII).

Public Consultation Number 2, for presentation of the findings of the EIA will be held after the submission of the EIA to NEPA and the mandatory notification period is adhered to.

4.5. Prediction of Potential Impacts

The various aspects of the project and the potential impacts on the physical, biological and socio-economic environment were identified and presented in an Impact Matrix.

The selected aspects highlighted for consideration in depth were:

- The Alignment
- Hydrology and Drainage
- Traffic Flow
- Location of Interchanges and Toll Plazas
- Social rights- of- way and dislocation issues
- Land Acquisition
- Sourcing, Transport and Deployment of Earth Material
- Noise and Air Quality
- Water Quality
- Modification of Habitats
- Soil Erosion

- Natural Hazard Risk
- Proposed Developments

Impacts were identified as follows:

Duration:	short, medium or long term
Direction:	positive or negative
Magnitude:	major or minor
Type:	reversible of irreversible

4.6. Limitations to the Study

Some limitations to the study were identified and are recorded here to ensure that there is complete understanding of the methodology used, the data generated and the application of impact prediction. These limitations are:

1. The geological and hydrological assessments were based on the review and evaluation of reports and maps varied by ground-truthing. No new data was produced but data were updated, where possible. Some government agency queries were unable to make current reports available within the requested timeframe.

2. Water quality data was collected over a 3 day period during June. The period was relatively dry and so no rainy period data was collected.

3. Assessment of birds was conducted in the summer months and no information on species actually observed during the winter months was available. However reference is made to species likely to be found on the site in winter months based on historical data.

4. The comments made on runoff are based on other published documents for the larger catchments. The smaller catchments are based on rainfall intensity equations developed in the Strategic Environmental Assessment (SEA) of June 2000 (Dessau- Soprin International, 2000).

5. The comments made on groundwater conditions are based on satellite maps, WRA data points and other reviewed public documents. It should be noted that groundwater levels will vary owing to seasonal, tidal and weather related effects.

6. The evaluations and recommendations contained in this report represent the professional opinion of the EIA team members. These opinions were arrived at in accordance with currently accepted industry practices as well as environmental and engineering practices.

5. The Existing Environment

5.1. Physical Environment

The data on the physical setting, site and situation was compiled from field reconnaissance, current public domain reports held within various governmental and non-governmental bodies and internet searches.

Data collection for the physical environment is detailed in Section 4.1 and 4.2 of this report.

5.1.1. Site and Situation

The highway starts at approximately 270000mE, 1983514mN (UTM) at the western end of Old Harbour Baypass, keeping south and roughly parallel to the existing A2 roadway. The proposed alignment travels to the north of Halse Hall, and crosses the Rio Minho parallel to the existing river crossing. It continues east across Denbigh and then north-westerly toward the existing railway line at around Belle Plain. It then runs parallel to the southern side of the railway until it crosses the railway at Clarendon Park. The highway then traverses hilly terrain of the limestone hills of Berry Dale continuing to the north-west keeping south of Old Porus before crossing the existing A2 roadway, the railway and the Milk River at a single point, just east of Porus. It then continues north-west incorporating the existing Melrose Bypass, and crossing the existing railway and before joining the main road just south of the Williamsfield roundabout at 242970mE, 1996008nN (UTM), (Figure 1.0).

Site walkovers were done on May 04 and June 27, 2007 to firstly visually appreciate the route of the highway, and then to investigate drainage issues on the western section of the highway as observed and catalogued by Mr. Tim Lankester (Pers. Com.) over the past decades.

The highway construction of approximately 38km long, two lane, tolled dual-carriageway with the expressed purpose of extending the existing highway to Williamsfield. The highway will alleviate much of the congestion now common on the existing A2 roadway that serves the southern parts of the island.

5.1.2. Climate and Rainfall

Local climate in the coastal plain is dry to very dry with average yearly precipitation of less than 1200 to 1800 mm. Daytime temperatures average 31^{o}C, with higher peaks between June and September and lower temperatures between December and January. Although this areas does not receive as much rainfall as the rest of the island, it still is an area prone to flooding because of the water flowing down the mountains that occupy the central part of the country. Poorly absorbent soils fail to retain any of the rainwater that flows down the gullies or disappears in sinkholes. Thus, despite the relatively low rainfall, where the corridor passes through alluvial plains and interior valleys such as the Rio Minho floodplains, there is high flood potential.

From Scott's Pass area to Williamsfield, the higher altitude affects the mean temperature range, which is 28oC. Recorded rainfall shows increase in this area, rising to 2100 mm yearly. The Mandeville area is known to have a particular microclimate that allows for cooler temperatures year round making it a favourite retirement area for Jamaican's who have lived overseas for long periods.

The rainfall data was obtained from the Meteorological Service of Jamaica (Met Service) website dated May 2007. Generally, Jamaica's rainfall pattern is bimodal (Figure 5.1.2a) with rainfall peaks occurring in May and October and the drier periods occur in February/March and July.

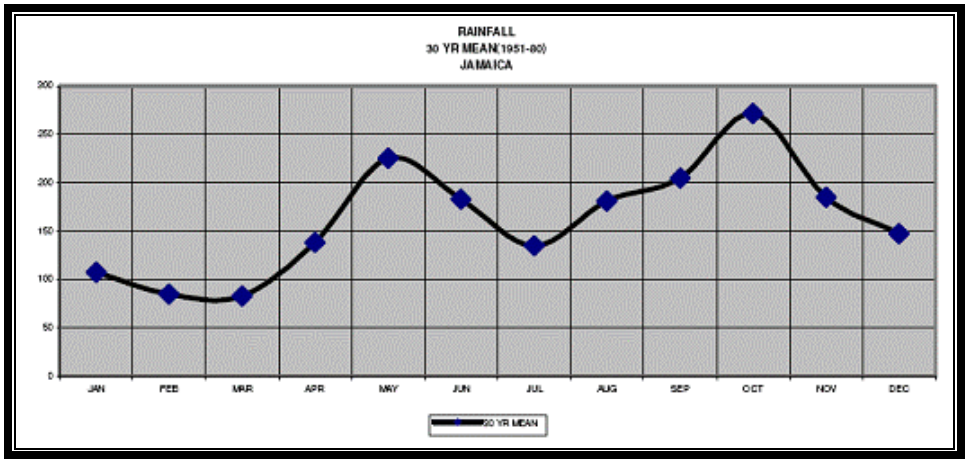


Figure 5.1.2a 30-yr mean precipitation pattern across Jamaica (1951-1980)

The 30- year mean rainfall patterns are presented below for the parishes of Clarendon (Figure 5.1.2b) and Manchester (Figure 5.1.2c), (all rainfall depths are in mm).

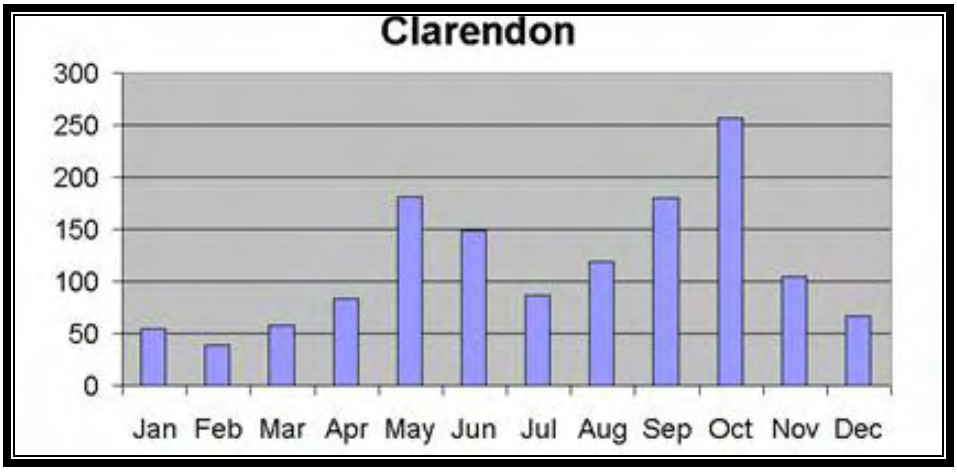


Figure 5.1.2b 30-yr rainfall pattern for Clarendon

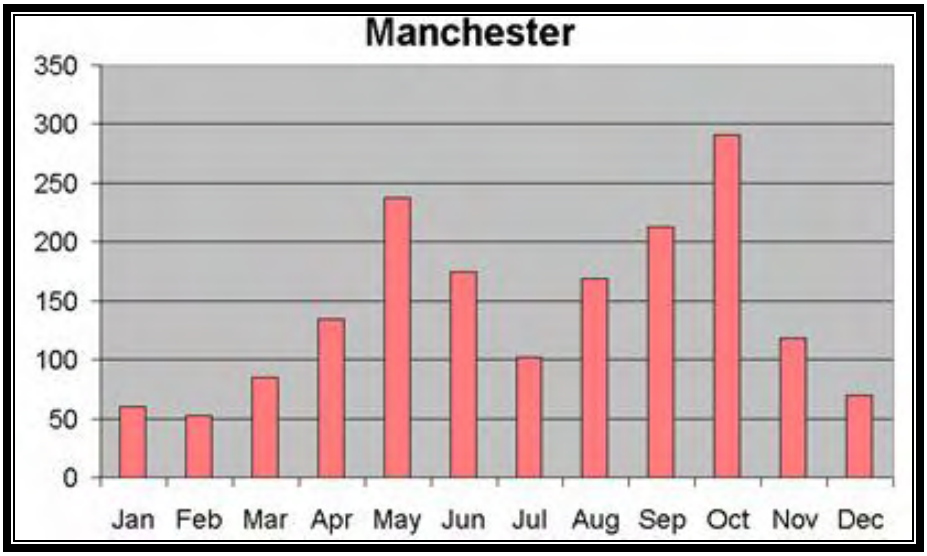


Figure 5.1.2c 30-yr rainfall pattern for Manchester

Current rainfall patterns show that for the parish of Clarendon the rainfall is 120% above the long-term average for the month of May 2007. Manchester on the other hand shows a 66% decline against its 30-yr mean. The previous two months, March and April 2007, showed

increases and declines respectively.

On a more regional scale, global warming models, suggest that changes in the Caribbean Climate will be linked negatively to temperature changes suggesting that "the bigger the temperature rise the larger the change in precipitation". The areas most likely to experience summer drying trends are the larger islands, such as Cuba, Jamaica and Haiti/Dominica Republic. But the report stresses that precipitation changes are very difficult to predict with certainty, and it should always be borne in mind that there is a natural variability, form month to month, year to year and decade to decade.

5.1.3. Geology, Topography and Soils

Published geological information (extracts of Sheet 12, 13, 16 and 20 shown in Figure 5.1.4a shows the superficial and solid geology along the right-of-way (ROW) for the highway. Topographically, Sandy Bay and Clarendon Park, is generally flat sloping gently to the south. The route beyond Clarendon Park is typified by rolling limestone hills.

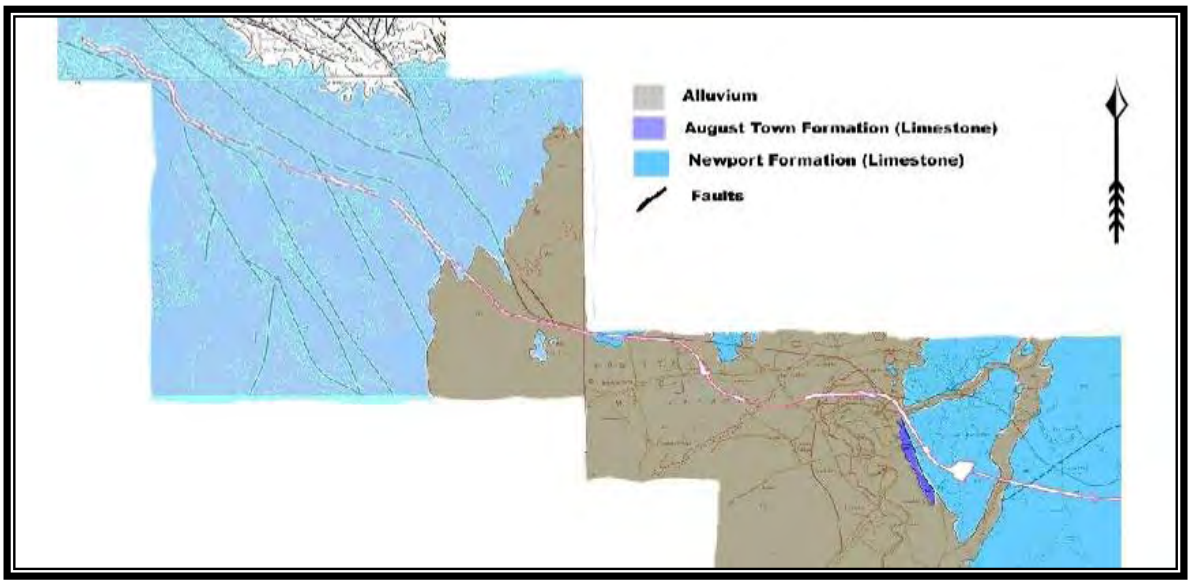


Figure 5.1.3a Geology Map Extract along the alignment (Not to Scale)

The geology is broken into four sections: Sandy Bay to Four Paths, Four Paths to Clarendon Park, Clarendon Park to Porus and Porus to Williamsfield.

Sandy Bay to Four Paths:

The overlying soil deposits beneath this segment comprise mostly of the Bonny Gate Stony Loam (Figure 5.1.3b) at Sandy Bay with the Agualta Clay and Loam being more prominent towards Four Paths.

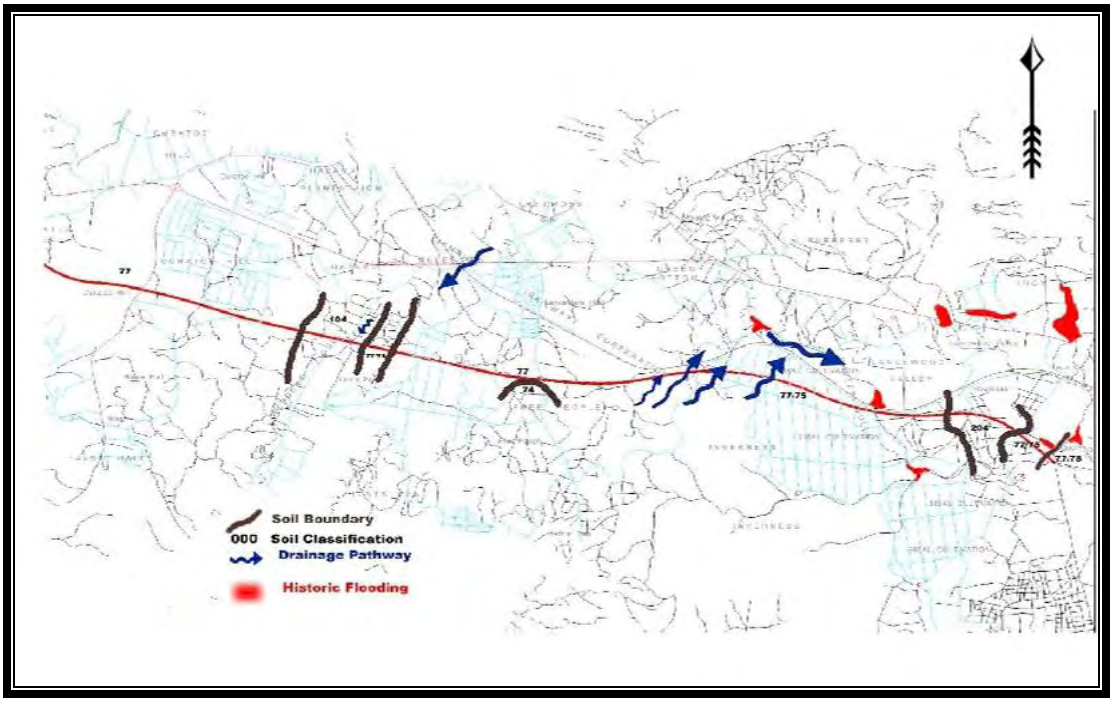


Figure 5.1.3b :Soils, Drainage and Historic Flooding Map along proposed Alignment

(Not to Scale)

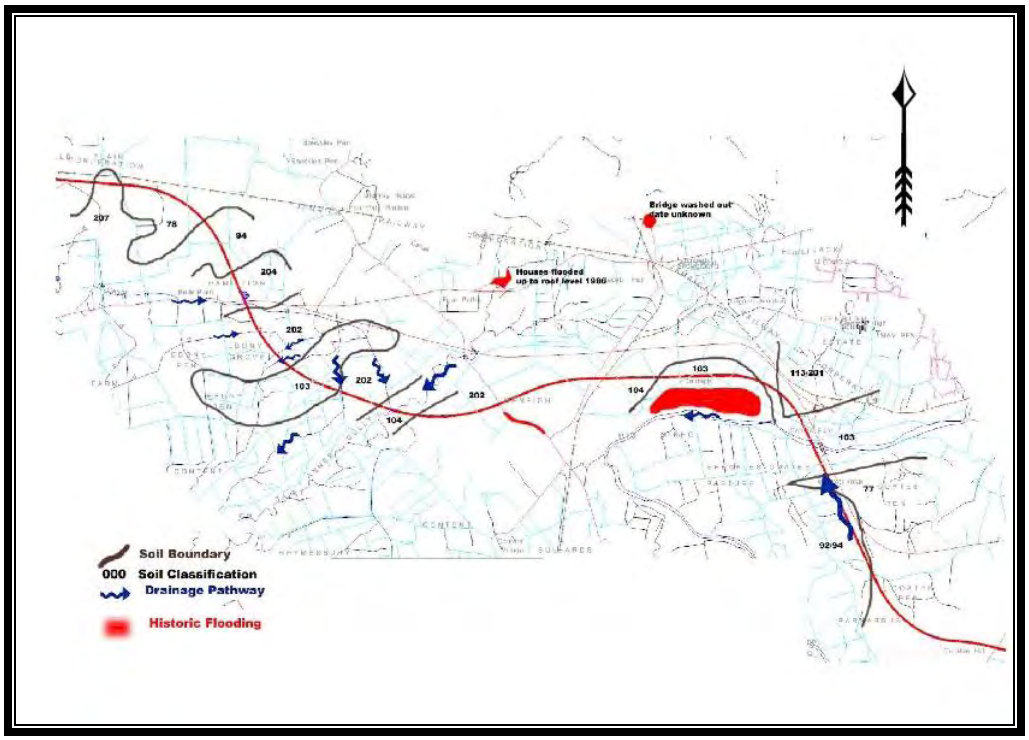


Figure 5.1.3b (Cont'd)Soils, Drainage and Historic Flooding Map along proposed Alignment (Not to Scale)

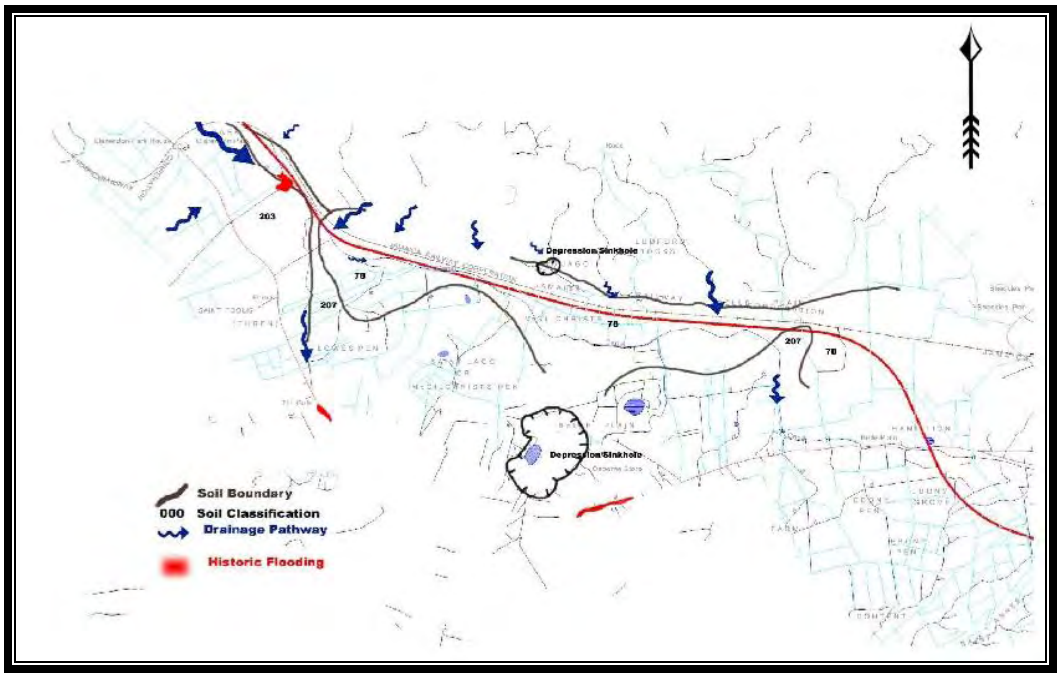
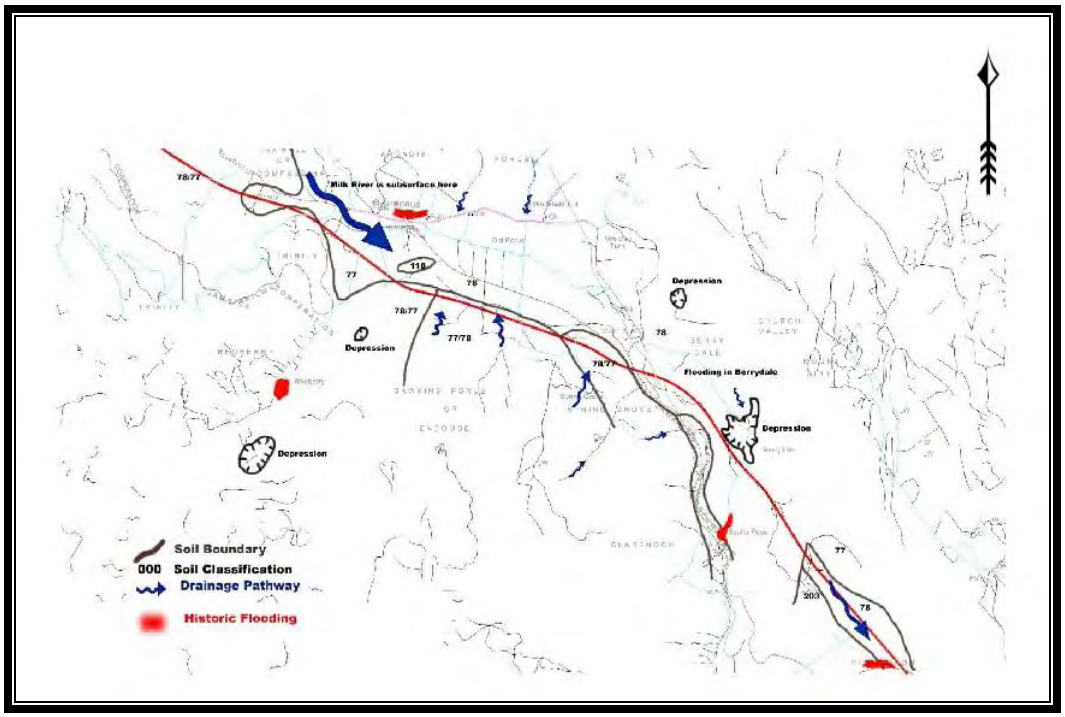


Figure 5.1.3b:(Cont'd) Soils, Drainage and Historic Flooding Map along proposed Alignment (Not to Scale)



.Figure 5.1.3b:(Cont'd) Soils, Drainage and Historic Flooding Map along proposed Alignment (Not to Scale)

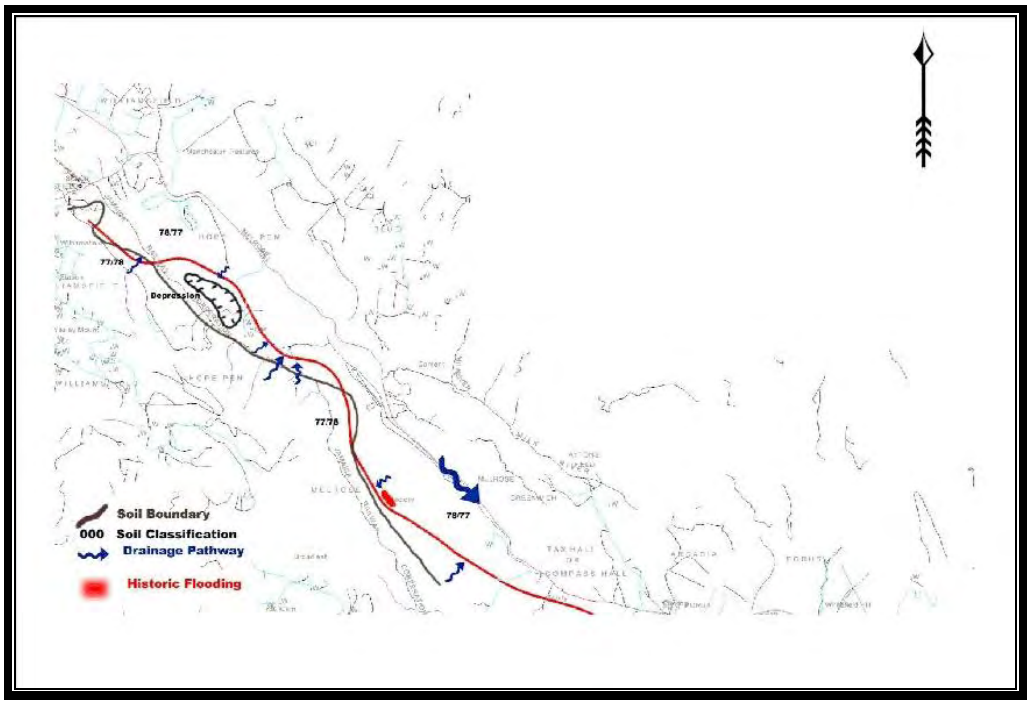


Figure 5.1.3b: (Cont'd) Soils, Drainage and Historic Flooding Map along proposed Alignment (Not to Scale)

The Alluvium deposits, which are similar to these soils deposits, are derived from Cretaceous rocks found further north of the site and comprise coarse gravel, sand and clay.

The Alluvium deposits generally occupy the, the ancient and extant, gully channels (Shutes/Webber gully) or river channels (Rio Minho) carved into the limestone. The Alluvium deposits of the Webbers Gully trending southwesterly represent one such fossil channel of the Rio Minho. There are two buried channels incised into the limestone, the deeper one runs in a NNE-SSW path from Jacobs Hut through Content carrying on to the sea at Marcarry Bay. The second lies along a NNW-SSE line just west of the Brazilletto Mountains.

These superficial deposits overlie the Miocene Newport Limestone Formation, which is broadly sub-divided into three horizons: lower, middle and upper. These are not demarked on the geological maps. The geological notes indicate that the detrital middle fraction (comprising rubbly, thin-bedded reef deposits with pockets of clay and quartz sand) outcrops substantially between Clarendon Park and Old Harbour to east. A minor outcropping of the August Town Limestone Formation (yellowish, marly limestone and sandstones and conglomerates), which lies unconformably above the Newport Formation exists just east of Woodleigh. Structurally, historic movements along the normal fault would have responsible for the juxtaposition of the younger August Town Formation against the older Newport Formation.

Structurally, two faults are crossed by this segment, one N-S trending fault in the vicinity of Inverness (b. km 33+500and 34+000) and the other NE-SW trending just north of Hunt's Pen (b. km 39+000 and 39+500). It is not known if these faults are active, but it is likely that material will be more fractured within these zones.

Both the limestone and the upper alluvial deposits are classified as aquifer by the WRA.

<u>Four Paths to Clarendon Park</u>

The overlying soil deposits beneath this segment, from east to west, comprise broadly of the St. Ann Clay Loam, Rhymesbury Clay and Four Path Clay (Figure 5.1.3b)

The Alluvium deposits occupy the majority this segment. In the west the Rio Minho and its associated gullies are mostly responsible for its development, draining Creatacous material to the north. Whilst in the west of this segment the Milk River is largely responsible for the alluvial deposits derived from erosion of the surrounding limestone hills. Interestingly the alluvial deposits roughly parallels the 76m (250ft) contour on the geological sheets.

These superficial deposits again overlie the Miocene Newport Limestone Formation.

Structurally, only one fault (NW-SE trend) is crossed during this segment just east of Clarendon Park (km 61+500). This is likely to be the eastern most normal fault (Whitney Fault) associated with the Porus/Wiliamsfield Graben. The Porus/Wiliamsfield Graben is considered major structural element within the Rio Minho Hydroglogic Basin and portions of Manchester. Several depressions are also noted on the 1:12,500 series sheets in the vicinity of St. Jago. The WRA map (Figure 5.1.3c) shows three depressions north of the railway (around km 59+000).

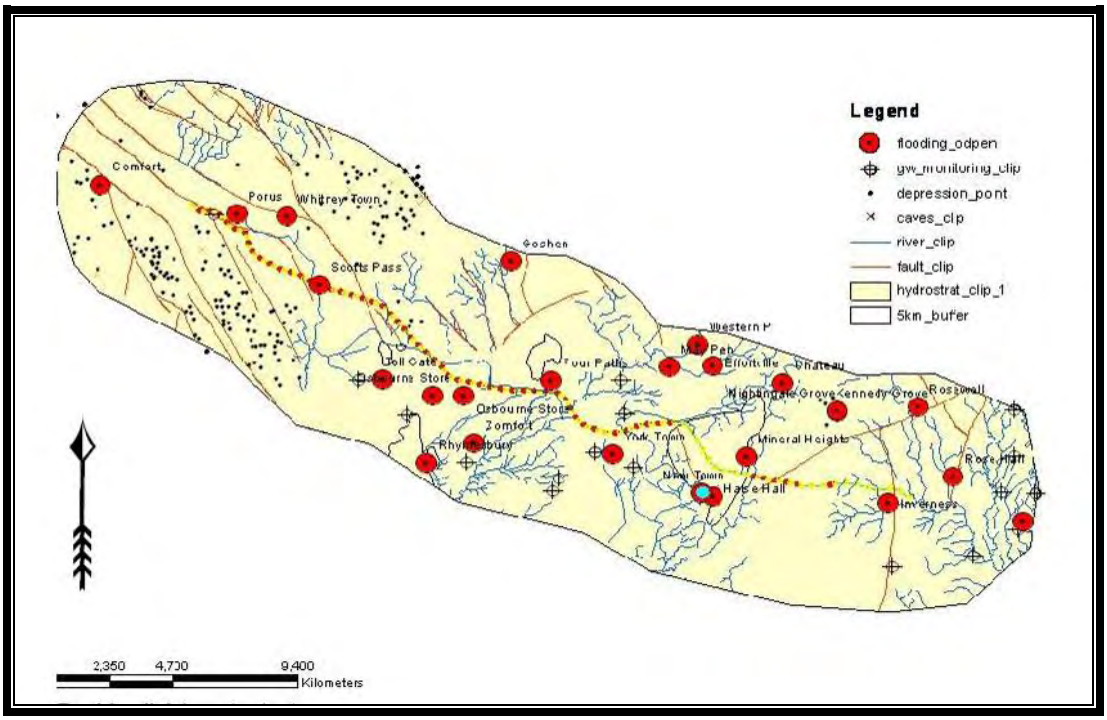


Figure 5.1.3c: Hydrogeologic Setting, showing caves, depressions, faults, floods (ODPEM) and groundwater monitoring points

Clarendon Park to Porus

The overlying soil deposits beneath this segment, from east to west, comprise broadly of the Bonny Gate Stony Loam and St. Ann Clay Loam (Figure 5.1.3b).

The Alluvium deposits occupy only the eastern section between Clarendon Park and Scotts Pass where becomes absent roughly above the 120m (400ft) contour. The Miocene Newport Limestone Formation represents the solid geology from Scotts Pass to Porus and continues beneath the Alluvium at Scotts Pass and Clarendon Park.

Structurally, the beds of the Newport Formation show a shallow dip (5° - 10°) to the east. One fault is crossed at around km 64+500 and is associated with the Porus/Williamsfield Graben faults. A Clarendon Park Caves is noted on the 1:12:5000 topographic map and caving maps held by the WRA in the vicinity of Berrydale (c. km 63+000).

Porus to Wiliamsfield

The overlying soil deposits beneath this segment, from east to west, comprise broadly of the Bonny Gate Stony Loam and St. Ann Clay Loam (Figure 5.1.3b). No Alluvium deposits occupy this section.

The Miocene Newport Limestone Formation represents the solid geology along the entire segment. Here the upper, recrystallised, white/pink limestone is the more dominant horizon. Structurally, the normal faults associated with the Porus/Willamsfield Graben are the main features. From the highway route in hand, it seems that the section from Porus to the Melrose Bypass parallels closely one of the faults of the graben possibly crossing it or lying on top of it. It then crosses over the fault again at km 70+500.

The dips of the limestone beds in this area are variable in both direction and amount due to the faulting. Appropriate engineering prudence will need to be taken during cutting operations to ensure that bedding planes do not daylight into final cut slopes.

5.1.4. Natural Hazard and Geotechnical Classification

5.1.4.1. Geotechnical Classification

Alluvium: deposits extremely variable vertically and laterally, excessive differential settlement and high erodability. The presumed bearing capacity ranges between moderate to low (40 – 700 KN/m^2). Slope stability is highly dependent on in-situ soil strength, particularly cohesion.

Newport Limestone Formation: in the exposures along the route are more variable ranging from soft to nodular chalks to recrystallised limestones. Soil development is minor or thin in mountainous areas and considerably thicker fills in depressions and low-lying regions. Bearing capacity is presumed to be good (1000 – 4000 KN/m^2). Karstic drainage features such as solution features (sinkholes) are present and checks need to be done for such structures wherever major structures will be placed. Flooding of these depressions and gully courses are listed amount the possible construction problems. Slope stability is generally good but landslip risk increases along faults and rock falls should be anticipated.

Earth Works: The earthwork assumptions for the preliminary design approval have been based largely on information reported in the Geotechnical Study Report (Dessau Soprin, June 2000). No additional ground investigations have been carried out. Assumed soil profiles are as follows:

Km33 to 39- silt and clay deposits over rock mass
Km 39 to 51- sand deposits over silt deposits or vice versa
Km 51 to 67- clay deposits over silt deposits or rock mass at shallow depth.
Km 67 to End- rock mass at ground level.

In developing this earthworks profile, the limited number of boreholes, which were carries out as part of the Dessau Soprin study, were examined and an assessment made of the levels of the rock mass at various locations. In that report, rock mass was generally at Km 57 to the end. On a general basis, the upper part of the rock mass is completely to highly weathered becoming moderately weathered with depth. Some locations exposed a slightly weathered rock mass. The

rock consists of an extremely weak to medium strong white to beige fossifiliferous limestone with some dissolution cavities. Locally, the rock is dolomitised. The rock quality is generally very poor to poor (i.e. very fractured).

It is understood that the design engineers will be suing the following assumptions for the cut and fill earthwork slopes:

Cut: in rock mass 5:1, in all other areas slopes will be defined depending on soil/rock type and the density of fracturing and fracture orientation into the cut slopes.

Fill: embankment height up to 2 metres 1:3, embankment height over 2 metres 1:1:5

The cut-and-fill budget is net-neutral so no surplus material requiring disposal during, or at the end of the project is foresee. In reality, the movement of earth along the alignment cannot be accomplished perfectly as planned, and there will always be some amount of waste. This will be short term and kept to an absolute minimum.

5.1.4.2. Seismicity

The OAS seismic risk maps of Jamaica (Figure 5.1.4.2a) 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 projected to be between 14 -18 cm/sec and 220 – 270 gals for horizontal ground acceleration reducing toward the west. These predictions assume a significant earthquake event in the eastern parishes – the most geologically active part of the island. A more localized event may change these figures.

The potential for earthquake related ground shaking throughout Jamaica was studied by Shephard, 1997. Figure 5.1.4.2a shows the range of peak horizontal ground acceleration that can be expected across Jamaica; Figure 5.1.4.2b shows the expected maximum Mercalli Intensity; and Figure 5.1.4.2c shows the horizontal ground velocity.

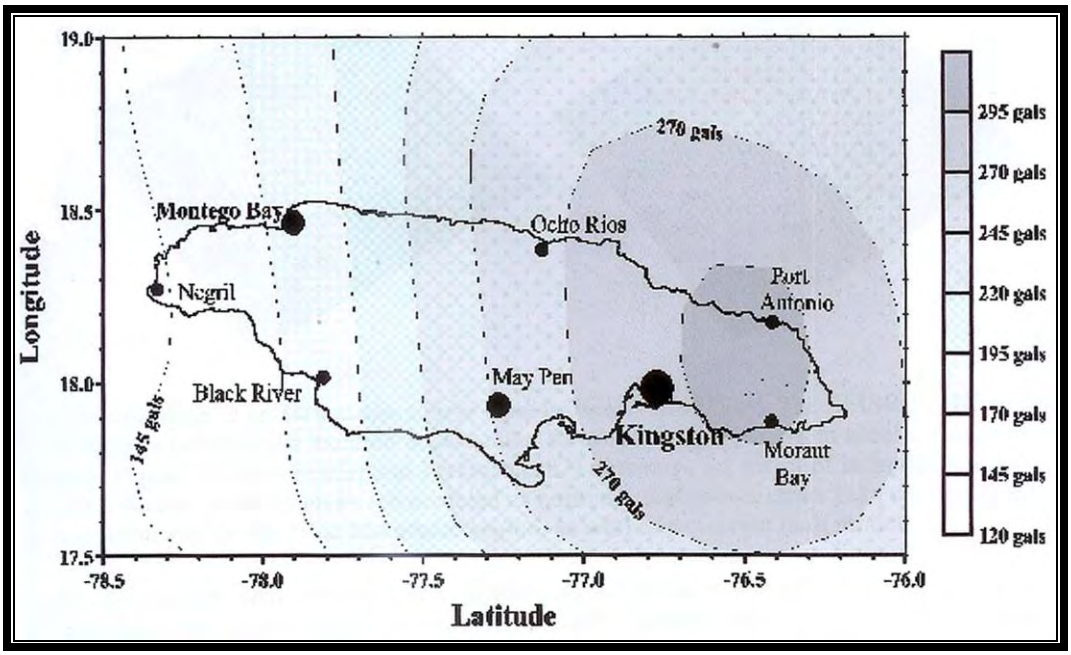


Figure 5.1.4.2a: Expected Peak Horizontal Ground Acceleration

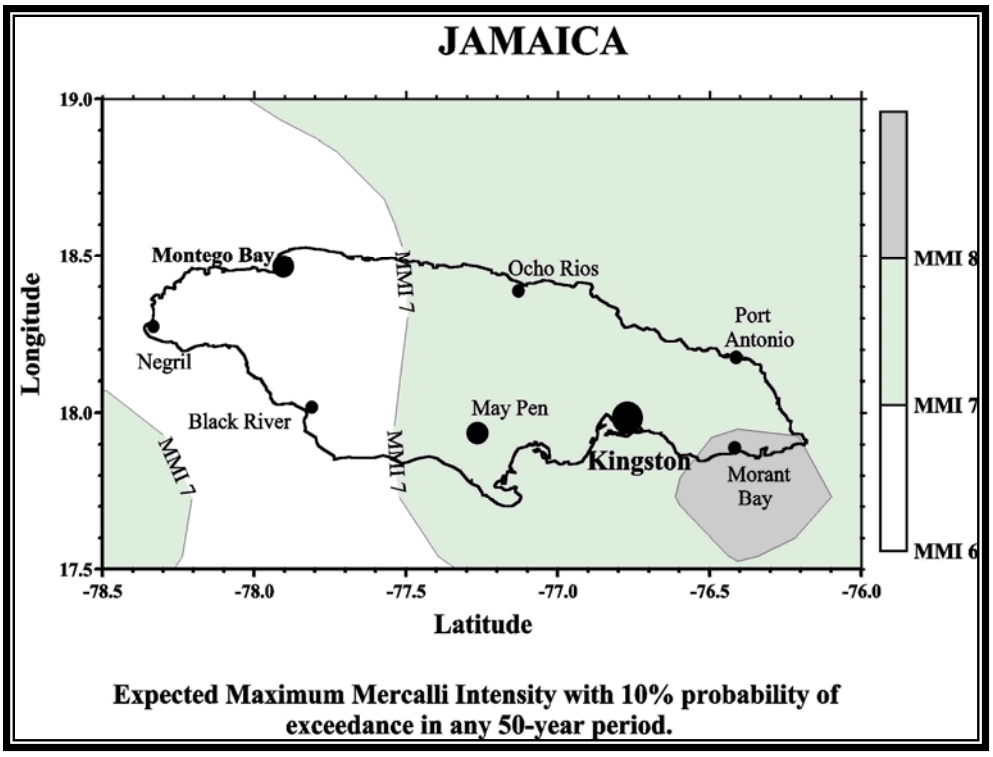


Figure 5.1.4.2b: Expected Maximum Mercali Intensity with 10% probability of exceedance in any 50-year period

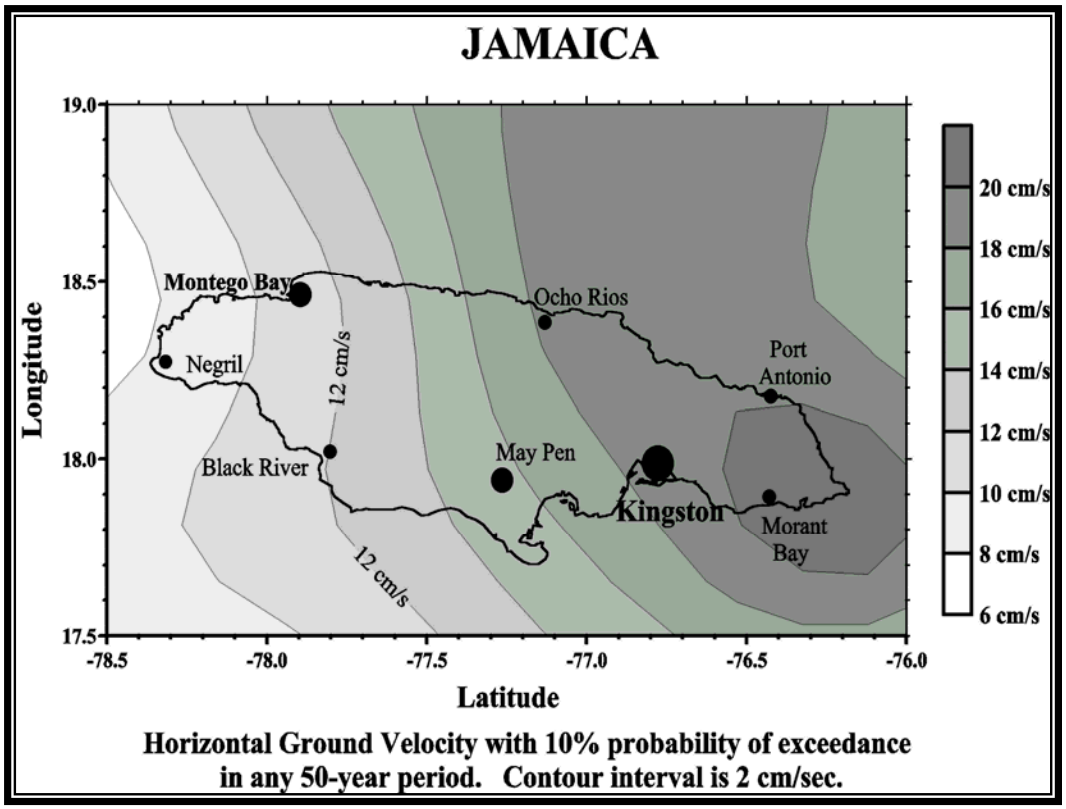


Figure 5.1.4.2c: Horizontal Ground Velocity with 10% probability of exceedance in any 50-year period. Contour interval in 2cm/sec.

Source of maps : Shephard, *et al*, 1997 and www.oas.org/cdmp/document/seismap/jamaica.hmt)

5.1.4.3. Landslide Susceptibility

Landslide susceptibility map of the upper catchment of the Rio Minho Catchment shows areas of significant soil erosion coinciding with high landslide susceptibility zones, shown in red. Though the study area is north of the proposed route it demonstrates that significant soil material is potentially available for mobilization in the mountainous zones of the upper catchment during rainfall events. If mobilised, this sediment load in the Rio Minho will modify the viscosity of its discharge waters resulting in increased hydraulic forces being placed on any structure crossing the Rio Minho downstream. Modeling considerations at crossings should include viscosity changes to the discharge water as this is are more likely to represent the reality experienced in Jamaica's rivers and gullies during high intensity rainfall events.

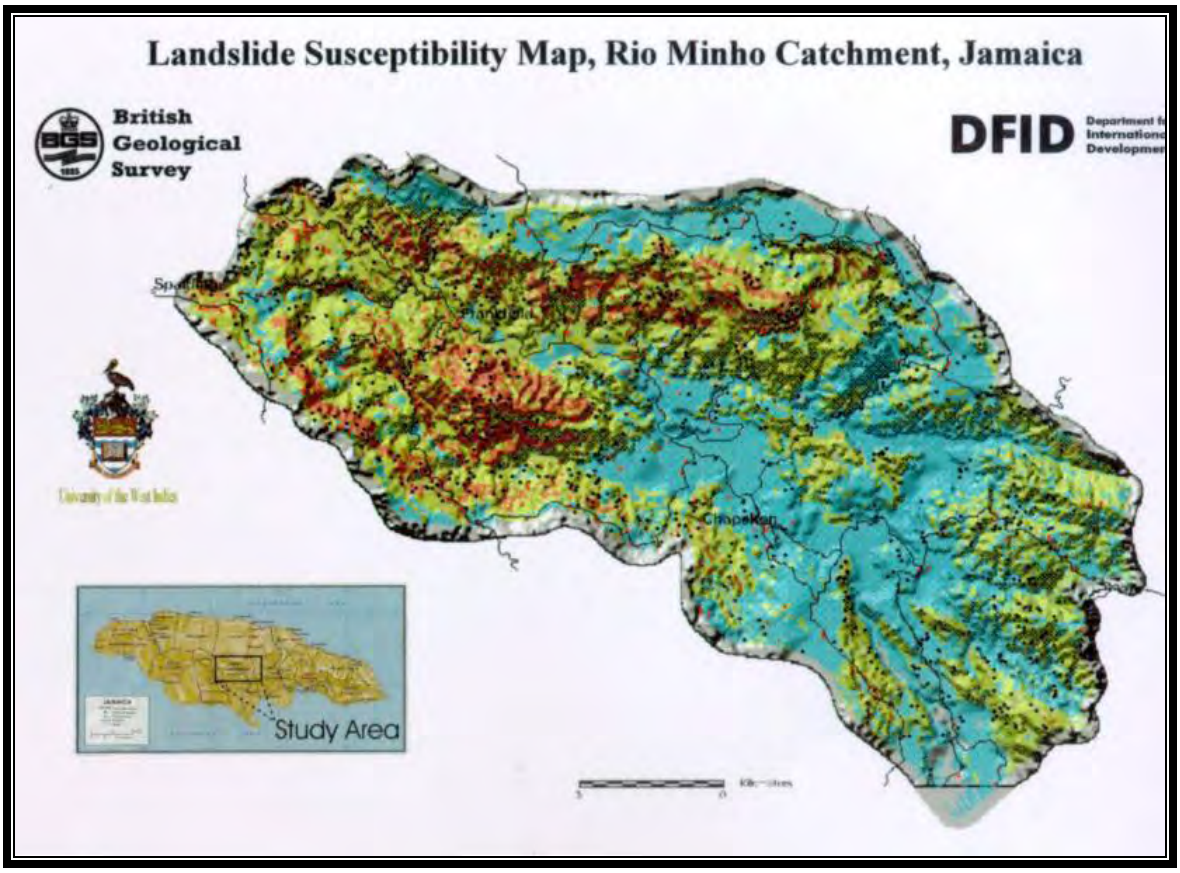


Figure 5.1.4.3 : Landslide susceptibility Map of the Upper Rio Minho Catchment (taken from http://www.mona.uwi.edu/uds/index.html)

Slope modification within the mountainous areas after Clarendon Park will modify the existing slope conditions possibly making them more susceptible to slope instability especially after intense and prolonged rainfall. However, this is completely manageable via the application of appropriate geotechnical mitigating solutions (e.g., appropriate finished slope angles, slope benching). The *Geotechnical Classification of Jamaican Rocks* suggests that a slope of 1:2 (26°) should be the design default in the absence of any other geotechnical information.

5.1.5. Groundwater and Surface Water Resources

The route crosses two main hydrological basins, the Rio Minho in the east and the Milk River Basin to the west. First, second and third order streams (or gullies) allied to either of the hydrologic basin are also intersected. The outline design document[i] anticipates the surface

water crossings shown below.

Table 5.1.5 - Anticipated water crossing and associated hydrologic basin

Chainage (approximate)	Water Crossing	Discharges to:
34+650	Shutes Gully 1	Bowers River via Palemetto Gully
35+650	Shutes Gully 2	Bowers River via Palemetto Gully
39+200	Webbers Gully 1	Rio Minho
39+480	Webbers Gully 2	Rio Minho
43+850	Rio Minho Bridge	Rio Minho
48+150	Jacks or St Ann's Gully	Milk River
61+250[2]	Milk River Bridge	Milk River

Of the five stream gauge stations within the 5km buffer only one, Milk River at Scotts Pass, is current and has associated instantaneous peak values. The figure below shows layout of these points along the proposed route. The Milk River at Scotts Pass (500m south of km 64+000) recorded a maximum flow of 134 m^3/s (4,721 cfs), draining an area of 288 km^2 on October 18, 2005. Based on records from 1972 to 2006 the average flow has been approximately 27 m^3/s (966 cfs).

Of the seventeen (17) groundwater monitoring points within the 5km buffer only two Porus No.2 (close to km70+000) in the west and Denbigh Farm No.1 (700m north of km 47+000) may fall within 1000m of the ROW.

Licensed water abstractions within 1000m of the ROW, includes Rules Pen (226500 mE, 142869 mN), Fattening Pasture (222447 mE, 145156 mN), Content (218758 mE, 145125 mN), Osborne Store (215894 mE, 146223 mN), McGilchrist Pen (213364 mE, 147747 mN), and Porus No. 3 (205318 mE, 153599 mN). The figure below highlights the licensed abstractions within a 5km buffer.

[2] This crossing was not specifically mentioned in the 01/06/07 document but mentioned through the document

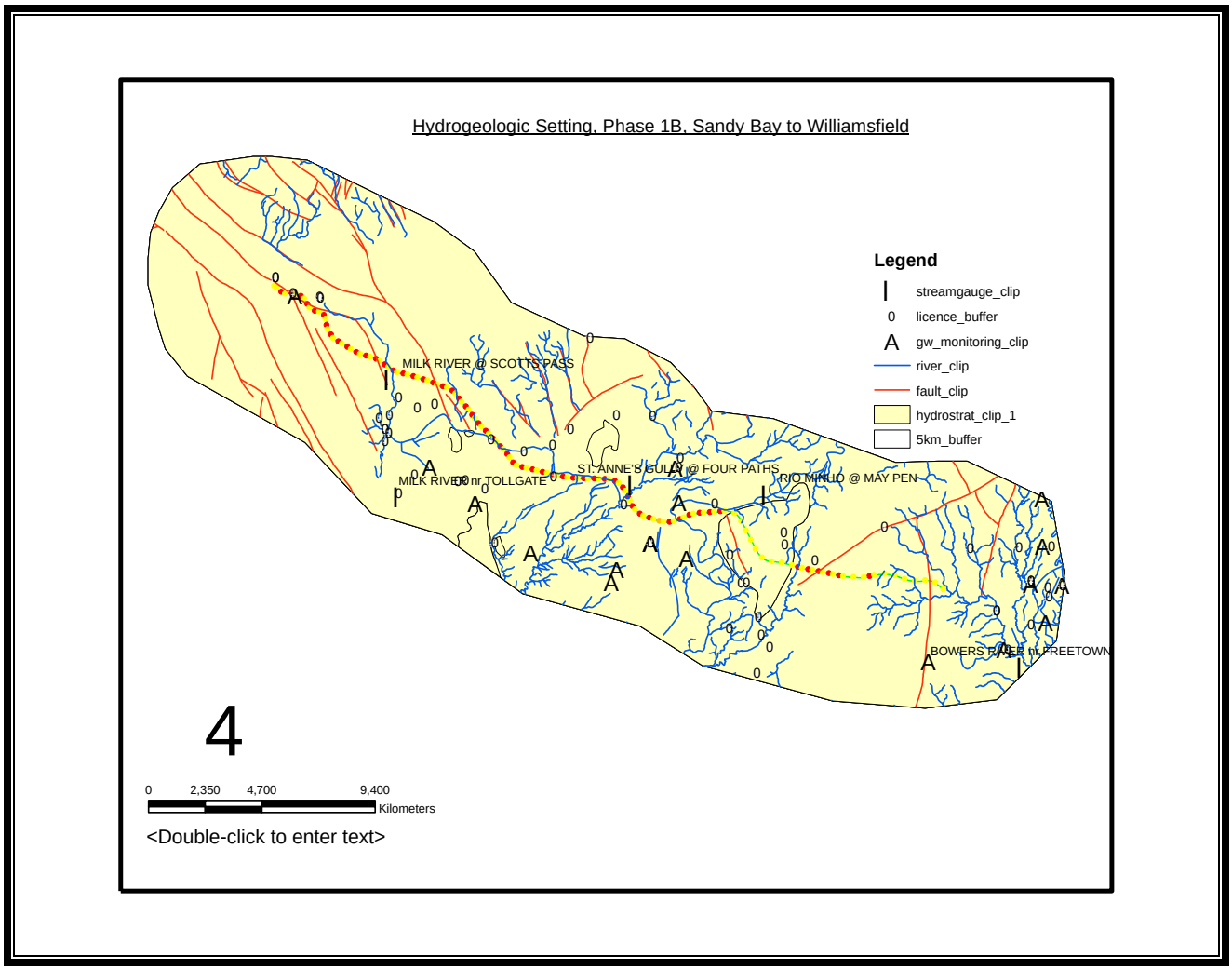


Figure 5.1.5 - Hydrogeologic Setting of Phase 1B, showing stream gauges, licensed abstractions and groundwater monitoring points.

5.1.5.1. Projected Water Demand

The proposed project will not be a significant charge on water resources in the area traversed by the alignment. The only constantly manned stations are the toll plazas at Four Paths and the May Pen Interchange, plus the Operations Building and the food concession stands. All other persons using the highway will be transient. The water demand will be minimal and will be easily met by the existing mains supplies.

5.1.6. Sewerage Facilities

There are no recorded sewerage facilities within 1000m of the ROW.

5.1.7. Historic Flooding along the Proposed Route

Southern Clarendon and Manchester are flood prone areas due in large part to their geology and hydrogeology. Several significant flood incidents in the recent past have sensitised the residents negatively. Events such as those at Inverness/Shutes Gully (May 20, 1993), Porus (May/June 2002) and Harmmons (September 2002) come immediately to mind and were brought up for debate at the public stakeholder meeting held on June 28, 2007 in May Pen (Public Consultation No. 1 Appendix VII). Mainly, concerns revolved heavily around the proposed highway's potential impact on increasing these flood hazards.

In order to address these concerns this section will discuss the three past flooding events in some details to ensure that the appropriate appreciation for there causes are established.

The section will look at the global flood events, as recorded by the ODPEM, and then look in detail at three significant flood events of the recent past.

5.1.7.1. ODPEM Flood Registry

The ODPEM database compiles flood events, normally, in populated areas. The figure and table below shows records held by the WRA for flood events recorded by the ODPEM.

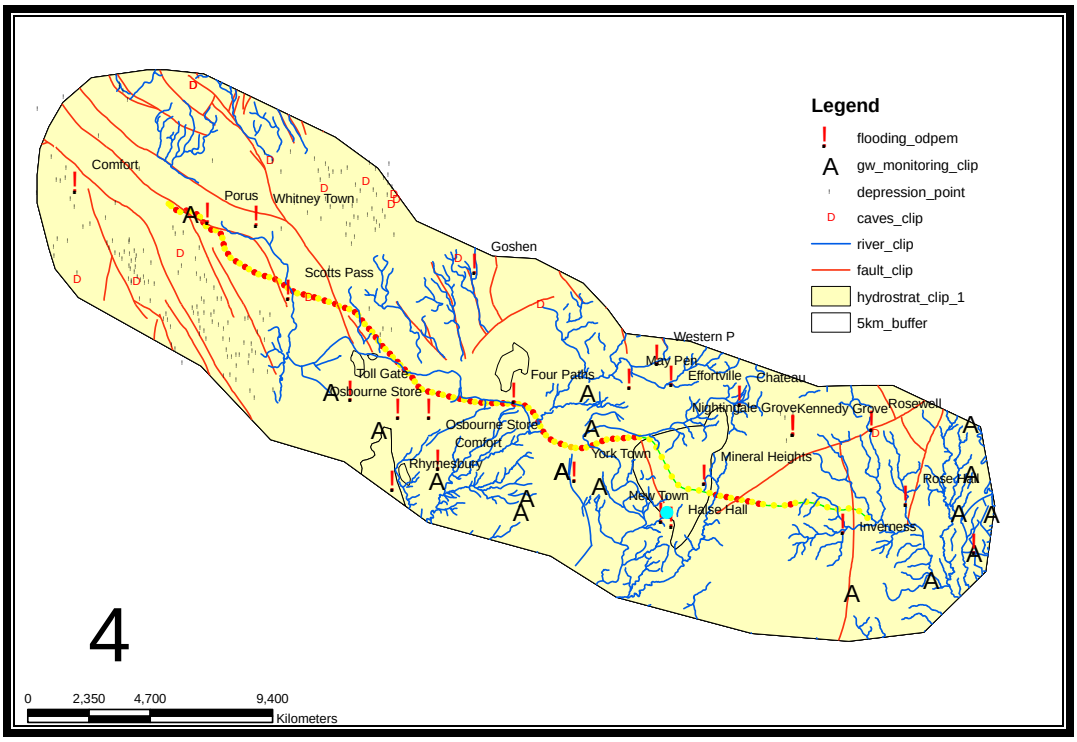


Figure 5.1.7.1: ODPEM Historic Flooding within the project area from 1996 to 2002

Table 5.1.7.1 - Attributes table for the ODPEM flood data, showing dates, co-ordinates and damages. Events shaded in yellow are within 1000m of the proposed ROW.

LOCATION	PARISH	TYPE_OF_DI	INFO_SOURC	DATE_OF_OC	EASTING_20	NORTHING_2	REPORTED_D
Chateau	Clarendon	Flooding	ODPEM	update from 1996	727103	646758	
Comfort	Clarendon	Flooding	ODPEM	update from 1996	715394	644262	
Effortville	Clarendon	Flooding	ODPEM	update from 1996	724455	647508	
Four Paths	Clarendon	Flooding	ODPEM-map	May-June 2002	718334	646874	
Goshen	Clarendon	Flooding	ODPEM	update from 1996	716804	651845	
Halse Hall	Clarendon	Flooding	ODPEM-map	May-June 2002	724450	642041	
Inverness	Clarendon	Flooding	ODPEM	update from 1996	731111	641787	
May Pen	Clarendon	Flooding	ODPEM	update from 1996	722815	647416	
Mineral Heights	Clarendon	Flooding	ODPEM	update from 1996	725727	643686	
New Town	Clarendon	Flooding	ODPEM	update from 1996	724053	642203	
Osbourne Store	Clarendon	Flooding	ODPEM-map	May-June 2002	715033	646234	
Rhymesbury	Clarendon	Flooding			713614	643444	
Rose Hall	Clarendon	Flooding			733558	642875	
Rosewell	Clarendon	Flooding			732228	645761	
Scotts Pass	Clarendon	Flooding			709558	650845	
Toll Gate	Clarendon	Flooding			711982	646930	
Western P	Clarendon	Flooding			723895	648341	
York Town	Clarendon	Flooding			720689	643812	
Comfort	Manchester	Flooding			701283	655024	
Porus	Manchester	Flooding			706432	653825	
Whitney Town	Manchester	Flooding			708324	653700	
		REPORTED FLOOD EVENTS	Nat. Irrigation Dvlp Maste		736207	640987	
Kennedy Grove	Clarendon	Flooding	assessment	heavy rains	729166	645587	houses abandoned (4)
Nightingale Grove	St. Catherine	Flooding	Observer Oct. 19, 2005	rains assoc. with Wilma	743067	644169	50 houses inundated
Osbourne Store	Clarendon	Flooding	Observer Oct. 19, 2005	rains assoc. with Wilma	713799	646259	widespread flooding

The above shows clearly that historic flooding events are an unfortunate, but pre-existing feature of south Clarendon and Manchester.

5.1.7.2. Documentary Evidence of Flooding

This section presents information on historic flooding along the following sections of the highway- Sandy Bay to Four Paths; Four Paths to Clarendon Park and Clarendon Park to Williamsfield. Information relies substantially on documentary evidence from Mr. Tim Lankester who has been resident in Clarendon for many years (Tim Lankester, Pers. Com.).

Sandy Bay to Four Paths - Flooding in Inverness/ Shutes Gully Environs

This section relies substantially on documentary evidence gathered by Mr. Tim Lankester (Pers. Comm.)

This section highlights flooding along the Sandy Bay to Four Paths section of the highway:

- During 18 – 19 May 1993 eastern Clarendon experienced a significant rainfall event. It resulted in the unfortunate loss of eight people living within the floodplains of the "Rasta Gully"; one of the unnamed tributaries of Bower's River. Though the rainfall was significant, flooding was exacerbated by the improper reinforcement of the Railway Bridge at Sandy Bay that in effect created a dam that is estimated to have flooded some 161,900 m^2 to a depth of 8m. The damning resulted in the catastrophic failure of the railway embankments on either side of the railway bridge that caused further down stream flooding and loss of life. The figure shows other areas of flooding as recorded by Mr. Lankester on the morning of 19 May 1993. Residents also recall that the during significant rainfall events the flood water within the gully overtops the bridge onto the road.

- At the Rio Minho visual observations indicate that during significant rainfall events the flood stage on the Rio Minho overtops the current gabion baskets on the eastern embankment; some 10 – 12m.

- The section of the highway that traverses the Denbigh plains rests on the floodplains of the Rio Minho. It is recalled that pre-1986 heavy rainfall completely washed away JPSCo's distribution lines that ran roughly east-west across the Denbigh plains. Saturated ground conditions ground conditions should be

anticipated. Groundwater depth from the Denbigh Farms No.1 (screened in the alluvium) is on average 6m below ground level (bgl).

- At Four Paths, on the main road to May Pen, the bridge that crosses the Jacks or St. Annes Gully had flood waters overtopping the bridge parapet in 1986. Immediately upstream of the bridge the community experienced significant displacement as houses adjacent the gully were flooded up to roof level 2 – 3m above ground.

Four Paths to Clarendon Park

- The ODPEM reports that flooding occurred at Osborne Store during the torrential rains associated with a tropical depression of May-June 2002 and October 19, 2005. The 2005 floods occurred due to rainfall associated with Category 4/5 hurricane Wilma. From the topographic maps there is a very large sinkhole/depression in the Osborne Store environs. Its invert elevation from the topographic map is 37m (asl). Average groundwater level at the closest existing limestone groundwater well (St. Jago Tollgate 4km west of Osborne Store) is recorded at 20 m asl. Given that sinkholes are natural depressions in surface topography they capture surface drainage, and can also be areas that express groundwater at the surface during period of rapid groundwater rise which may be the most likely explanation for the flooding occurrences at Osborne Store. Locals in the area indicate that drainage infrastructure seems inadequate.

- At McGilchrist Pen (or St. Jago) no reports of flooding are indicated within the ODPEM database. However, residents indicate that localised flooding does occur along existing agricultural drains, especially were slopes are sufficiently gentle to cause ponding. The presence of several natural surface ponds appears to substantiate the evidence that localised ponding occurs on flat or gentle slopes. There is also flooding along the St. Jago main road.

- At Clarendon Park, in the vicinity of the fish ponds, several natural and constructed land drains converge between km 56+500 and km 57+000. The owner of the fish ponds have reported that during heavy rainfall surface water originating from the hills north of the railway, flows under the railway near the apex through a culvert

and follows the drainage line that bisects the ponds before discharging to the irrigation canal and continuing east to the Jacks or St. Annes Gully. It was recalled that during recent heavy rains (date uncertain but within last five years) the magnitude of flow from the hills north of the railway track washed out the railway line and its original culvert and flooded the area between the railway and the ponds. Flooding was also noticed north of the railway culvert. Given that this area a largely unpopulated it is unlikely that reports would have been made to the ODPEM, hence its absence from their database. The owner also reported that during the construction of the large industrial complex to the southwest, construction debris flowed through their property and along the land drains and canals. This suggests that the natural drainage flows toward the railway line from the plains to the south, and that the A2 main road may not significantly interrupt this drainage pathway.

- Along the railway line there are two 2m wide and 1.5m deep trapezoid earth drains; one on either side of the track. The northern drain accommodates flow originating in the hills and the southern drain takes surface flows originating in the south. It was unclear where these side drains ultimately discharge, but it's likely that they take the north and south flows and continue east most likely discharging to the Jacks/St Annes Gully.

- The ODPEM records historic flooding at Toll Gate but provide no further details. Other reports indicate flooding along the St. Jago main road and within St. Jago.

Clarendon Park to Williamsfield

- At Berrydale a large sinkhole/depression (150m asl invert) is present between km 59+500 and km 60+500. From the 1:12,500 topographic maps it appears that the main road through Berrydale bisects the sinkhole. The H2K alignment approaches, and possibly intersects, the southwestern edge of sinkhole. Given that the Milk River is to the southwest of the alignment it will intercept runoff flowing north-easterly. Runoff from Mount Airy and Berrydale mountains to the northeast of the alignment will flow south-westerly toward the sinkhole. Flooding, temporal springs and groundwater ponds where reported in Berrydale following the unusual 2002 rainfall

event. The Jamaica-Gleaner (June 28, 2002) reports that residents in the environs were seeking investors to develop the new water features as public attractions.

- The 2002 flooding events at Berrydale, as at Trinity, Redberry, Porus, Melrose Bypass, St. Toolies, Toll Gate and Harmons are all connected though they were temporally separate events. Work done by the WRA (Technical Notes) shows that the 22 May to 12 June 2002 torrential rains dumped between 500 – >1500mm (200 – 490% increase over 30-yr mean) of rainfall on to the highland areas of Manchester. This precipitated the flooding at Porus, Trinity, Berrydale and Redberry. Later that same year two additional torrential rainfall events associated with Tropical Storm Isidore (Sept. 17-19, 2002) and Tropical Storm Lili (Sept. 24 – 29, 2002) created a hydrologic/hydrogeologic event that had not been experienced by residents in recent history.

- Ground level in the flooded areas of Porus ranged between 125 – 135 m. Groundwater levels over the same area rose to between 137 – 152 m. Several ponds and depressions along the Melrose Bypass road became filled with water as groundwater springs emerged at the base of these depressions. The table below shows the flow levels as recorded by the WRA during the May/June 2002 flood event. The WRA estimated that approximately 80 million m^3 (29 million nos., 600 gallon “black tanks”)of recharge water fell as rainfall during the period.

Table 5.1.7.2: Flow measurement data from Porus Area (reproduced from the WRA Flooding in Manchester report 2002[ii])

Date	Milk River @ Scotts Pass	St. Toolies Springs	Melrose Hill Depressions overflow (m^3/s)			Redberry
	m^3/s	m^3/s	#1	#2	#3	m^3/s
18.06.02	9.5	.38				.63
19.06.02		.42				.66
20.06.02	8.9	.53	.54			.87
21.06.02	9.0	.43	.79			.77
25.06.02	no meas	No Meas.	.73			No Meas
26.06.02	8.2	.64	.77			1.00
28.06.02	8.2	.92	1.00			1.3
2.07.02	8.2	.78	.91	.46	0.12	1.5

- All groundwater from the graben is drained via the Milk River and/or the St. Toolies Spring. Redberry flows contribute to the Milk River and the groundwater from Melrose drains via Redberry. As the WRA noted that there was a positive correlation between increased flows at Melrose and at emergent flows at Redberry to the south. The total volume of water discharging from the system in May/June 2002 was estimated at 9 million m^3/s. Fractures along the Porus road (at the foot of the Melrose Bypass), were reported by the WRA, to be 4m deep with groundwater steadily flowing from them.

- At Redberry the districts sits in a topographic low and is also located at the headwaters of the surface expression of the Milk River as it flows past Porus. Therefore, water is taken via two routes, surface expression of groundwater due to topographic lows and surface water via the Milk River. The WRA reports that the only real outlet for drainage in the Redberry area is a canal (that discharges to the

Milk River ultimately) that is not sufficient to carry the estimated flows from both the Milk River and groundwater. This resulted in retention (backup) of water within the depression lead to the flooding. Additionally, the occurrence was compounded by the presence of a log dam on the Milk River between Redberry and Spring Ground to the south. This log dam was erected to retain water during the dry periods. It was not clear as to when, or who, built the log dam.

- Water budget calculations by the WRA predicted that just over 100 days before groundwater levels would recede as outflows drained the surplus water from the system.

- Not appreciated by the general public, the Williamsfield/Porus Graben system, which is mainly defined by the Whitney Fault to the east and the Queen Town Hill Fault to the west, stretches from Mile Gully/Golden Grove in the north of Manchester, through Willamsfield/Porus and terminates over 20 km southeast in the St. Toolies area of Clarendon. This massive graben system governs both the hydrogeology and the topography within its zone of influence, as the numerous fracture zones within the graben act as preferential pathways for groundwater flow in the massive limestone aquifer. Rainfall enters the aquifer as recharge in the Manchester Highlands with groundwater principally flowing to the south coast though fractures and solution features (caves).

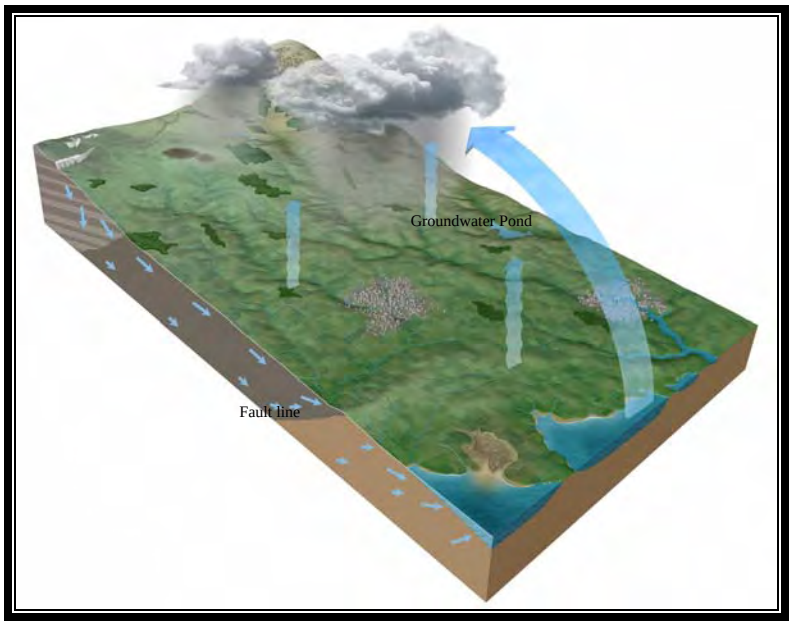


Figure 5.1.7.2a – Typical catchment hydrogeology with recharge in the hills, springs and groundwater ponds due to faults and rising groundwater

- Topographically, (see figures below) the Melrose, Porus, Redberry, Harmons and St. Toolies represent the low points within the graben system. The blue line represents the groundwater profile are determined by the WRA pre-May 2002. The red line shows the increase in groundwater levels on Nov. 01, 2002 following the three torrential rainfall events. The measured rise in groundwater between Sept. 13 and 01 Nov. 2002 was 17.7m, 2.5m, 7.8m, 6.8m and 5.5m in Melrose, Porus, Redberry, Harmons and St. Toolies respectively. By comparison, groundwater rose 18m in Porus during the May-June 2002 rainfall event. Though larger increase, up to 52 m were recorded in Content, the combination of topography (low lying land), aquifer properties (reduced storage), and geology (faults and fractures) resulted in groundwater being discharged at the surface. The existence of a groundwater spring requires that below the surface (the area commonly called the aquifer), the infiltrating water encounters a low permeability zone and is unable to continue to move downward as fast as it is supplied at the surface; as a result, the water spreads laterally until it intersects the land surface where erosion or tectonic activity has lowered the topography to the water's level (e.g. on the side of a depression).

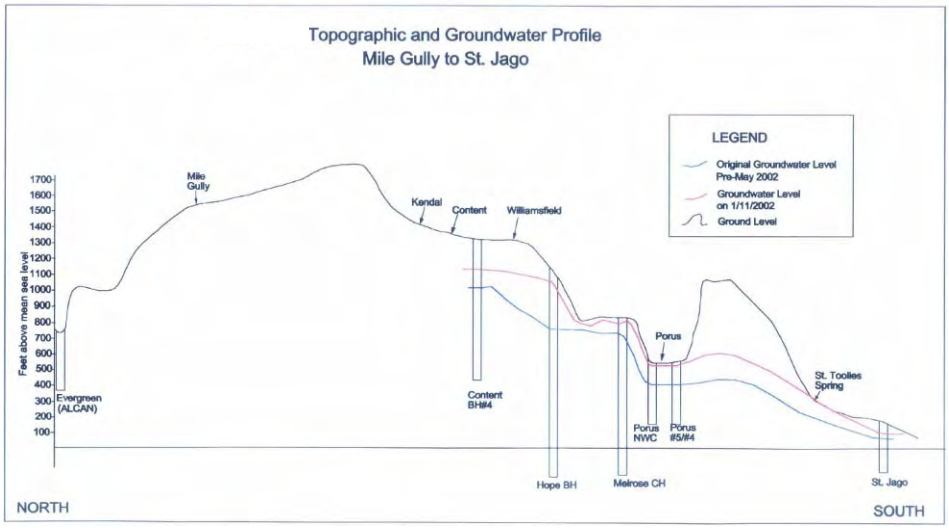


Figure 5.1.7.2b: Topographic and Groundwater Profile: Mile Gully to St. Jago

(Adapted from the WRA showing the longitudinal N-S groundwater levels pre-May 2002 (blue line) and post May 2002 (red line) from Mile Gully to St. Jago. Ground level is represented by the black line. All wells are screened within the limestone aquifer). (taken from WRA report on Harmons Flooding, Nov. 2002[iii]).

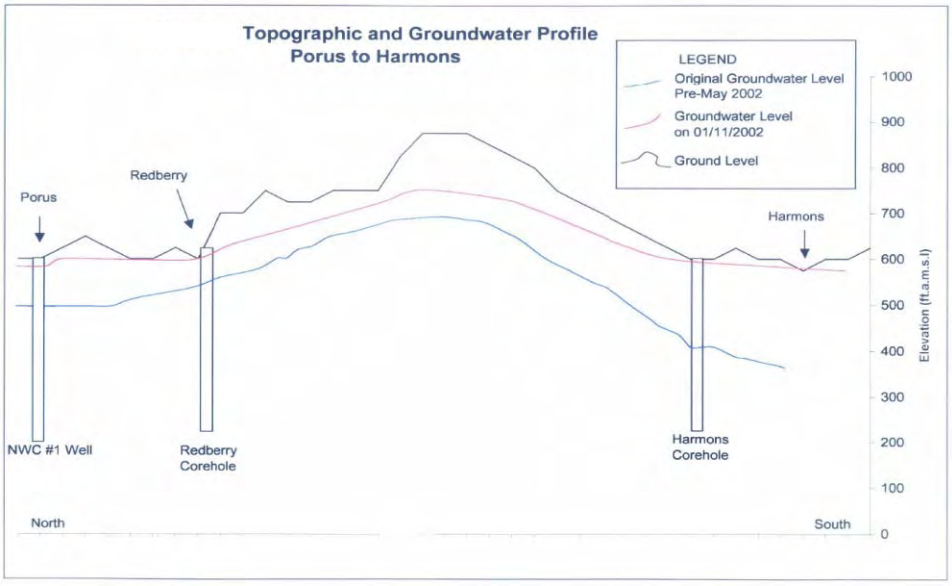


Figure 5.1.7.2c: Topographic and Groundwater Profile: Porus to Harmons

(Adapted from the WRA showing the longitudinal N-S groundwater levels pre-May 2002 (blue line) and post May 2002 (red line) from Porus to Harmons, Manchester. Ground level is represented by the black line. All wells are screened within the limestone aquifer)

- The WRA estimated that approximately 302 million m^3 (approximately 117 million nos., 600 gallon "black water" tanks!) of water was added to the aquifer as recharge during the heavy rains. The estimated aquifer outflow was approximately 1.8 million m^3/day (about 3000 nos., 600 gallon "black tanks"). This massive difference in inflows and outflows from the aquifer resulted in rapid and sustained groundwater rise. The WRA predicted, based on these figures, it would take about 164 days to return to its pre-elevated levels of Sept. 13, 2002. Harmons, due to is hydrogeology, was predicted to remain flooded for some time after this 164 days.
- At Harmons the WRA estimated that approximately 1.1 to 1.3 million m^3 was held within the depressions. The flood level rose to the 167 m (550ft) contour which would represent the groundwater level within the aquifer. Drainage out of Harmons is quite restricted and generally occurs via vertical drainage in to the subsurface. As this avenue was not available the WRA concluded, and rightly so, that the reduction in levels would only occur once groundwater levels fell below the base of the depressions.

Pollution Incidents

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

5.1.8. Hurricanes

Jamaica is susceptible to hurricanes and other storm events as indicated by the historic hurricane tracks (Figure 5.1.8). The rainy season is from May to October, with peaks in May and October, and tropical depressions, storms and hurricanes can occur any time during this period. These systems usually bring large volumes of rain with or without flash floods, slow inundation and high winds.

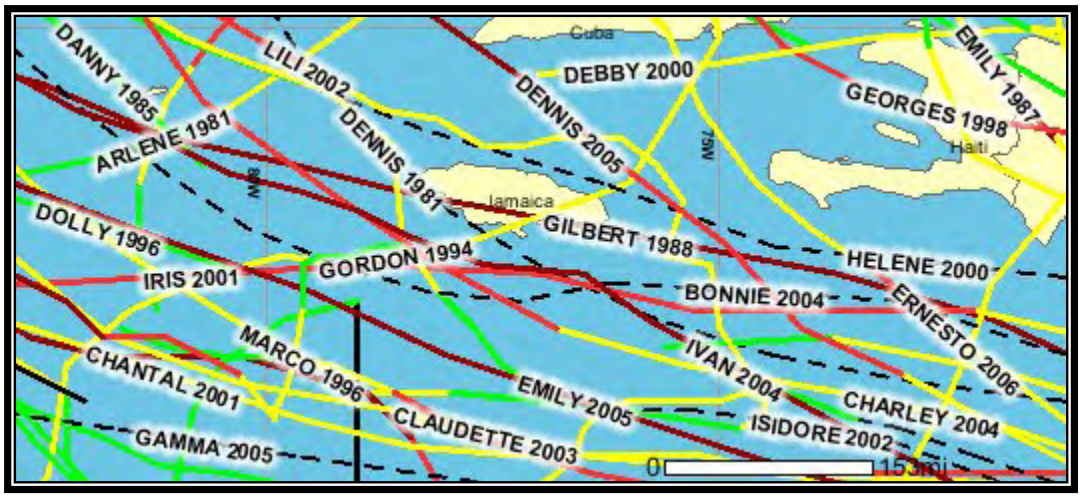


Figure 5.1.8: Historic Hurricane Tracks Across Jamaica – 1980-2006

(Source: http://maps.csc.noaa.gov/hurricanes/viewer.html)

5.1.9. Air Quality

Two sets of data were collected for the Environmental Baseline Study conducted along the alignment for the proposed Sandy Bay to Williamsfield leg of Highway 2000. The monitoring events were carried out on June 5-6 and 7-8, 2007.

Twelve (12) stations were selected for sampling particulate matter in the air.

Respirable particulates are defined as those particulates with internal diameter at or below 10 microns. These particulates are of considerable concern due to their ability to be inhaled into the lungs of humans. Respirable particulate levels obtained were well within the 150 $\mu g/m^3$ 24hr. Total particulates were sampled at the Rock Halt (19.9 $\mu g/m^3$) and Scotts Pass (64.2 $\mu g/m^3$) stations on the first day of the two sampling events. Total particulates include respirable particulates as well as those particulates above 10 microns in diameter. In these instances respirable particulates would be much lower than the readings obtained for total particulates.

Table 5.1.9: Respirable Particulate Levels - conducted June 5-6, and 7-8 2007

LOCATION	Particulates Results extrapolated to 24 hrs μg/m^3		NRCA 24-hr PM_{10} Guideline μg/m^3
	June 5-6, 2007	June 7-8, 2007	
INVERNESS	20.1	47.3	
SAVANNAH CROSS	6.2	23.0	
WEBBERS GULLY	5.9	33.4	
MINERAL HEIGHTS 1	11.5	23.0	
MINERAL HEIGHTS 2	21.3	24.1	150
RIO MINHO	-	1831.99 *	
FOUR PATHS	17.8	22.3	
ROCK HALT	19.9	6.1	
SCOTTS PASS	64.2	23.9	
SPRING GROVE	16.1	24.8	
PORUS	10.3	20.9	
RED BERRY	9.4	5.9	

*NB: Sampling was conducted during the wet season and in many cases the level of respirable particulates are very low as a consequence. The site at Rio Minho is in close proximity to sand mining activities. (*collected July17-18).*

5.1.9.1. Nitrogen and Sulphur Measurements (NOx and SOx)

The ambient sulphur and nitrogen dioxide measurements conducted at the twelve stations located along the proposed Sandy Bay to Williamsfield alignment are presented in Table 5.1.9.1 below. The results recorded are well within the limits established in the National Ambient Air Quality Standard for nitrogen and sulphur dioxide.

Table 5.1.9.1: Ambient Nitrogen and Sulphur Dioxide Measurements for proposed Sandy Bay - Williamsfield, July 30, 2007

LOCATION	SULPHUR DIOXIDE ppm	NRCA Ambient Air Quality SO_2 Standards Annual ppm	NITROGEN DIOXIDE ppm	NRCA Ambient Air Quality NO_2 Standards Annual ppm
INVERNESS	0.0	80	1.5	100
SAVANNAH CROSS	0.0		1.9	
WEBBER GULLY	0.0		0.8	
MINERAL HEIGHTS 1	0.0		1.3	
MINERAL HEIGHTS 2	0.0		1.3	
RIO MINHO	0.0		1.3	
FOUR PATHS	0.0		2.3	
ROCK HALT	0.0		1.3	
SCOTTS PASS	0.0		1.3	
SPRING GROVE	0.0		1.3	
PORUS	0.0		1.8	
RED BERRY	0.0		1.6	

5.1.10. Noise

Two sets of data were collected for the Environmental Baseline Study conducted along the alignment for the proposed Sandy Bay to Williamsfield leg of Highway 2000. The monitoring events were carried out on June 5-6 and 7-8, 2007.

Noise levels at all the locations were within the perimeter guideline of 75.0 dBA set by NRCA. The Inverness and Four Paths stations are located along busy thoroughfares, which contributed to the increased noise levels in these areas.

Table 5.1.10: Noise Levels – conducted June 5 and 7, 2007

LOCATION	Noise Levels (dBA)		NRCA Guideline (dBA)
	June 5, 2007	June 7, 2007	
INVERNESS	70.1	73.0	75.0
SAVANNA CROSS	51.6	51.6	
WEBBER GULLY	61.4	51.6	
MINERAL HEIGHTS 1	63.7	68.8	
MINERAL HEIGHTS 2	66.0	68.8	
RIO MINHO	-	-	
FOUR PATHS	70.5	68.8	
ROCK HALT	61.0	53.1	
SCOTTS PASS	51.6	51.6	
SPRING GROVE	57.3	51.6	
PORUS	51.6	67.1	
RED BERRY	51.6	51.6	

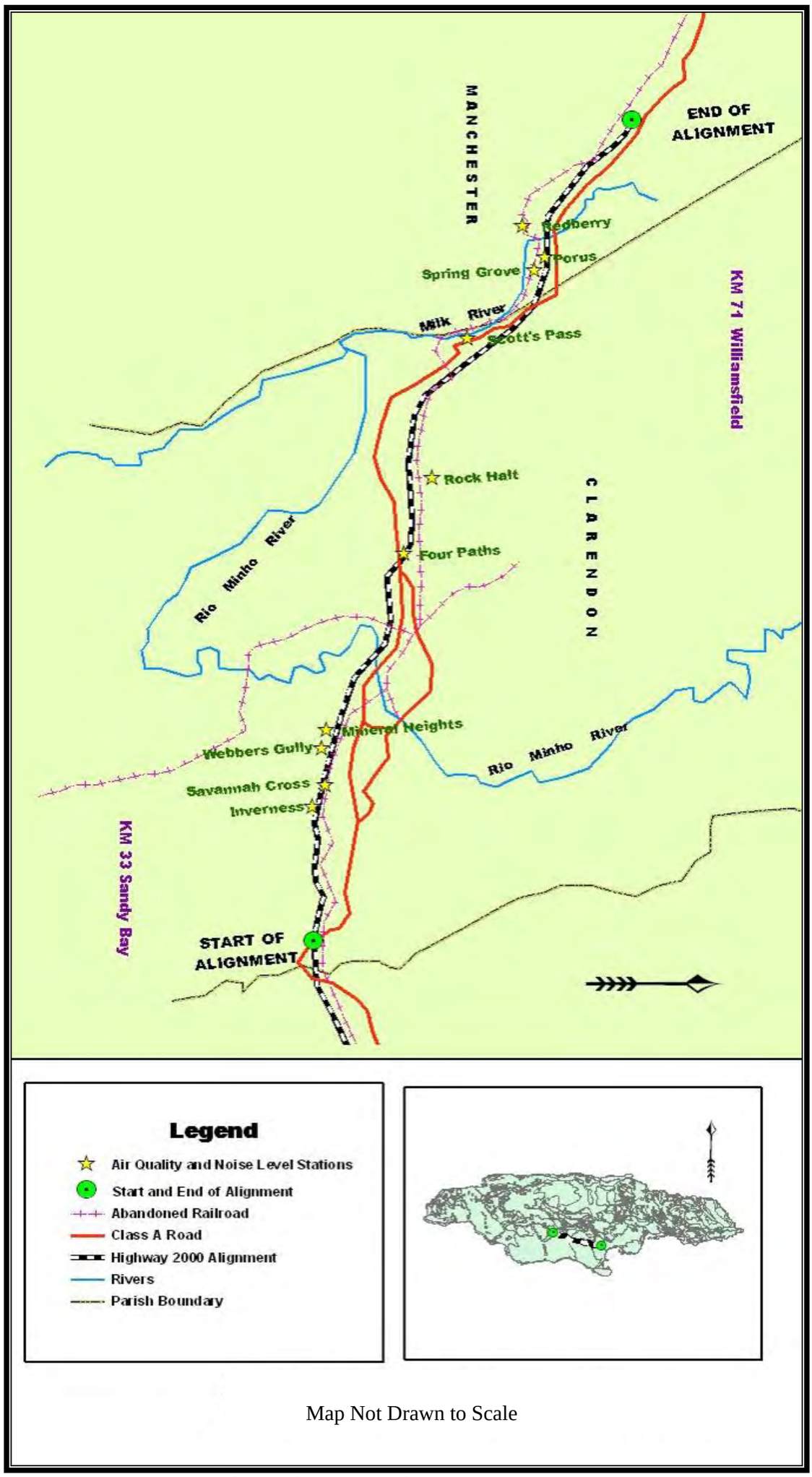


Figure 5.1.10 Air Quality and Noise Level Stations

5.1.11. Water Quality

Two sets of data were collected for the Environmental Baseline Study conducted along the alignment for the proposed Sandy Bay to Williamsfield leg of Highway 2000. The monitoring events were carried out on June 5-6 and 7-8, 2007.

The water quality data showed that pH and phosphate levels were 100% compliant with the NRCA Ambient Fresh Water Standards. The pH levels recorded for the Rio Minho water quality station indicated that the waters are somewhat alkaline.

With the exception of the June 5, 2007 result at the Rio Minho sampling station, all other stations yielded results above the 0.8-1.7 mg/L range. The same trend was observed for the nitrate levels. The Rio Minho water quality station was just in compliance recording 7.5 mg/L on both monitoring events. The elevated nitrate levels may be associated with farming activities for which these interior areas are noted.

The presence of bacterial coliform in surface water is an indication that pathogenic material from animal excreta is present in the water. Coliform levels varied significantly over the two monitoring occasions for the Milk River and Rio Minho stations. The results obtained at the Rock Halt and Spring Grove stations were highly comparable for both monitoring events. Faecal coliform levels were consistently high at the Spring Grove (2400 MPN/100 ml) station.

Table 5.1.11: Sandy Bay - Williamsfield Surface Water Quality conducted June 5 and 7, 2007

PARAMETERS	TEST METHOD	Milk River		Rio Minho		Rock Halt		Spring Grove		NRCA Ambient Fresh Water Standards
		June 5	June 7	June 5	June 7	June 5	June 7	June 5	June 7	
pH (pH units)	DR	7.6	7.4	8.4	8.2	8.0	8.1	7.5	7.3	7.0-8.4
BOD (mg/L)	H-10099	9.0	5.0	1.0	3.0	3.0	2.0	-	3.0	0.8-1.7
COD (mg/L)	H-8000	4.0	4.0	49.0	16.0	12.0	9.5	33.0	8.0	-
TSS (mg/L)	SM-2540D	2.3	5.0	4.3	1.3	4.6	0.0	6.7	0.0	-
Nitrate (mg/L)	H-8039	10.1	11.0	7.5	7.5	8.8	11.4	11.4	13.6	0.1-7.5
Phosphate (mg/L)	H-8048	0.01	0.08	0.09	0.04	0.03	0.08	0.01	0.00	0.01-0.80
Total Coliform (MPN/100ml)	SM9221	≥2400	460	1100	460	460	460	≥2400	≥2400	<1000*
Faecal Coliform (MPN/100ml)	SM9221	≥2400	460	1100	75	460	150	≥2400	≥2400	<100*
Oil and Grease (mg/L)	PR/GRV	1.87	NA	2.00	NA	2.67	NA	3.20	NA	10*

NA – results not yet available

KEY H - HACH Water Analysis Handbook 3rd edition DR - Direct Reading
SM - Standard Methods for the Examination of Water and Wastewater 20th edition
PR/GRV - Partition/Gravimetry * - Trade Effluent Standard

Quality Control – Analytical and Field duplicates, standard reference materials.

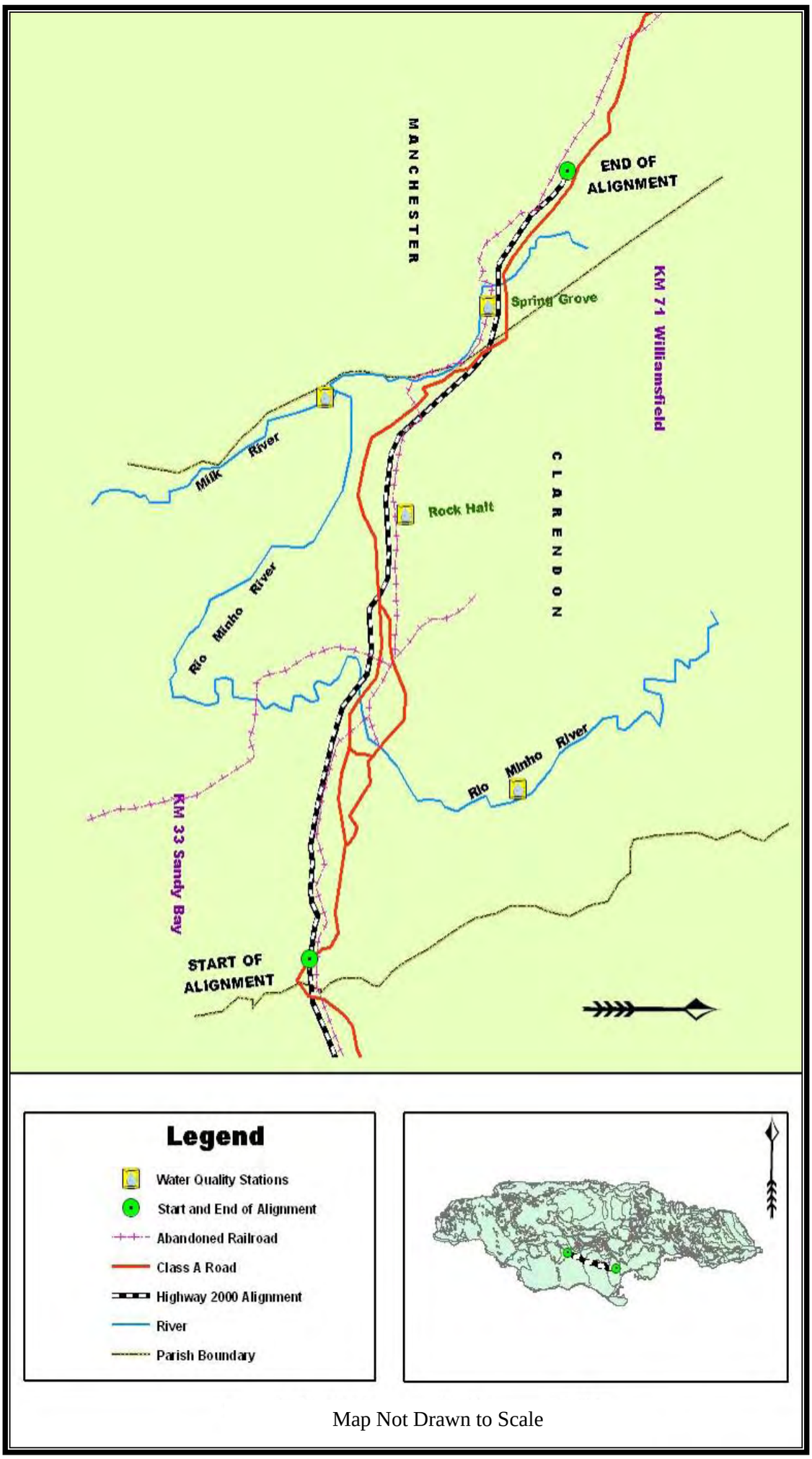


Figure: 5.1.11 Water Quality Stations

5.2. Biological Environment

The study area was a strip of land between Sandy Bay and Williamsfield. Baseline data for the biological environment is detailed in Section 4.1 and 4.3 of this report.

It consists of four habitat zones, influenced by soil, topography, elevation and land use. The first zone (disturbed dry limestone woodland) includes the highly disturbed dry limestone forest and abandoned sisal plantation at the northeastern edge of Harris Savanna. The second zone (pasture and cane fields) includes the agricultural areas between Harris Savanna and Clarendon Park, characterized mainly by sugar cane, with mixed agriculture and some pastures. It also includes scattered fish ponds, streams, ditches and boggy areas. The third zone (rural settlement and cultivation) occurs as the corridor cuts up into the hills and follows the valley of the upper Milk River through Porus. It includes human settlements and cultivation, gardens, and very disturbed remnants of wet and riverine woodland. The fourth zone (roadside scrub) occurs along the Melrose Hill bypass on 'reclaimed' bauxite land.

5.2.1. Vegetation

The entire study area was strongly influenced by human activities and therefore highly distubed. The vegetation zones were influenced by gradients of elevation, rainfall and disturbance, as well as geology and drainage patterns. More than 170 species of plants were encountered in the surveys (Appendix VI), the majority of which were introduced, common and widespread. Few endemic species were found in any habitat, nor were they expected, based on the level of disturbance.

1. Disturbed dry limestone woodland/ abandoned sisal plantation

Harris Savanna is known for its rich species diversity. The study area runs along its northern edge, through an area that was once sisal plantation, where the forest was totally cleared and cultivated for many years. Abandoned about 20 years ago, it is regenerating into woodland. Common species include Logwood (*Haematoxylum campechianum*), Leucaena (*Leuceana leucocephala*), various species of Acacia (*Acacia* spp.) and West Indian Ebony (*Brya ebenus*). Scattered emergents include *Thrinax parviflora*, Guinep

(*Melicoccus bijugatus,)*, Silk Cotton (*Ceiba pentandra)*, and Red Birch *Bursera simarouba.* There are also planted fruit trees such as Ackee (*Blighia sapida*) and invasive ornamentals such as *Cassia* spp.. The understorey is dense and impenetrable and includes Wild Rosemary (*Croton linearis*), various species of *Lantana* and many thorny vines and shrubs.

2. Cane fields and pasture

From Harris Savanna to Clarendon Park the route runs across flat, alluvial agricultural land, including sugar cane, mixed agriculture and pasture with housing in subdivisions and along roads. There are also irrigation canals, fish ponds and some seasonally flooded pasture, characterized by the presence of wetland plants such as *Typha domingensis*. These plains are prone to flooding and are also known to retain standing water in shallow depressions for a considerable period after heavy rains. This area has been under intense cultivation for hundreds of years and few remnants of natural or semi-natural vegetation remain. The grasses that dominate the rough pastures are all introduced. Large trees such as Guango occur mainly along field boundaries and along canals. *Tilandsia recurvata* occurs commonly on power lines.

3. Rural settlement and cultivation

As the elevation increases between Clarendon Park and Williamsfield, the route passes through some forest, then through the Upper Milk River Valley where Scotts Pass and Porus are located. In the past this area probably supported mesic limestone forest on the hillsides and riparian forest along the valley bottom. However the entire route is very depauperate of species compared to less disturbed areas.

On the hillside, common species included West Indian Cedar *Cedrella odorata*, Broadleaf *Teminalia latifolia,* Leucena, Prickly Yellow *Xamthoxylum fagara.* Steep rocky banks supported Maidenhair Ferns and Portlandia *Portlandia* sp.. (probably *grandiflora*) and a few large trees supported orchids such as *Encyclia frangrans*. However most of the large

timber trees had been removed. The understorey had been subjected to grazing and cultivation of food crops, such as cassava and corn.

The banks of the upper Milk River are lined with highly disturbed riparian woodland, most of which has been replaced by food and timber forest and crops. Many large fruit trees are distributed through this area. This was probably once a distinct community, but so many trees and other crops have been planted that it is distinguishable from the surrounding area mainly be the size of the trees that grow there. Native species include Starapple (*Chrysophyllum cainito*), Guango, Royal Palm (*Roystonea princeps),* Broadleaf and *Lonchocarpus latifolius* – among the few remnants of the native forest in this area. Other common fruit trees include Naseberry *Manilkara sapota,* Guinep *Melicoccus bijugatus*, Sweet Sop, Soursop and Custard Apple trees (*Annona spp*), Otaheite Apple (*Syzygium malaccense,* citrus *Citrus spp.*), Breadfruit *Artocarous altilis,* Ackee *Blighia sapidum,* Coconuts *(Cocos nucifera),* Mango *Mangifera indica* and many others. Where the canopy is open there may be dense growth of vines (*Ipomoea* spp.). Bananas and plantains (*Musa* spp.), pumpkin, dasheen (*Coloclasia esculenta*) and Sugar Cane (*Saccarum officinarum*) are cultivated on the fertile banks of the river. Scratch Coco (*Aloclasia* sp.) and various species of watergrass (*Commelina* spp.) are also present.

In Porus the survey corridor cuts though homes and gardens, which include typical fruiting and ornamental plants, such as Crotons (*Codiaeum variegatum*), Ixora (*Ixora coccinea)* and Bougainvillea (*Bougainvillea glabra*). and the June Rose (*Lagerstroemia indica).* Larger ornamental trees included Poinciana (*Delonix regia*), Cassia trees (*Cassia fistula*), African Tulip (*Spathodea campanulata*)and Yellow Poui (*Tabebuia rufescens*).

4. Roadside scrub

Above Porus the road corridor takes in and parallels the existing Melrose Bypass, running through ‘restored’ bauxite lands. The soils are very poor and the vegetation highly disturbed. Common trees include Guango, Trumpet Tree (*Cecropia peltata),* Castor Oil and

Water Oak. The verges are characterized by common weedy species including Search-me-heart.

5.2.2. Birds

Seventy nine species were observed in surveys or previous observations or predicted based on knowledge of the area and bird ecology. Winter migrants were not present at the time of the study so their presence is to be inferred. Only eleven of Jamaica's twenty eight endemic species were observed (or predicted). No threatened or rare species were observed or predicted.

5.2.3. Reptiles

Several anole lizards were observed, mainly in the sub-urban gardens and limestone forests. Common reptiles included anoles such as *Anolis lineatopus* and Geckoes (*Aristelliger praesignis*).The American Crocodile *Crocodylus acutus* is the only species of special concern in the PBPA that might be found in the study area. Crocodiles might visit the fish ponds via the rivers and streams in times of drought or food shortage but this is probably quite rare. They have not been reported from Porus. The endemic pond turtle or Jamaican Slider *Pseudemys(Trachemys) terrapen* is known to inhabit the area and is common in fish ponds. Little is known of the ecology of this species. Although it is known to migrate, it is not known whether its movements are seasonal or simply in response to drought. The highway will be a major impediment to any such migrations, but in the absence of detailed information about the size of the local population or migration patterns in general, it is impossible to assess the impacts or determine whether mitigation measures will be needed.

5.2.4. Mammals

The only mammals observed in the study area were the Small Indian Mongoose (*Herpestes javanicus)*, and at least two species of bats. Bats were not abundant at any of the nocturnal survey points.

5.2.5. Amphibians

The only frogs seen or heard in the study area were the introduced, invasive tree frog *Eleutherodactylus johnstoni*. The introduced cane toad (*Buffo marinus*) was predicted to be present in the area but was not observed, probably due to dry conditions at the time of the survey.

5.2.6. Aquatic animals

Observations of the offerings of roadside vendors indicated that the most common shrimp in the river is the introduced Red Claw (*Cherax quadricarinatus*). This was confirmed by discussions with the vendors who reported that native shrimps have become uncommon. At least two species of 'ticky-ticky' fish were seen in the river, but they could not be captured for identification. The literature on Jamaican freshwater fish does not indicate that any rare species have been found in the study area.

5.2.7. Portland Bight Protected Area

The Portland Bight Protected Area (PBPA) had been earmarked for special protection under the NRCA Act and was declared as a Protected Area under Section 5 of the Natural Resources Conservation Act (1991) on Earth Day, April 22, 1999. The propose alignment will be just within the northern boundary of the PBPA and will follow the existing railway line for the most part. Figure 5.2.7 shows the Portland Bight Protected Area. The highway is not expected to impact on the dry limestone habitat of the endemic and endangered Jamaican Iguana in Hellshire Hills, the Braziletto Mountains nor the caves at the southern end Portland Ridge which provide a habitat for endemic fauna.

The proposed route of Highway 2000 cuts through a small section of the northwestern margins of the Portland Bight Protected Area (PBPA). It is Jamaica's largest protected area and has been in existence since April 1999. The Caribbean Coastal Area Management (C-CAM) Foundation has been delegated management responsibilities within the PBPA since 2003. The highway route passes throughout the northern edge of the PA but remains for only a few

kilometers. The area is not currently considered ecologically sensitive and has not been zoned for any special protection under the PBPA management plan.

C-CAM the co-managers of the Park have been contacted with regard to the alignment and the TORs sent to them for review (Appendix V). The relevant legislation for the PBPA has also been reviewed.

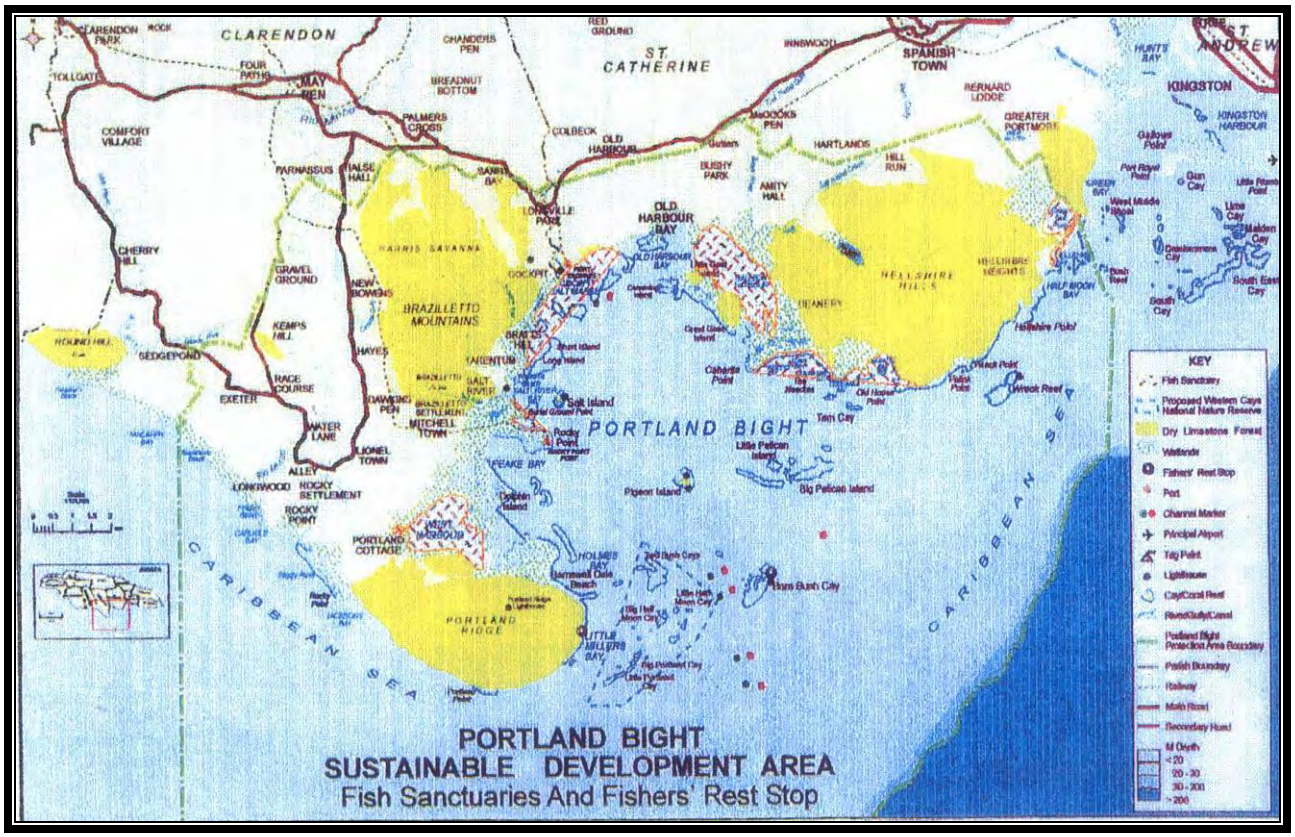


Figure 5.2.7: Portland Bight Sustainable Development Area (source: CCAM, 1992)

5.3. Socio-economic Environment

The methodology for baseline data for the socio-economic environment is presented in Sections 4.1 and 4.4 of this report.

5.3.1. The Socio-economic Context

Analysis of the socio-economic environment focuses mainly on land use, demographics & livelihoods, community perceptions of flooding, community attitudes to the project, acquisition and displacement, social right of ways, traffic flows, economic benefits, archaeological and cultural heritage, others including social services & health. These reflect the main issues of interest in the human environment centred on the alignment.

5.3.1.1. The Zone of Impacts

Collectively, the communities crossed by the alignment or close to it, define a zone within which immediate and cumulative project impacts will be first experienced. Impacts of the project will permeate well beyond this limited zone, particularly the travel time reduction impacts and the development generation effects.

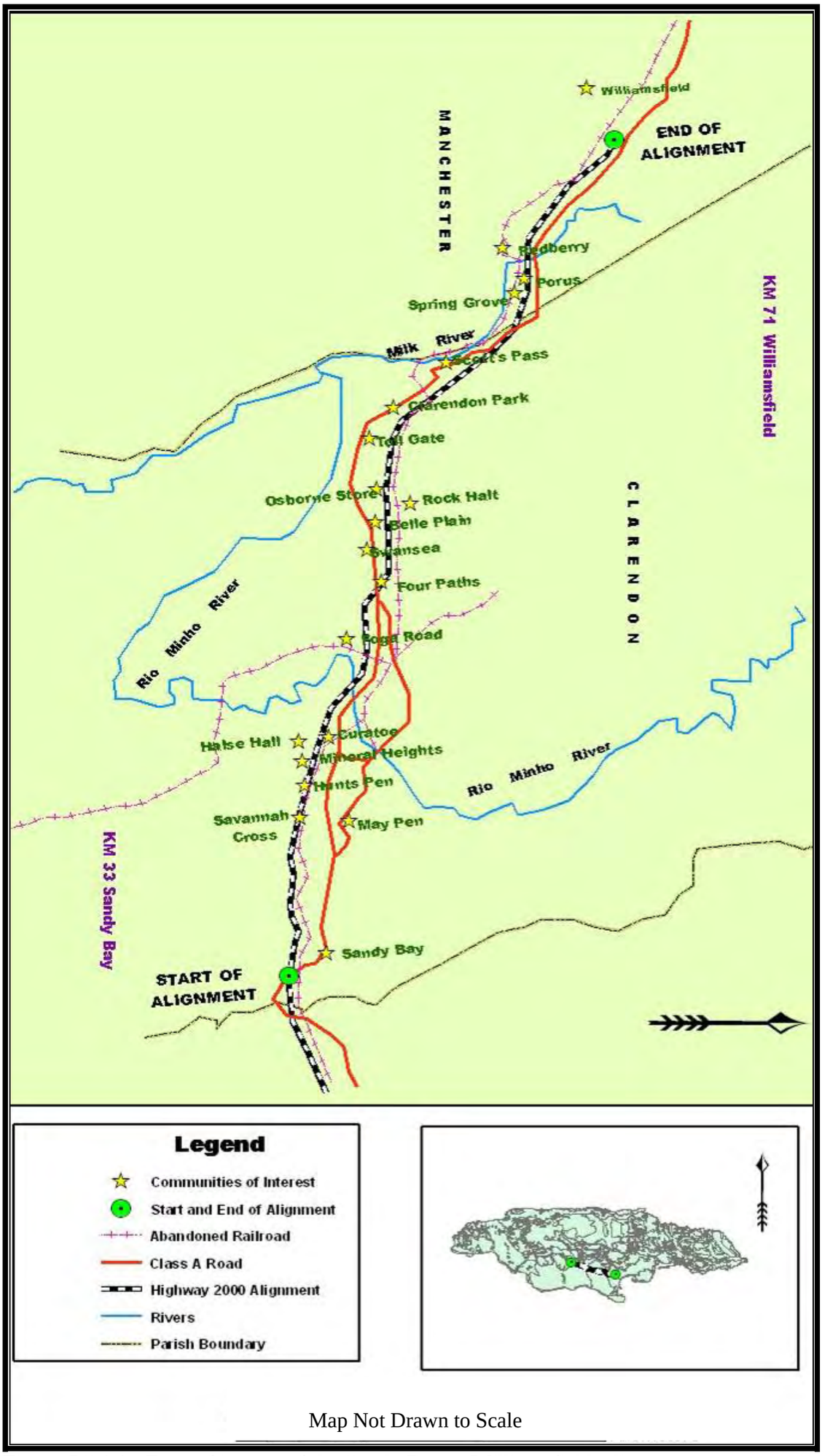


Figure 5.3.1.1: Zone of impact of the Sandy Bay to Williamsfield Alignment

The main data gathering for this section was through conducting rapid rural/urban appraisals in communities close to or directly impacted by the alignment. Starting from the Sandy Bay end of the project, these were:

Table 5.3.1.1a: Communities of Interest

Section	Communities	Approximate Chainage (actual or adjacent to)	Description & Justification
Section 1	Sandy Bay	35+ 000 to 37+000	A grouping of several sub communities. Traffic diversion. Taken as representative of issues arising along the densely populated main road leading to May Pen Roundabout.
	Savannah Cross	37+ 000 to 38+000	Directly impacted community. Residential & Church displacement.
	Hunts Pen	39+000 to 41+000	Directly impacted community. Residential displacement.
	Mineral Heights	40+000 to 41+000	Highway passes just south of this largest housing scheme in Clarendon. Potential construction issues. Displacement of social infrastructure.
	Halse Hall (Top & Bottom)	41+000 to 42+000	Highway passes just north of both communities. Potential flooding issues. Alignment crosses May Pen to Hayes main road.
	Curatoe	41+000 to 42+000	Highway passes just south. Residential displacement.
	May Pen	41+000 to 45+000	Capital city. Commercial centre. Impact on business & traffic congestion.
	May Pen ByPass	42+000 to 45+000	Negative business impact. Business displacement
	Foga Road	46+000 to 48+000	Cultivation loss. Directly

Section	Communities	Approximate Chainage (actual or adjacent to)	Description & Justification
Section 2			impacted community. Residential, business & church displacement.
	Four Paths	49+000 to 50+000	Small township to north of highway. Flooding issues
	Swansea	50+000 to 51+000	Village closest to Toll Plaza where highway crosses existing main road. Business diversion.
	Belle Plain & Rock Road area.	51+000 to 53+000	Residencies small farming stretched along secondary roads. Residential acquisition , flooding issues.
	Osbourne Store	52+000 to 53+000	While highway passes about a km north, Osbourne Store typical of a number of communities between May Pen and Clarendon Park impacted by traffic diversion.
	Rock Halt	53+000 to 54+000	At foot of Rock community. No threats identified.
	McGilchrist Pen Toll Gate/ & Clarendon Park	53+000 to 57+000	Potential construction issues re traffic & heavy duty vehicles. Negative business impact.
Section 3	Scotts Pass Village	59+000 to 60+000	Mocho Mountains side community. Residential & micro business displacement. Construction impacts on other residents.
	Scotts Pass along main road	60+000 to 61+000	Negative business impact on vendors. Construction impacts
	Spring Grove	61+000 to 62+000	Residential displacement
	Porus Area	62+000 to 64+000	Main township. Commercial centre. Negative impact on business positive impact on traffic congestion
	Redberry	64+000 to 65+000	Residential, church & small

Section	Communities	Approximate Chainage (actual or adjacent to)	Description & Justification
			business displacement
Section 4	Melrose Hill	65+000 to 71+000	Community uncertainty re long term status and maintenance of old road
	Melrose Bypass	65+000 to 71+000	Vendor accommodation a concern with vendors. Also construction dislocation.
	Williamsfield	71+000	Construction Impacts. Construction period economic benefits

The project is linear, and traverses two thirds of the length of Clarendon and almost half the length of Manchester as measured along the A1 main road. Four Sections of this corridor have therefore been defined and select issues are dealt with within each. This permits a closer identification of the impacted communities with the alignment and considerably reduces repetition. However some issues, can conveniently be dealt with from the more general perspective, and this is done under specific heading following the sectional comments (Table 5.3.2).

Table 5.3.1.1b: Sections of the Alignment and Corresponding Issues

Ref	Sections	Issues within Each
5.3.2	Sandy Bay to Rio Minho	Land Use Demography & Livelihoods Community Perceptions of Flooding Community Attitudes to the Project
5.3.3	Rio Minho to the Parish Border	
5.3.4	The Parish Border to Redberry	
5.3.5	Melrose Hill & By Pass To Willamsfield	
5.3.6	Entire Alignment	Acquisition and Displacement
5.3.7	Entire Alignment	Transport Sector
5.3.8	Entire Alignment	Social Right of Ways
5.3.9	Entire Alignment	Traffic Flows & Benefits
5.3.10	Entire Alignment	Macro Economic Benefits

Ref	Sections	Issues within Each
5.3.11	Entire Alignment	Archaeological & Cultural Heritage
5.3.12	Entire Alignment	Other -Social Services -Public Health

Only those communities and neighborhood's with discernable and direct project impacts, are described.

5.3.2. Section 1 -Sandy Bay to Rio Minho

5.3.2.1. Land Use

Land use is considered in two contexts. Land utilized by the highway in relation to zoning regulations and land use bordering its alignment.

Land Used by the Highway and Regulations

When it formally approves the alignment the Government of Jamaica will have defined (and also contracted) permissible land use within its boundaries. The exception to this is where the alignment traverses the Portland Bight Protected Area, as it does within a small section at its commencement. In consultation with the co manager of the protected area it is in the purview of the regulatory agencies to allow or otherwise development within this area. Outside of this protected are land use by the development is not an issue for zoning regulations in the normal planning sense and is not again mentioned.

Land Use bordering the Highway

This section of the alignment passes mainly through secondary degraded limestone woodland and scrub which supports limited agriculture, including coal burning activity and subsistence and market gardening. Coal burning activity takes place in many locations within the bordering woodland areas, but no kilns or currently active coal burning operations were determined to be lying within the proposed alignment. The highway passes through 3 residential communities (Savannah Cross, Hunts Pen, Curatoe.

It displaces approximately 48 structures comprising residences and micro & small business establishments including some associated small scale farming (market gardening and pen keeping) activity and social infrastructure. No obvious communally used recreational or green areas are directly impacted, though these are not necessarily well defined by structures.

The highway runs south of and roughly parallels the existing main road including the Bustamante Highway. The land use in this area is residential and commercial, comprising dwellings and business places along the main road but also extending away from the main road. Urban infrastructure exists in the form of schools, churches and recreational facilities. Impacts on these densely populated communities will mainly arise from construction related inconvenience and during the operational phase reduced traffic congestion, but also diversion of business away from the many roadside establishments that currently make a living from traffic along the main road.

The alignment is generally not disturbing of the main land uses in the project area. Where it impacts, it does so on a limited scale. It does not significantly affect neighbouring land use even in those communities where structures are actually impacted. However there are some communities that are divided such as Savannah Cross and significantly fragmented such as Hunts Pen. Also some communities are significantly separated from each other in relation to informal north -south communication lines as for example the communities approaching and bordering Mineral Heights such as Hunts Pen and Upper Halse Hall. One consequence of the alignment as it passes through this section is that it arrests the natural north southward expansion and con-urbanization of the communities that is taking place. While this movement may not be totally stopped, it will impose a redirection in relation to the opportunities for crossing the highway.

In the vicinity of the Rio Minho, acquisition is required of two moderately large business enterprise, each on opposite sides of the river and both representative of mining land use.

5.3.2.2. Demography & Livelihoods

In this section, the footprint of the highway follows some of the least populated areas along its alignment but it also borders the most densely populated areas found throughout its alignment.

The communities in proximity to the highway contain the following populations.

Table 5.3.2.2: Population by Communities

Community	Male	Female	Total
Sandy Bay	1,156	1,061	2,217
Savannah Cross	600	581	1,181
Hunts Pen	410	387	787
Mineral Heights	584	722	1,306
Halse Hall (Top & Bottom)	1,027	1,115	2,142
Curatoe	128	158	286
May Pen	27,185	28,447	55632
May Pen By-Pass	50	60	110
Total	31,130	32,531	63,661

By comparison the Special Area May Pen which comprises 99 electoral divisions and includes most of the above communities has a population of 57,334. This wider population will very likely, at some stage over the projects life, use the highway.

Demographic Profile

The populations in the two Clarendon based sections identified in Table 5.3.2.2 are not significantly differentiated in terms of their demographic profiles. In fact since their total populations account for perhaps 87% of the urban parish populations, the parish urban averages very likely describes community populations adequately. Even where variations occur, they would be relatively small and not materially affect the overall socio

economic impacts in either direction. Where data gathering during the rapid appraisals indicates to the contrary, this will be mentioned. The following profile is therefore held to typify the populations in the zone of impact for both Sections and will be cross referenced accordingly.

In this sector the ratio of males to females is separated by about 2 percentage point. Females comprising about 51% of the population and males 49% based on the above tables. About 35% of the population is under age 15 and 56% between 15 and 64. 8 percent are over 65. Those employed age14 and over, account for about 52% of the population over 14 years, a ratio somewhat confirmed by observation and community feed back. The ratio of male employment to female employment is about 4 to 1. The dependency ratio, a measure of the dependency of the parish population on those within the labour force is 77% meaning that 77 persons per hundred are dependent on the remainder. It is likely that this ratio holds true in the communities making up the impact zone. Clarendon is a parish with the highest youth population and also the highest youth dependency ratio of 62%. The conclusion being that 62% of youth are dependents. In relation to housing, a rough indication of the number of dwellings would be 2153 with an average occupancy of 3.73. Female headed households are likely to account for 42%.

Generally the demographic profile confirms supporting observation that typically the impacted communities are poor, with significant numbers of persons either unemployed or very underemployed. The main occupational skills reported being labouring and building skills among males and service oriented skills (mainly domestic and home based cosmetology and sewing services) and petty trading including shop keeping and market and subsistence gardening for the females. However other middle income skills are also represented. In Section 1, Mineral Heights is middle class and in the communities of Hunts Pen and Hayes bauxite employment is important. In Section 2 McGilchrist Pen comprises upper middle income housing.

Community expectation of temporary employment, downstream economic benefits and the advantages associated with rapid transit are the principal bases for the acceptance of the project among these populations.

5.3.2.3. Community Flooding Experience

The communities reported flooding problems in Section 1 are set out in Table 5.3.2.3

Table 5.3.2.3: Community Flooding

Community	Perspectives
Sandy Bay	Flooding mainly occurs in the lower eastern quadrant towards the Petcom gas station. Flooding is associated with overtopping of what is variously referred to as the Sandy Bay Bridge or the Sandy Bay Gully (a.k.a. Mother Booth Gully) or the Sandy Bay River. Flooding originates from the higher lands to the north, but also off from other neighbouring communities. Gullies are reported as cleaned regularly, so the flooding has reduced over time.
Savannah Cross	Flooding is reported to be a problem after about 2 days of rain. Roads become impassable but main impact is towards the south of the community. Lots of ponding occurs in the area.
Hunts Pen	Community opinion is evenly divided on whether there is a flooding problem. However when events do occur it is attributed to poor drainage and the flooding out of gullies. There are 2 specific gullies that play a role. The gully carrying the Mineral Heights Sewage plant discharge is regarded as a major problem with the heaviest discharge; it is also regarded as toxic and dangerous as waste becomes part of the flow stream. The other gully lacks maintenance. The source of the flooding was not identified but seems to come off of nearby hills.
Mineral Heights	Confined mainly to the main entrance and to the south east border of the scheme.

5.3.2.4. Community Attitudes to The project

The project received overwhelming support among the sample of 132 persons interviewed in this Section. When asked to select the statement most reflective of how they felt on the need for the highway, the responses given are summarized in shown in Table 5.3.2.4a.

Table 5.3.2.4a: Community Acceptance of the Project (% of Respondents by Community)

Communities	V. Necessary	Necessary	Not V Necessary	Unnecessary
Sandy Bay	45	55	0	0
Savannah Cross	20	80	0	0
Hunts Pen	35	75	0	0
Mineral Heights	56	39	5	-
Halse Hall (Top & Bottom)	7	73	20	-
Curatoe	0	100	0	0
May Pen By-Pass	20	80	0	0
Median value	*20*	*75*	*5*	*0*

May Pen was not sampled, but based on interviewing some 8 business leaders including leadership of the Clarendon Chamber of Commerce, and judging from comments offered at a briefing of the Clarendon Parish Council facilitated by NROCC, and also a Public Meeting in May Pen to explain the Project attended by 27 persons, the Project was well received. Useful insights were offered in relation to drainage challenges along the alignment and several of these were contributory to the assessment of the hydrological issues.

Within all four sections of the entire impact zone the range of perceived benefits or fears and reservations about the project expressed, can be grouped under the following categories of responses. These are approximately ranked in the order of the frequency with which they occurred. The responses were mainly on 'a top of mind' basis. Between communities emphasis and ranking may have varied, but generally all opinions offered were offered in all communities. Therefore in the interest of minimizing repetition, reference is made to Table 5.3.2.4b in all the sections.

Table 5.3.2.4b: Ranking of Main Benefits, Fears and Reservations Perceived for the Project

Benefits by Large Majority	***Ranking***
Construction employment potential	1
New development potential for Communities	2
Rapid transit time	3
Reduction of existing road congestion	4
Fears & Reservations by Small Minority	-
High toll & loss of choice/inconvenient access	1
More serious accidents	2
Additional flooding	3
Benefits only the few	4

Business operators along the existing main road collectively react as a threatened group. Approximately 25 large small and micro business operators were spoken to during the Rapid Appraisal and covered the entire alignment. The largest was JAMALCO the smallest ones were the vendors in Sandy Bay to Rio Minho. The larger the impact risk perceived the more likely initiatives were being contemplated by business operators to approach NROCC directly for discussions. For those larger businesses directly impacted (facing acquisition) this process is well in hand.

All but one business operator thought that their enterprises would suffer loss of revenues as a result of the highway. Though pushed for a percentage decline or a monetary yardstick by which to gauge the loss, most business persons were unable to estimate this. This was not because of confidentiality issues, but because they had generally not given the matter much thought and had little empirical data to work with. One larger operator volunteered a loss of 50%. And one community based grocery shop thought 15%. The impression was formed that the implications of the highway on their operations are only now being taken seriously. The lone business that was indifferent to the coming of the

highway was a medium size roadside automobile garage in Redberry Manchester, that claimed they served a very local clientele.

While aware of potential business losses, business operators were almost unanimous in supporting the concept and need for the highway. They echoed the benefits already summarized. Though all were invited to suggest an alternative or a better alignment for the highway, very few responded and mainly questioned the need for a new highway between the May Pen Roundabout and Clarendon Park. As one example of the perceived benefits, JAMALCO was supportive of the highway, citing employee travel time savings as a very noticeable plant benefit arising from the existing H2K Kingston to Sandy Bay leg. By contrast the large and very popular travelers halt, Juici Beef Ltd. perceives themselves as a potential major loser in relation to business diversion resulting from the highway.

5.3.3. Section 2 -Rio Minho to the Parish Border

5.3.3.1. Land Use

After crossing the Rio Minho land use patterns change. The alignment moves through a significant area of commercial agriculture (sugar cane) and thereafter crosses land under some agricultural production, including inland fisheries and chicken farming. but mainly comprising degraded pasture land and uncultivated holdings. Interspersed but mainly south of the alignment are residential holdings of mixed housing types and the impact zone itself is bordered to the south by a number of small roadside communities comprising the normal mix of commercial operations typically found in such communities. Residential land use is not as high density as the Greater May Pen Area just transited. However the sugar belt embedded community of Foga is impacted with approximately 4 dwellings a church and a garage being taken. Once the highway crosses the May Pen to Mandeville main road just west of Porus it continues to traverse cultivated properties and residences in the Belle Plain area taking some 13 structures and two chicken houses as it approaches Rock Halt. Continuing, the land use becomes mainly agricultural through degraded pasture land in ruinet, a fish farm and scattered

residential (11 houses taken) until just before leaving the parish and climbing over Morgan's Pass.

Running adjacent to this portion of the alignment, are several important rural centers. These are Four Paths, Osborne Store, Toll Gate and Clarendon Park. Business losses, due to traffic diversion, are foreseen by these main road communities.

The alignment does not significantly alter land in this Section although it does impact important residential and farming structures. Neither does it fragment communities or infringe significantly, social right of ways.

5.3.3.2. Demography & Livelihoods

The communities in proximity to the highway contain the following populations.

Table 5.3.3.2: Population by Communities

Community	Male	Female	Total
Foga Road	120	130	250
Four Paths	464	493	957
Swansea	150	160	310
Belle Plain & Rock Road area.	722	756	1,458
Osbourne Store	1,499	1,455	2,954
Rock Halt	163	163	256
McGilchrists Pen Toll Gate/ & Clarendon Park	1,476	1,611	3,087
Total	4,594	4,768	9,362

Demographic Profile

As explained earlier, please refer to 5.3.2.2 in Section 1. However, the gender ratio changes in favour of the females (51%) based on the data in the above table.

Generally the demographic profile confirms the impacted communities are middle and lower income in social classification, with significant numbers of persons either unemployed or very underemployed.

5.3.3.3. Community Flooding Experience

In Section 2 the communities reported flooding problems are set out in Table 5.3.3.3.

Table 5.3.3.3: Community Flooding

Community	Perspectives
Four Paths	Flooding occurs mainly along the main road and in Settlement. It is attributed to poor drainage infrastructure and poorly maintained drains. The entire area is said to be very low lying and subject to ponding.
Osbourne Store	The community experiences serious flooding in heavy rain fall events. Flooding is mainly attributed to the existing drainage system being very old (1940's -50's) and therefore inadequate. They are also not maintained. Flooding is reported as having worsened since the construction of McGilchrist Park housing estate. It results in ponding on the main highway and inundation of shops. It is claimed that storm water comes off of the hills and across Belle Plain.
Belle Plain & Rock Road area.	The Rock Road, runs from the Mocho foothills through to Osborne Store. It is said to be a natural channel for storm water towards the south.
Toll Gate/ & Clarendon Park	Some flooding is reported mainly along the St. Jago main road.

5.3.3.4. Community Attitudes to the Project

The project also received very strong support among the sample of 90 persons interviewed. When asked to select the statement most reflective of how they felt on the need for the Highway, the results are shown in Table 5.3.3.4.

Table 5.3.3.4: Community Acceptance of the Project (% of Respondents by Community)

Communities	V. Necessary	Necessary	Not V Necessary	Unnecessary
Foga Road	0	100	0	0
Four Paths	29	71	0	0
Swansea	0	100	0	0
Osbourne Store	50	50	0	0
Belle Plain & Rock Road	0	100	0	0
Rock Halt	86	0	0	14
McGilchrists Pen Toll Gate/ & Clarendon Park	58	42	0	0
Median value	*29*	*71*	*0*	*0*

As previously indicated within the entire impact zone the types of benefits or fears and reservations about the project expressed by respondents, can be grouped and ranked within a limited range of responses. In the interest of minimizing repetition, reference is made to Table 5.3.2.4 and associated comments.

Similarly the impression was formed, speaking to business persons in this section, that the implications of the highway on their operations are only now being taken seriously. Business operators were strong in supporting the concept and need for the highway, notwithstanding the perceived threats to their own businesses

5.3.4. Section 3- The Clarendon Parish Border to Redberry

5.3.4.1. Land Use

Approaching the border and then crossing the border into Manchester, land use becomes mainly agricultural production on small holdings, between large areas of uncultivated secondary limestone forests intermingled with low income residential communities,

mainly aligned along the May Pen to Porus Main road. The alignment severely impacts Scotts Pass Village. In this relatively small Clarendon hill top community and as it descends through Berrydale, the highway displaces close to 50 substantial structures, most of them houses, before crossing over the A1 road and then the Milk River in quick succession. From the aerials it is likely that some 90 additional structures could be impacted between this crossing of the main road and the end of the alignment.

Section 3 presents the most rugged terrain found along the alignment with several cuts and fills being necessary. Along the existing main road vending activity starts in Scotts Pass (the local name for the roadside community and to be distinguished from the geographical feature on the Clarendon side of the border) and increases in intensity as the road approaches Porus.

5.3.4.2. Demography & Livelihoods

The communities in proximity to the highway contain the following populations.

Table 5.3.4.2: Population by Communities

Community	Male	Female	Total
Scotts Pass Village	279	256	536
Scotts Pass	394	421	815
Spring Grove	351	333	684
Porus	2,644	2,594	5,240
Redberry	141	151	292
Total	3,809	3,757	7,566

Demographic Profile

Along the alignment itself, the communities are mainly rural in nature and the demographic profiles of these communities should not vary too much from other inland

rural communities in Manchester. However the alignment is mainly contained within the wider Porus Special Area with its mix of urban and rural populations. Since this is a significant sub set of the impact zone along this portion of the alignment, the demographic features of this area will be imputed from data available for this Special Area, except for gender ratios that are taken from the table.

The ratio of males to females in the population is separated typically by about 1 percentage point. Females comprise about 50.5% of the population and males 49.5%. About 33% of the population is under age 15 and 58% between 15 and 64. 9 percent is over 65. Those employed age14 and over, account for about 59% of the total population 14 & over. The ratio of male employment to female employment is 1.7 to 1 for the parish. This may be slightly lower in the Porus Special area, but would still be in the same order of magnitude. The dependency ratio a measure of the dependency of the parish population on those within the labour force is 69% meaning that 69 persons per hundred are dependent on the remainder. It is likely that this ratio holds reasonably true within the impact zone.

In relation to housing, a rough indication of the number of dwellings would be 2028 with an average occupancy of 3.73. Female headed households are likely to account for 41%.

Generally the demographic profile confirms supporting observation that typically the impacted communities are poor, with significant numbers of persons either unemployed or very underemployed. The main occupational skills were reported as being in farming and building & construction for the males, and household based services, vending and market gardening for the females.

In these communities expectation of temporary employment is the principal basis for the acceptance of the project among the respondents sampled.

5.3.4.3. Community Flooding

The communities that reported flooding problems are set out in Table 5.3.4.3.

Table 5.3.4.3 Community Flooding

Community	Perspectives
Scotts Pass	Not a particularly flood prone area unless the Milk River overflows its banks in sustained rainfall events. Main road drains also over flow. Surface water runs of fairly quickly.
Spring Grove	Due to a number of springs in the area during heavy rain events, flooding occurs as water passes across the A1 road towards the Milk River Flooding in Berrydale said to be heavy.
Porus	The community reports flooding affects mainly the potion of the town near the police station. Some attribute flooding to bauxite mining operations taking place in bordering mountains.
Redberry	The community acknowledges a flooding problem that they associate with The claim that the community receives water directly from the Milk River watershed area. Also that the river flows underground in this area.

5.3.4.4. Community Attitudes to The project

The project also received strong support among the sample of 82 persons interviewed in this Section. When asked to select the statement most reflective of how they felt on the need for the Highway, the percentage results are shown in Table 5.3.4.4.

Table 5.3.4.4: Community Acceptance of the Project (% of Respondents by Community)

Communities	V. Necessary	Necessary	Not V Necessary	Unnecessary
Scotts Pass	18	82	0	0
Spring Grove	30	70	0	0
Porus	2	86	5	7
Redberry	40	60	0	0
Median value	*24*	*76*	*0*	*0*

As earlier established, within the entire impact zone the types of benefits or fears and reservations about the project expressed by respondents, can be grouped and ranked under generally recurring responses. Reference is therefore made to **Table 5.3.2.4** and associated comments. The impression was similarly formed speaking to micro business persons in this section that the implications of the highway on their operations are only now being taken seriously. Small business operators were strong in supporting the concept and need for the highway, notwithstanding the perceived threats to their own business. In a notable exception 3 small business operators in Porus stated that the highway was unnecessary and they felt no benefits would derive to the community from it.

5.3.5. Section- 4 Melrose Bypass to Williamsfield

5.3.5.1. Land Use

The final six kilometers of the Highway's alignment takes place though predominately sparsely cultivated thinly wooded re-vegetated mined out bauxite land which characterizes the Melrose Bypass. Outside of the footprints, land use becomes mainly agricultural production on small holdings between large areas of uncultivated secondary limestone forests which are also intermingled with residential clusters. This is along the Melrose Hill 'old' road .

5.3.5.2. Demography & Livelihoods

The communities in proximity to the highway contain the following populations.

Table 5.3.5.2: Population by Communities

Community	Male	Female	Total
Melrose By Pass	0	0	0
Melrose Hill	494	530	1024
Williamsfield	1812	1874	3686
Total	2306	2404	4216

Demographic Profile

The communities impacted by the alignment in the final Sector are mainly contained within the Williamsfield Special Area with its mix of urban and rural populations. The demographic data for this special area will be used to profile Williamsfield and Melrose Hill, with the exception of Gender ratios that are taken from the above data . The only community lying along the Melrose By Pass is the vendors lay-by.

The ratio of males to females in the population of the based on the above is Males 43% of the population and females 57%. About 41% of the population is under age 15 and 39% between 15 and 64. 10 percent is over 65. The ratio of male employment to female employment is 1.7 to 1 for the parish. The dependency ratio which we assume takes the value for the parish is 69% .

Generally the demographic profile suggests and observation supports, that these communities are typically poor, with significant numbers of persons either unemployed or very underemployed, notwithstanding the presence of the mining sector. The main occupational skills were reported as being building construction for the males, and shop keeping services and market gardening for the females.

In these communities as well, expectation of temporary employment is the principal basis for the acceptance of the project among these populations.

5.3.5.3. Community Flooding

The communities reported that flooding was not a problem.

5.3.5.4. Community Attitudes to The project

The project also received strong support among the sample of persons interviewed in this section. When asked to select the statement most reflective of how they felt on the need for the Highway, the percentage results are shown in Table 5.3.5.3.

Table 5.3.5.3: Community Acceptance of the Project (% of Respondents by Community)

Communities	V. Necessary	Necessary	Not V Necessary	Unnecessary
Williams Field	20	50	30	0
Median value	*20*	*50*	*30*	*0*

Since the number of persons interviewed in the Rapid Appraisal was small (15 persons) their responses can be directly analyzed. 47% of respondents identified reduced travel time as the main benefit of the project. 33 % say the main benefit being economic growth and development. 20% identified employment as the main benefit. The majority of persons who expressed an opinion, accepted that the highway would bring development with it.

5.3.6. Acquisition & Dislocation

Along its length of approximately 37km, the footprint of the highway will require acquisition and removal of some two hundred and twenty (220) structures. This is a projection based on the most recently available estimates from NROCC. Approximately 30% of lands required for the highway construction are Crown Lands. The Concession Agreement requires that the Government of Jamaica represented by the Grantor (NROCC) owns the land within the right -of- way for the toll road. NROCC will acquire the lands for the highway in accordance with the schedule set out in the Concession Agreement. NROCC will not be engaged in any relocation exercise (Appendix VI).

The practice in relation to squatters or persons not having legal claim on the land is where this is on public lands, some compensation is negotiated. Where this is on privately held land, the rightful owner is required to treat directly with the squatters.

The Issue of Acquisition

The lands required by the highway can be acquired through negotiation or by compulsory acquisition under the Land Acquisition Act 1966. This right of acquisition is also conferred by The Jamaican Constitution. The Commissioner of Lands is the Competent Authority under the Act. The agency that the Government has appointed to negotiate land acquisition for this segment of the highway is the National Road Operating & Construction Company. While the power exists with Government to acquire the lands needed, the right of affected individuals to seek judicial review of the terms of purchase is also set out in Section 17 of the Act. Perhaps the most important of these terms being the price offered.

Land acquisition, when viewed from the negotiating advantage implied by the Act, means that Government has an obligation rooted in the concept of natural justice, to ensure that the process is both equitable and transparent.

5.3.7. Transportation

The main means of transportation within the impact zone is public transportation. Public transportation is also the main means of persons travelling between Kingston and Mandeville within which the alignment falls.

A sub set of transport operators was interviewed for their attitude to the project. These were mainly taxi and mini bus operators, and they were interviewed while working in the May Pen area.

Though the sample was small the unanimity of responses suggests that members of the wider public transport sector are likely to be supportive of the project.

Table 5.3.7: Public Transport Operators Acceptance of the Project (% of Respondents)

	V. Necessary	Necessary	Not V Necessary	Unnecessary
Taxi & Mini Bus	80%	20%	0	0

Travel time savings was the main benefit perceived.

5.3.8. Social Rights –of- Way

To members of the motoring public, transport operators and frequent commuters the highway offers immediate and significant benefits. To others, less concerned with rapid transit, the presence of this tolled roadway in proximity to or passing through their communities can potentially represent a very profound and direct and permanent inconvenience. The aged or infirm or even the young and healthy can suddenly be confronted with a physical un-crossable barrier that can easily add two hours walking journey each day, to circumvent. These people have a right to some protection, and this is embodied in the concept of a social right- of –way.

In Section 1.0 of this report, a list of the proposed intersections and crossovers was presented. The EIA has looked closely at each from the standpoint that any trade-off with costs, must be skewed towards this population of affected persons.

The conclusion is drawn that the design of the highway has tried to be sensitive to the protection of these rights. There are however three locations where further investigation is thought desirable, mainly because time has not permitted adequate empiricism. These are identified in Table 5.3.8.

Table 5.3.8: Locations For Review of Social Rights Infringement

Chainage	Comments
35+500	Road as it crosses Shu Gully Area. This is very likely an access route by forest users, coal burners perhaps wild hog hunters. The highway cuts off all access to these southern woodlands except at points where communities are crossed.
40 + 000	This community (Hunts Pen) is divided and although the road systems may allow eventual linkage it is very likely that south/ north social rights of way are being ignored. Domestic & artesian workers as also non-driving community dwellers probably use this axis to move in and out. Long walking distances would be involved.
60+000 to 61+000	Concern for the extent to which hill side dwellers in the Berrydale area may have to reroute to cross over the alignment. Terrain inhospitable.

Because the highway represents such a permanent barrier, the very seriously impacted may have to consider relocation.

5.3.9. Traffic Flows

This section quotes directly from a report entitled *Highway 2000 Phase 1 Traffic & Revenue Forecasts. Final Report. 19 April 2007.* Prepared by Steer Davis Gleave for Trans Jamaican Highway. The writers of the report caution that the findings represent best estimates, and that numerous assumptions and judgements are relied upon. Also the external circumstances can change quickly and can affect income. However the report represents the most up to date attempt to quantify these flows and benefits. Selectivity has been exercised to protect sensitive disclosure.

5.3.9.1. Traffic Projections

The forecast daily traffic flows (in vehicles per day) is presented below. This flow project underpins revenue projections for the Highway, and in interpreting the locations assigned these would be reference points along the alignment taking into account the interchanges designed for.

Table 5.3.9.1a: Forecast Daily Traffic Flows, at May Pen & Toll Gate In Years 2011 and 2021

	May Pen	Toll Gate
2011	4,656	12,449
2021	7,281	16,835

Estimated Time Savings

The estimated time savings attributable to the highway are shown in Table 5.3.9.1a.

Since the current phase is one segment of the corridor linking Kingston to Mandeville the table reflects overall time savings between the main towns served.

Table 5.3.9.1b: Time Savings (In Minutes) In 2006

From	To	Via A2	Via H2K	Time Savings
Kingston*	Spanish Town	20	10	10
	Old harbour	47	22	25
	May Pen	67	30	37
	Mandeville	105	50	55

*** Staring point is junction of Highway with Mandela Highway**

Overall time saving along the highway will be 55 minutes between Kingston and Mandeville.

5.3.10. Macro Economic Benefits

The Steer Davies Gleave study while forecasting revenues generated by the highway (Kingston to Mandeville) through to the year 2036, did not recast these figures into an expected impact on the GDP. This is outside the scope of the EIA.

5.3.11. Archaeological and Cultural Heritage

Each of the over 300 respondents interviewed was asked to identify any heritage elements that might be threatened by the alignment as it passed near to their

communities. But none of the respondents were able to point to any. This issue was particularly probed when speaking to key informants and community leadership. For example the former long time owners of the extensive and mostly uninhabited Inverness estate, through which the alignment passes for several kilometers in Clarendon, were consulted. They were very familiar with the land claimed by the alignment and felt fairly certain that there were no surface relics in its path that would be disturbed.

At the time of the Strategic Environmental Assessment of the corridor in 1999-2000 (Dessau Soprin International, 2000) the Jamaica National Heritage Trust (JNHT) had identified areas of potential impact. The following table lists the heritage assets identified as being of concern within the 1 kilometer wide corridor.

Table 5.3.11a: Listed Sites Noted within the Highway 2000 Corridor, Clarendon (Taken from: Dessau Soprin International, 2000)

Location	Grid Reference	Nature of Site	Description of Monument
Freetown	233900E/141900N	Village	Taino settlement (650AD). Post-emancipation village (1900's. African-Jamaican, Anglo/Jamaican
Tobby Abott		Pen	Taino settlement (650AD). Anglo-Jamaican influence
Inverness	230300E/140100N	Pen	Taino Settlement (650-1950AD). Important sisal hemp factory. Taino, Anglo-Jamaican influence
Free People		Church	18th century settlement of free Negroes, historic church
Hunts Pen		Church	18th century structure
Sandy Bay		Caves (3)	Several limestone caves housing bats, guango
Halse Hall		Estate, Great House and tombs	18th century great house on Jamaica Gazette List. Associated with an early settlement family
Belle Plain		Estate	Former sugar cane plantation, old ruins, works. Anglo- Jamaican influence
Toll Gate (Erin)		Estate	Sugar plantation. Possible ruins. Toll was taken not far from this property
Scotts Park		Church	18th Century structure

Source: Jamaica National Heritage Trust, 1999

Table 5.3.11b: Listed Sites Noted within the Highway 2000 Corridor, Manchester (Taken from: Dessau Soprin International, 2000)

Location	Grid Reference	Nature of Site	Context of site
Porus	206400E/153400N	Midden	Former Taino settlement which may contain vernacular structures.
Hope		Pen	Old Cattle range which may have old stone works and other stuctures
Williamsfield		Historic Town	19th Century settlement, early Pen-church, post office, great house, Anglo-Jamaican influence

Source: Jamaica Heritage Trust, 1999

It is recommended that the Jamaica National Heritage Trust be allowed to hold a watching brief in those locations identified above if required.

The following areas are recommended for specific attention:

- Free People (Savannah Cross) area.
- The alignment as it crosses north of the existing Halse Hall property.
- Belle Plain in relation to plantation relics.

The Jamaica National Heritage Trust (JNHT) was written for guidance and a map of the alignment provided to them, but at the time of this report the JNHT had not responded.

5.3.12. Other

In high density and site specific environmental impact assessments, typified by a housing or hotel development the impact of the project on social infrastructure carrying capacity is different than that occasioned by a tolled highway. The important difference being that the highway's 'population' transits, non stop, through the communities they encounter

and typically do not make claims on any social services. Further, since traffic volumes between destination points (for example Kingston & Mandeville) is more a function of vehicle population (which in turn is dependent on economic and importation policies) there is only the assumption that the highway will, of itself, increase these flows.

At this level therefore, the analysis of the social services infrastructure within the project area is limited to the following comments.

5.3.12.1. Fire Services

Emergencies that allow use of the alignment will be considerably facilitated by the time savings identified. A challenge is implied in rescue missions, since vehicular accidents along the highway can be expected to be relatively more devastating due to the speed involved. Crossing over the alignment is already facilitated by the highways design which accommodates existing roadways.

5.3.12.2. Police Services

The same considerations apply with the additional dimension that movement of criminals across parish borders is greatly facilitated by a rapid transit highway. This emerging reality has been publicly acknowledged to by the police. There is no available data on inter parish criminal activity that would permit more than an acknowledgment by the study, that this could occur.

5.3.12.3. Public Health

The new highway falls under the South East Regional Health Authority and respectively under the Clarendon and Manchester Health Departments. Within the zone of impact as defined, there are 5 health clinics within the Clarendon sectors and two within the Manchester. Both parishes have a type B hospital located in the parish capitals.

Public health services are designed to serve the residential populations in their prescribed catchments. To the extent that residential populations within the impact zone, increase

due to the developments opened up by the highway, there will be added demand for public health services. Currently, public health infrastructure both in terms of space and equipment requirements and professional health care personnel, is recognized as being inadequate and under stress. However plans are being pursued for the rapid expansion of these services within the areas served by this Authority, partly in response to the projected development potential identified in the Portmore to Clarendon Park –Highway 2000 Corridor Plan [iii] and the then proposed New Town Development.

5.3.12.4. Planned Developments

Each respondent in the rapid appraisal survey was asked to disclose any knowledge of planned developments close to or along the proposed alignments. No developments for which the alignment might create a negative physical impact were identified. The larger housing estate developers such as The National Housing Trust, the Ministry of Housing and NHDC (in the public sector) and Gore Developments Ltd. and West Indies Home Contractors (in the private sector), and no similar projects were determined.

Similarly a search of NEPA's website revealed no permit applications being processed that indicated a potential conflict. Nevertheless, two large entities were concerned that the alignment impacted their development plans indirectly. Juici Beef Ltd. has a proposed expansion plan that may have to be revisited in light of the new alignment. Shagore Aggregates, an aggregates mining company, had indicated that they would need to revisit their plant and expansion plans (at Rio Minho) due to pending acquisition. Similarly an interest was noted by JAMALCO in exact details of the alignment to ensure that their plans for realignment into Williamsfield were not affected. Discussions with NROCC have taken place.

The National Housing Development Corporation (NHDC) has indicated a proposed housing development at Unity Farms/ Mid Island Estates (Pers. Com. Ms. J. Newby, NHDC). The status of approvals could not be ascertained.

Where acquisition occurs, there is an implied dislocation, very often to workers. It is possible that acquisitions are to benefit of vendor as it would be to the purchaser. It was not possible to determine accurately whether genuine expansion plans will be impacted and negotiations for acquisition will determine the validity of any potential loss.

5.3.12.5. Projected Population

In the long term, a highway permits the relocation of populations at a faster rate and in a direction than might otherwise have happened. This is a necessary corollary to the basic assumption that development will follow the Highway.

This general trend is easy to predict but the specific forms this development will take is impossible to know or quantify. This EIA does not attempt to do this. It is the responsibility of the physical planning agencies to project population movements and provide guidelines within which policies with respect to resource allocation for improving both physical and social infrastructure in the short medium and long run can take place. Notwithstanding, demographic planning has been responsive to the implications of Highway 2000 along its existing alignment and, in relation to population projections, along its general alignment in Clarendon.

In both parishes (Clarendon and Manchester) the Statistical Institute of Jamaica (STATIN) special population areas, cover to a significant extent the communities impacted by the alignment. In Clarendon the population projections by the Planning Institute of Jamaica undertaken for the Portmore to Clarendon Park –Highway 2000 Corridor Plan serve as a good proxy for the zone of impact in this parish. They were predicated, partly on the assumption that rapid housing expansion would continue to take place along this corridor, as populations moved out of the KMA and Portmore in particular. The resulting projections reflect an anticipated average annual growth rate

over the period of 3.149%. An unusually high growth rate when compared with the national annual average growth rate of just under 1% between 1991 and 2001

Table 5.3.12.5a: Projected Population for Clarendon

CLARENDON								
SPECIAL AREA	**1991**	**2001**	**2003**	**2005**	**2010**	**2015**	**2020**	**2025**
May Pen	49146	62230	65238	68392	76959	81666	84133	86675
Sandy Bay/Green Park	4362	6049	6458	6894	8119	8816	9188	9576
Toll Gate/Osbourne Store	5639	6740	6985	7238	7914	8652	9048	9462
TOTAL OF SPECIAL AREAS.	**59,147**	**75,019**	**78,681**	**82,524**	**92,992**	**99,134**	**102,369**	**105,713**

Source : Extracted from, correspondence from The Planning Institute of Jamaica, August 2007.

Similar projections were not available for other impact zones in Clarendon or impact zones in Manchester. This is because there is no land use planning document similar to that developed by the Corridor Plan referred to above. This report has therefore constructed its own projections based on maintaining the combined population average annual growth rate 1991-2001 of 2.89% for STATIN's two special areas in the impact zone. This growth rate is partially justified by the recognition that the Manchester special areas grew over the 10 year period (1991-2001) at a greater average annual rate (2.89%) than the Clarendon special areas which are projected to grow over the ten year period (2005-2015) at a rate of 2.01%. It is also justified because PIOJ growth rate for Clarendon assumed factors such as the development of a New Town and the pre-highway rapid expansion of housing developments between Spanish Town and May Pen. The continuation of this momentum between May Pen and Williamsfield is less certain, hence the more conservative growth rate used.

Table 5.3.12.5b: Projected Population for Manchester

MANCHESTER								
SPECIAL AREA	**1991**	**2001**	**2003**	**2005**	**2010**	**2015**	**2020**	**2025**
PORUS	5095	5924	6454	6834	7884	9095	10492	12103
WILLIAMSFIELD	2800	4251	4632	4904	5658	6527	7529	8686
TOTAL	**7895**	**10175**	**11086**	**11738**	**13542**	**15622**	**18021**	**20,789**

Projections calculated for this report: **2.899 /annum**

Of interest, if not significance, is the observation that in year 2020 one vehicle will use the highway for every 8 persons making up the population of the zone of impact.

5.3.13. Public Consultation Process

5.3.13.1. Meetings, Interviews, Requests and Information Sharing

The Public Consultation Process for Phase 1B has included the following components:

12. Individual stakeholder meetings

13. Application of interview instruments to over three hundred (300) persons in twenty (20) communities in the zone of impact (Appendix VI)

14. Meeting with the GOJ regulatory agency, the National Environment and Planning Agency (NEPA) and presentation to the Technical Review Committee (TRC) of the Natural Resources Conservation Authority (NRCA)

15. Meetings with Government of Jamaica (GOJ) agencies (eg. National Works Agency, National Roads Operating and Construction Company (NROCC))

16. Requests to GOJ agencies for information (eg. Jamaica Bauxite Institute, Forestry Department, Water Resources Authority, Office of Disaster Preparedness and Emergency Management, Jamaica National Heritage Trust) (Appendix V)

17. Information sharing with and requests to NGOs, in particular the Caribbean Coastal Area Management Foundation (CCAM) the co-managers of the Portland Bight Protected Area (Appendix V)

18. Meetings with Parish Councils (Manchester and Clarendon) (Appendix VI)

19. Availability of the Terms of Reference for the EIA for public review and comment through distribution of hard copies to the Manchester and Clarendon Parish Libraries and Parish Council offices (Appendix V); posting of the electronic version on the ESL website; submission of the electronic version of the TORs to NEPA for posting on the NEPA website.

20. Public notification and presentation of the project (Advertisement in the Sunday Gleaner on June 24, 2007 and the staging of Public Consultation No. 1 held in May Pen on June 28, 2007)

21. NEPA's request to its sister agencies for review of the Terms of Reference (Appendix III) and incorporation of the agencies' comments

22. Private sector companies and stakeholders (e.g. JAMALCO)

The comments of NEPA and the NEPA sister agencies that have responded, have been incorporated into the Terms of Reference for the EIA as indicated in Appendix III. Comments from stakeholders and individuals have been incorporated as appropriate in the EIA report and the information shared with the Grantor (NROCC) and the developer (TJH).

5.3.13.2. Issues Raised

The following substantive issues have been raised by different entities during the consultations:

1. Flooding and flood history particularly in Four Paths, Scotts Pass, Clarendon Park and Porus.

2. Land acquisition process, timing and compensation.

3. Details of the exact location of the alignment in relation to privately owned lands

4. Use of local labour (skilled and unskilled) by the contractor

5. Incorporation of any existing roads into the highway alignment (such as the Melrose Bypass, which is included as a contractual agreement with the Grantor).

6. Involvement of the management of the Portland Bight Protected Area in the EIA process.

7. Maintenance of the existing Jamaica Railway Corporation ROW

5.3.13.3. Consultation No. 2 _ Presentation of the Findings of the EIA

After submission of the EIA Report to NEPA, a notification will be placed in the print media (the Sunday Gleaner and one week day placement) with the requisite twenty-one (21) day notification period announcing the staging of Public Consultation No. 2 which will be the Presentation of the Findings of the EIA. The staging of the entire event will be done according to the NRCA Guidelines of Staging Public Consultations, and as is usually done by Environmental Solutions Ltd., the venue, chairman and agenda of the meeting will be selected in consultation with NEPA.

A Verbatim Report of the meeting will be prepared and submitted to NEPA for review, as part of the EIA process.

A thirty (30) day period after Public Consultation No. 2 will be given in which the public may send written responses to NEPA on the EIA Report.

5.4. Photo Display

Plate 5.4.1 Land Use - Residential

Plate 5.4.2 Land Use - Residential

Plate 5.4.3 Land Use - Residential

Plate 5.4.4 Land Use – Agriculture – Sugar Cane

Plate 5.4.5 Land Use – Irrigation Canals

Plate 5.4.6 Land Use –Sand Mining

Plate 5.4.7 Land Use - Urban

Plate 5.4.8 Vegetation

Plate 5.4.9 Vegetation

Plate 5.4.10 Crossings - Railroad

Plate 5.4.11 Crossings - Roads

Plate 5.4.12 Crossings – Pedestrian/Social

Plate 5.4.13 Crossings – River

Plate 5.4.14 Drainage Issues – Rio Minho

Plate 5.4.15 Drainage Issues

Plate 5.4.16 Drainage Issues

Plate 5.4.17 Drainage Issues

Plate 5.4.18 Drainage Issues

Plate 5.4.19 Drainage Issues

6. Identification of the Issues

Phase 1B Sandy Bay to Williamsfield will commence at Sandy Bay at the end of the existing Highway 2000 Kingston to Sandy Bay segment. Several issues have been identified in respect of the proposed alignment. These issues have been incorporated into design phase discussion with the developer to ensure that the relevant mitigation measures can be considered for the final stage.

6.1. The Alignment

6.1.1. Proposed Route

Issue: The original alignment considered and presented in the Strategic Environmental Assessment (SEA) (Development Bank of Jamaica Limited, 2000) will be utilized. This alignment starts at Sandy Bay, traveling south of the railway line and then crossing north. The alignment will be south of Porus and May Pen, crossing north through Scotts's Pass. The existing Melrose Hill Bypass will be incorporated into the highway. The highway will cross the Rio Minho and the Milk River and northward to Williamsfield.

Development Guideline: The alignment begins on relatively even terrain and rises towards the hills of Manchester. Several communities will be traversed by the current proposed alignment.

As part of the on-going information sharing process and public consultation, the proposed alignment should be communicated with stakeholders including community groups and NGO's. This Environmental Impact Assessment (EIA) has been baseline information for the physical, biological and socio-economic components of the environment.

The information presented indicates that the proposed route for the current alignment goes through areas that have recorded historic flooding events; which are pre-existing features of South Clarendon and Manchester. The alignment traverses six types of

biological habitats, but more of these are considered of high ecological sensitivity. The socio-economic context shows the alignment traversing several major communities.

6.1.2. Drainage and Flooding

Issue: Drainage has been identified as a significant issue for this section of the alignment. The ODPEM historic flooding data shows several areas in Clarendon and Manchester with flooding history including Four Paths, Inverness, Mineral Heights, Scotts Pen, York Town, Porus and Osbourne Store. Seven water crossings have been identified for the alignment.

Development Guideline: NEPA has requested a Drainage Assessment for the EIA, which is to include an assessment of Storm Water Drainage. This is to cover the construction and operation phases and include mitigation measures for sedimentation in the aquatic environment. Drainage control for crossings of gullies should include impacts that drainage control features could have on aesthetics, water quality and sedimentation. A drainage report is presented as part of the design for approval (Appendix II).

The engineering design must consider the implementation of a 100 year return period for design of all major structures.

6.1.3. Cut and Fill

Issue: A significant amount of cut will be required along the hilly terrain and this material will be used for fill in the required areas.

Development Guideline: Slope stability is a major consideration in the areas for both cut and fill. Additional quarries may be required, to provide sufficient material for fill areas. If additional earth materials are required TransJamaican Highway Ltd. will be required to secure the relevant permits for access to this material.

Slope modification in the mountainous areas beyond Clarendon Park will alter the existing slope conditions and may make them more susceptible to slope instability. Geotechnical mitigation measures should be incorporated into the final design including appropriate finished slope angles and slope benching.

6.1.4. Increased Levels of Fugitive Dust

Issue: Clearing of vegetation and cut and fill operations are all major construction activities that will result in an increase in the levels of fugitive dust during the construction phase.

Development Guideline: Levels of fugitive dust should be minimized by adequate wetting of cleared areas and exposed topsoil. Construction workers should be equipped with dust masks when necessary. A significant portion of the alignment will be south of major communities. The EIA has established levels of baseline data in and around these communities.

6.1.5. Noise

Issue: Construction activities requiring the use of earth moving equipment and other heavy machinery will increase levels of ambient noise.

Development Guideline: Baseline noise data has been generated for selected noise sensitive receivers (NSRs). During the construction period noise levels are expected to increase. The developer should be responsible for notifying communities of the construction schedule and construction works should be structured to standard daylight working hours.

6.2. Biological Issues

6.2.1. Loss and Modification of Habitat

Issue: Areas of the alignment will traverse four categories of habitat. These are: Disturbed Dry Limestone Woodland/ Abandoned Sisal Plantation; Cane Fields and Pastures; Rural Settlement and Cultivation; and Roadside Scrub. This will result in the loss of vegetative cover and loss of habitat for some species of flora and fauna.

Development Guideline: None of the habitats are based in primary forest and do not represent ecologically sensitive areas. However, the modification of the habitats should be minimized as far as possible. Construction works should be restructured to the ROW only and no side-tipping of earth materials should occur outside the ROW.

6.2.2. Forest Reserves

Issue: The alignment has been submitted to Conservator of Forests at the Forestry Department to ascertain the location of any Forest Reserves in close proximity to or being traversed by, the alignment.

Development Guideline: The proposed Highway as outlined does not seem to threaten any forest reserves or forest management areas between Sandy Bay and Williamsfield (Appendix V).

6.2.3. Parks and Protected Areas

Issue: The alignment traverses a relatively small portion of the Portland Bight Protected Area, near the northern boundary, at the beginning at Sandy Bay.

Development Guideline: The Portland Bight Protected Area is Jamaica's largest protected area which incorporates both terrestrial and marine environments. The PBPA is co-managed by the National Environment and Planning Agency (NEPA) and the Caribbean Coastal Area Management Foundation (CCAM) a Non-governmental Organisation. CCAM was contacted advising them of the proposed alignment, and

requesting any comments to the project and to the Terms of Reference for conducting the EIA. Preliminary investigations for the EIA show that the location of the alignment in the PBPA does not appear to impact any ecologically sensitive habitats.

6.3. Socio-economic Issues

6.3.1. Toll Plaza

Issue: Two Toll Plazas are proposed for this alignment one at the Interchange at May Pen (41 +080) and one on the alignment at Four Paths (52+000). There will be no junction at Four Paths with the existing road.

Development Guideline: Information on the location of the Toll Plaza and the toll required should be communicated to the public.

6.3.2. Access Points and Crossings

Issue: The public is always concerned about the adequacy and location of access and exit ramps for the highway, interchanges, the provision of crossings for local roads and existing social rights-of-way, as well as disruptions to existing traffic patterns during the construction period.

Table 6.3.2 Access Points and Crossings

Chainage	Local Name	Overpass/Underpass
33+900	Sandy Bay	Overpass
34+650	Shu Gully 1	Underpass
35+650	Shu Gully 2	Underpass
37+600	Savannah Cross	Overpass
39+200	Webbers Gully 1	Underpass
39+300	Hunts Pen	Underpass
39+480	Webbers Gully 2	Underpass
41+080	May Pen Interchange	Overpass
42+650	Coates Pen	Underpass
43+850	Rio Minho	Underpass
45+100	Sheckles Pasture	Underpass
46+100	Content	Underpass
46+200	Content	Underpass

Chainage	Local Name	Overpass/Underpass
47+150	Denbigh	Overpass
48+150	St.Ann's Gully	Underpass
48+700	Ebony Pen	Underpass
49+950	Four Paths	Overpass
51+700	Belle Plain	Underpass
53+000	Ludford Rocks	Underpass
57+500	Clarendon Park	Underpass
57+950	Clarendon Park	Underpass
59+850	Berry Dale	Underpass
61+250	Milk River	Underpass
62+450	Spring Grove	Underpass
64+100	Redberry	Underpass
64+500	Porus	Underpass
64+700	Porus	Underpass
65+600	Trinity	Overpass
70+400	Williamsfield	Underpass

Currently twenty nine (29) access points and crossings have been identified for the alignment.

Development Guideline: The Preliminary Design has considered the issues of access and crossings. The EIA adequacy of the crossings have been considered by the EIA report. Social rights of way have also been considered.

6.3.3. Construction Spoil and Vegetative Waste

Issue: Construction will result in the generation of several tonnes of construction spoil and land clearance will result in the generation of several tonnes of vegetative matter for disposal.

Development Guideline: As far as possible material is recommended for reuse and, where possible, include the crushing of concrete for fill. Vegetative matter will also have to be dumped or made available for collection and reuse. Side tipping of construction and vegetative spoil outside the right-of-way is not recommended and construction spoil should be removed from the site and disposed of at an approved dumpsite. Discussions

should be held with the National Solid Waste Management Authority (NSWMA) to identify a suitable dumpsite.

6.3.4. Traffic Management

Issue: Traffic flow may be affected by construction works where the Highway joins and/or crosses the existing road network.

Development Guideline: Recommendations to minimise traffic disruptions and facilitate the passage of commuters while construction activities are underway include the use of appropriate signage, establishment of detours and public notification in the print and electronic media as necessary.

6.3.5. Land Acquisition and Dislocation

Issue: Land acquisition and the identification of any relocation needs is the responsibility of NROCC.

Development Guideline: The issue of relocation is significant as over 200 buildings have been identified within the alignment (from satellite imagery). NROCC has responsibility for land acquisition and has committed to contacting relevant affected persons within a reasonable
time. This process is on going and individual community meetings will be held as necessary.

7. Drainage Assessment

7.1. Drainage and Stormwater Management

The drainage system will be designed to accommodate Jamaican climatic conditions, comprising heavy rainfall and rapid runoff, through a system of drainage with two components:

- The minor drainage system, which will collect runoff resulting from the more frequent storm events and will be designed to convey the runoff to the outlet at the receiving major drainage system. The minor drainage system will consist of kerbs, channels, storm sewers, small cross-culverts and roadside ditches.

- The major drainage system consists of the large existing gullies and rivers, which take and discharge the runoff from the minor drainage system.

Crossings will be designed to comply with the recommended average number of 2.6 per km and will be designed with a minimum diameter of 900 mm. Ditches will be of a trapezoidal design and their size will be consistent with the calculated flow to be accommodated. In general, all ditches will be lined, where their longitudinal gradient is greater than 3% or where in-situ material is likely to scour), with concrete, rip rap, grouted stone, or precast concrete elements.

Generally, the 3.6 m wide median will slope away from the barrier but, where the road is super-elevated and the paved surface slopes toward the median, a system of prefabricated channels shall be installed alongside the median barrier with longitudinal pipes discharging transversely at intervals to the outside of the carriageway.

7.2. Drainage pathway and hydrogeology considerations along the alignment

- These considerations discussed below are highlighted in Figure 5.1.3b (section 5.1.3) and obtained from the 1:12,500 topographic maps, aerial photographs and geological maps along the alignment.

- Km 33+000 – 33+100 no documented flooding at gully crossing. No reduction in present culvert size.

- Km 34+700 – 34+600 Shutes Gully 1 Underpass – Green Bottom Floods (1993). Reduction in channel capacity due to cut and fill. Ensure underpass volume is equal or greater than removed capacity due to cutting and filling. Proper housekeeping required to reduce sediment load to gully during rainfall events. Slope stability may be an issue during flash flood events.

- Km 36+050 (Shutes Gully No. 3) – perennial gully that drains to the Shutes Gully. Filling not recommended. An underpass to similar to km 35+650 Shutes Gully (B33) needs to be considered to accommodate gully flow during heavy rains. Not a track.

- Normal fault at around km34+000 within the Newport limestone. Poor quality, fractured material maybe present in the limestone. Expression of the fault (fractured material) in the overlying Alluvium may not exist.

- Km 36+600 and 36+800 (Shutes Gully No. 4 & 5) – Aerial photography (see Appendix C) and 1:12,500 topographic maps suggest temporal dry gullies, associated with the Shutes Gully that are likely to have surface runoff during heavy rains. Culverts need to be considered at these areas. These drainage pathways allow surface runoff from the northern highlands, west of Free People, to the south via the Shutes Gully.

- Km 37+500 to Webber Gully – minor drainage considerations will need to incorporate overland sheet runoff from lands to the north which is currently drained by a 1.5m diam. culvert beneath the railway which ultimately discharges to Webber's Gully. Though the surface runoff may be diffuse principal flow will be toward Webbers Gully.

- Fault trace between km 38+000 – 38+500 within the limestone. Expression within the alluvium may be absent.

- Km 41+900 to 42+250 - NNE- SSW trending fault before Coates Pen Underpass (B38) at on geological maps. Slope is toward the Rio Minho and the aerial photographs suggest a possible drainage feature. Considering the soil classification is reported as low permeability Nonsuch Clay and confirmed to be a "low drainage soil with surface ponding in rains" by the Soils Survey Map. Considerations should be given to further engineering evaluation during the detailed design given that desktop evidence suggests a possible dry gully. Filling without a culvert or may be inappropriate.

- Between Km 44+000 and B41 Content Road Underpass & the Railroad (R/R) – The highway will be within the historic flood plans of the Rio Minho. The area was inundated during the 1986 floods that washed away several JPS 69kv poles that crossed the same area. The lines are noted on the engineering drawing and are an artefact of the older 1970s 1:12,500 base topographic maps. The poles were relocated by JPS adjacent the roadway after the event. The final flood invert levels are uncertain. Flood prediction modelling should be done to ensure that the invert levels of the alignment are above the predicted and historic flood levels.

- Km 49+300 – 49+500 – Old land drains that dewatered the fields of Ebony Grove are present. These drain to an unnamed tributary (dry gully) of the Rhymesbury Gully that flow southwest towards Comfort Village and ultimately joining the Jacks and St. Annes Gully. Aerial photographs show standing water within the gully and 1:12,500 maps confirm these drainage pathways. These are not tracks and should not be filled. Culverts will need to be considered for these drainage features.

- Km 50+000 Four Paths Overpass B45 – pond adjacent existing A2 local road and intersected by highway on its southern edge. The pond may be an

expression of subsidence in the underlying limestone. Geotechnical investigation should confirm whether pond is an actual depression or manmade water retention feature.

- Km 53 +650m – Drainage path from mountains to the north drains under the R/R. The 1:12,500 suggest that land drains allowed flow from the northern end of the R/R across to the Southern side then ultimately to the irrigation canal. Culverts will need to be considered to allow unimpeded flow if culverts are beneath the R/R.
- Km 53+800 – 56+800 – the alignment shall ensure that any land drains/culverts beneath the existing R/R that permits runoff from the Mocho Mountains to the southern plains are not obstructed by the highway. A similar sized drain or large stall should be installed. Otherwise, this runoff shall be collected and discharged at a suitably sized culvert at a designated highway crossing. It should be borne in mind that if the latter solution is used then it must be appreciated that multiple flows will be concentrated to a few point(s). Detention/storage devices (dry wells, swales) should be installed to ensure that both flow velocity and magnitude of the surface runoff is released in a controlled manner to the receiving discharge point(s).
- Km 56+800 – At the level crossing of the track and the R/R, flooding has been reported by local residents. Invert levels are not known. The most likely cause is confluence of flows from several land drains and a natural drainage pathway that receives water from the Mount Airy Hills. Figure 5.1.3b shows a linear land drain draining toward the SSW which interests a natural drainage pathway (that also receives overflows from the fish ponds) about 100m from the R/R. They then both flow NE toward the R/R where they merge with the southern trapezoid earthen drain and flow east toward the irrigation canal before finally going south. Its discharge point is uncertain, but it seems to join with a natural drain that discharges into the Flemmings Gully at Toll Gate. Photo below show that this drainage pathway has flowing water, most likely a

combination of natural flow and fish pond discharge water. The alignment crosses this drain and it is noted as "fill" on the preliminary drawings. This/these drains should not be filled. A suitably sized culvert will need to be designed to accommodate the flows during heavy rainfall. Residents indicate that these drains take runoff from the Juicy Beef complex and environs to the south east.

Plate 7.2: Looking south at approximately km 56+800 (May 04, 2007).

Drain at east (lower right) continues through fish ponds and beyond the railway. The railway culvert for this drainage pathway was completely washed away by heavy rains after catastrophic failure of culvert, embankment and rail lines after surface water damning behind culvert. Southern drain reportedly takes surface drainage from Juici Beef complex. Confluence floods during heavy rainfall.

- Km57+200 – 58+100 – The adapted aerial photograph shows a drainage line leading to a sediment depression before going under the R/R (km 57+400) and continuing southeasterly. This drainage feature takes significant surface runoff from the Mount Airy Hills to the north and northeast. The owners of the fish ponds indicate that within the last five (5) years the quantity of surface runoff damned behind the

railway culvert and eventually caused a catastrophic failure of the embankment and culvert. This drainage pathway should not be filled. The alignment will cross this dry gully as it goes over the R/R into the hills after Clarendon Park. Given the historic evidence a culvert shall be installed that is appropriately sized to accommodate the modelled flows.

Figure 7.2: Catchment and drainage pathway along alignment between 57+200 and 58+100.

Note sediment settlement pond north of drainage discharge point. This is the point of damning, and corresponding failure of the railway embankment, as noted by the residents.

- Km 59+900 – 60+000 – A depression/sinkhole at the 150m ASL contour (500ft, 1:12,500 topographic map) is noted. The alignment skirts the southern section of the depression. Given the WRA's objections to the blocking of sinkholes/depressions, coupled with the historic flooding at Berrydale, consideration must be given to shifting the alignment southwesterly to accommodate this sinkhole. The

evaluation of the groundwater rise flooding that occurred indicate that surface breaches occurred generally between the 150 – 180m contour; suggesting that depression with inverts close to these elevations have an increased risk of flooding.

- Km60+500 – 60+600 – This area is a probable temporal drainage pathway drains the hills to the northeast taking surface flow to the Milk River. The topographic maps suggest that a temporal drainage pthway may exist. This should be investigated further.

- Km 62+600 – 63+400 – These drainage lines are related to the Milk River. Surface runoff from the hills to the south flows north along these channels to the Milk River. The alignment will need to accommodate the Milk River in this area by culverts or river underpasses. As long as the anticipated flows are predicted and designed for either solution would be appropriate. In this area the Milk River's flow is mostly subsurface but during significant rainfall events significant overland flow is evident. There area also several N-S trending land drains on the 1:12,500 topographic maps. Filling this area is not recommended, unless suitable drainage solutions are demonstrated for the Milk River and its contributing gullies.

- FAULT: From the Milk River Underpass (km 61+100) to the Porus Railway Underpass (km 64+500) the alignment parallels or intersects a NW-SE trending normal fault. This fault is associated with the Porus/Williamfield Graben Fault system. The Melrose Bypass begins in this zone. It is likely that fractured limestone will be encountered in this zone. And given the historic flooding that has been reported at the base of the bypass, it is likely that the fractures act as high permeability flow paths for ground water flow during heavy rainfall. The Melrose Bypass runs parallel the eastern normal fault of the Porus/Williamsfield Graben. During 2002 groundwater springs appear along fractures in

the rock face at the foot of the Melrose Bypass. The springs flowed continuously for several weeks until the groundwater levels in the limestone aquifer declined. The WRA reports that residents were able to insert 4m rods into these water filled fractures. WRA estimates between 0.1 – 0.9 m^3/s of cumulative groundwater flow emerged at the ground surface. Considerations will have to be given to the increased possibility of groundwater surface breaches. The WRA has recommended that "marl" not be used as road-base during construction in areas where such breaches have been demonstrated. Permeable (free-draining), non-calcareous aggregate base would be more appropriate in minimising groundwater rise and allow free-draining without clogging of the pores of the aggregate with fines. Sub-surface horizontal/longitudinal underdrains will also need to be installed to keep groundwater rise to a controllable minimum and facilitate immediate draining across the alignment.

- Km 68+100 – 67+000 – The alignment crosses drainage features (1:12,500 topographic map) that drains to the Milk River in the east. These drainage features will need to be suitably culverted to allow surface runoff from Hope Pen Hills to continue to discharge to the Milk River. Filling these drainage pathways should be avoided.

- Km 69+750– A drainage feature is noted on the 1:12,500 topographic map. This feature apparently takes surface runoff to the depression north of the R/R (See Figure 3e, Appendix A). The alignment will cut existing ground to a proposed ground level that corresponds with the invert level of the drainage feature. It is recommended that the drainage feature be evaluated and a culvert of suitable size be incorporated into the design.

- Km 70+100 to 71+100 the design drawings were not available for review at the time of writing. However, the topographic sheets show a

drainage feature close the R/R crossing that drains portions of Williamsfield toward the Milk River. This feature should be further evaluated and if evidence of surface flows are evident then it should not be blocked.

The original Outline Design anticipates the following major crossings;

Ref	Km	Name
B32	34+650	Shutes (Shu) Gully 1
B33	35+650	Shutes (Shu) Gully 2
B35	39+200	Webbers Gully 1
B36	39+480	Webbers Gully 2
B39	43+850	Rio Minho Bridge
B43	48+150	St Ann's Gully
B50	61+250	Milk River Bridge

However, based on the forgoing these possible minor crossings are anticipated;

Ref	Km	Name
-	36+050	Shutes (Shu) Gully 3
-	36+600	Shutes (Shu) Gully 4
-	36+800	Shutes (Shu) Gully5
-	42+100	Unmamed Gully
-	49+300 to 49+500	Dry Gullies of the St Annes Gully
-	53+650	Drainage pathway
-	56+800	Drainage pathway
-	57+200 to 58+100	Drainage pathway
-	62+600 to 63+400	Drainage pathway to Milk River
-	68+600 to 69+000	Drainage pathway to Milk River

Appendix IX shows the catchment delineations for some of these drainage pathways (km 43+900, 49+400, 53+650, 57+200, 62+600 and 68+600).

Other probable minor drainage crossings that require further evaluation are;

-	60+500 to 60+600	Drainage pathway of the Milk River
-	69+750	Drainage pathway of the Milk River

Design of minor water crossings will generally involves two basic tasks: analysis for a

stream modification and development of the water crossing. Due to the numerous adverse impacts associated with them, important stream modifications are to be avoided as much as possible. They may, however, be considered in the following situations:

- To reduce an excessive angle of skew (> 45°).
- To eliminate or reduce excessive encroachment of fill on the stream channel. This may occur with high fills at skew crossings or where the channel is alongside the alignment.
- To eliminate a serious erosion problem at the alignment or downstream property.
- To reduce the number or length of water crossings at a complex interchange.
- To reduce the number of crossings.
- To reduce the height of fill by moving the crossing away from a high valley side.
- To reduce the number of crossings of a meandering stream flowing generally parallel to the alignment.

7.3. Irrigation Crossings

From the field survey, the following irrigation systems have been identified that will need to be accommodated in the detailed design of the project;

4. Km 48+100 (St Ann's Gully), where an existing irrigation siphon passes underneath the route
5. Km 50+000 (Four Paths), where an existing irrigation channel passes underneath the route
6. Km 54+500 to 56+500, where an existing irrigation channel will need to be diverted outside the ROW limit.

7.4. Outline of the Hydraulic Design Criteria used by the Design Engineers

The minor storm sewers on arterial roadways are to be designed to convey the 10-year storm without exceeding capacity (surcharge) and to pass the 100-year storm via the overland system (major drainage) with maximum permissible flooding of 300 mm above roadway surfaces, without affecting the highway. The roadside ditch system will also be designed with the 10-year storm and freeboard, as measured from the edge of through traffic lanes to the design high water level in the ditches, should not be less than 1.0 m for the 100-year storm. Flow velocities will be checked for erosion and scour for 100-year events, with appropriate scour protection measures provided as necessary.

The major drainage system must provide a continuous overland route for the parts of the runoff produced by the 100-year runoff event The system will be checked to ensure that it is not inadvertently cut off by highway profiles and that it can convey the major storm (100-year) without affecting the highway. Overflow routes from road drains to the receiving system will be provided to ensure that water does not pond to excessive depths (> 300 mm) on the highway surface for the 100-year event. The major drainage system will also be checked to prevent undue hazards to the public and damage to property adjacent to, and downstream, the highway.

As for the hydraulic criteria for the water crossings, Highway 2000 is to be designed to operate satisfactorily under the severe weather conditions of a **100-year storm**. All bridges and culverts over 5.0 metres in total opening width are to be designed to pass the 100 year storm with a minimum freeboard of 1.0 m between the lowest point of the bridge (soffit) and the high water level. Culverts of under 5.0 metres in total opening width are to pass a 25-year storm without surcharge and to provide a minimum of 600 mm of freeboard between the edge of road and the high water level during a 100-year storm event.

Different approaches will be used by the design engineers to determine the design flows

at each drainage crossing, as given in the following table:

Table 7.4: Different Approaches to Determine Design Flows

Method	Assumptions	Data Required
Rational	Small catchment (<1.3km^2) Concentration Time <1 hour Storm Duration> or =Concentration Time Rainfall is primarily overland flow Negligible Channel Storage	Time of Concentration Drainage Area Runoff Coefficient Rainfall Intensity
NRCS (TR55)	Small or Mid-Size Catchment (<8km^2) Concentration Time from 0.1 to 10 hours(tabular hydro graph method limit <2 hours) Runoff is overland and Channel Flow Simplified Channel Routing Negligible Channel Storage	24 hour rainfall Rainfall Distribution Runoff Curve No. Concentration Time Drainage Area
NRCS (TR20)	No limit to catchment size	24 hour rainfall Rainfall Distribution Runoff Curve No. Concentration Time Drainage Area
Unit Hydrograph (Gauged Data) NRCS Unit Hydrograph Synthetic Unit Hydrograph	Midsize or large Catchment (0.4-2500 km^2) Uniformity of Rainfall Intensity and Duration Rainfall/Runoff relationship is linear Duration of direct runoff constant for all uniform/intensity storms of same duration regardless of differences in total volume of direct runoff Time distribution of direct runoff from a given storm duration is independent of concurrent runoff from preceding storms Channel routing techniques used to connect streamflows	Rainfall Hyetograph and direct runoff Hydrograph Drainage area and lengths along main channel to point on watershed divide and opposite watershed and opposite centroid (Synthetic Unit Hydrograph)

For example, Shu Gully 1 and Shu Gully 2 will be analysed by the Rational Method, while Webber's Gully 1, St Anns Gully, Rio Minho and Milk River will be analysed by TR55, TR20 or the unit hydrograph method, as appropriate.

7.5. Drainage Assessment

The assessment below uses the Rational Method to evaluate major and minor drainage pathways that cross the alignment. The assessment then compares this anticipated, pre-highway runoff with the anticipated road surface runoff combined with the pre-highway figures. Drainage ditches from Design for Approval (DFA) drawings were used to

quantify the actual 100m lengths of the alignment discharging to each natural drainage outlet. This runoff from a typical 100m section was then multiplied by a factor based on the number of 100m sections draining to the discharge outlet. This "new" water was then compared to the pre-existing condition to evaluate whether the additional runoff from the highway would be significant or acceptable using the 1:25 yr rainfall intensity figures.

Catchments and drainage pathways were visually defined using, 1:12,500 topographic maps, and balanced with aerial photographs and digital elevation data held within the Google Earth database. Due to the presence of caves and sink holes in many locations, the delimitation of the drainage basins using only this information must be validated with in-situ observations and site inspection. These will be carried out in the detailed final designs as the EIA is not a design document but a platform to evaluate preliminary designs. Significant differences can be observed between the visual/topographic delimitation and the actual limits of the drainage system. Consequently, a thorough site inspection at each identified crossing site and a critical hydraulic analysis of the existing dry-gully cross-section will also be required by the design engineers in assessing the validity of their discharge evaluation in terms of actual evidence of observed/measured vs calculated stream conveyance. This assessment relies strictly on visual/topographic information and the cognitive uncertainty (bias) must be appreciated.

The Rational equation was developed from a simplified analysis of runoff. The method assumes no temporary storage in the basin, so the ratio between the peak runoff and the rainfall intensity is then the same as the ratio of the volumes of runoff and rainfall. If a constant rainfall intensity (mm/hr) begins at time t=0 and has a duration of the time of concentration (t_c) for the basin, the hydrograph will reach an instantaneous peak at Ci. The t_c of the basin can be thought of as the time after rainfall excess begins to when all portions of the watershed are contributing to the peak flow at the outlet. If the duration is longer than t_c, the hydrograph will remain constant after reaching a value of Ci for a time period equal to the difference of the rainfall duration and t_c. In either case the time of rise and time of recession are equal to t_c. The Rational Equation is defined:

$Q = kCiA$

where:

- Q - peak flow (cfs or m^3/s).
- k - conversion factor equal to 1.008 (SI) or .00278 (metric).
- C - dimensionless runoff coefficient.
- i - rainfall intensity (in/hr, mm/hr).
- A - catchment area (acres, ha).

Time of concentration is a fundamental watershed parameter. It is used to compute the peak discharge for a watershed. The peak discharge is a function of the rainfall intensity, which is based on the time of concentration. Time of concentration is the longest time required for a particle to travel from the watershed divide to the watershed outlet. The time of concentration was determined for the alignment using the FAA method:

$$t_c = 1.8\ (1.1 - C)\ L^{0.5} / S^{0.33}$$

Where

C = Rational method runoff coefficient. *As a conservative approach* v*alues for the runoff coefficient C used in the rational method should not be less than 0.35 for a return period of 25 year and 0.45 for 100 year, even for rural areas. For completely paved areas, the coefficient is 0.9, whereas for urbanized areas well drained with sewer networks and canal, it should not be less than 0.6.*;

L = Longest watercourse length in the watershed, ft

S = Average slope of the watercourse, unitless.

Intensity values were obtained from an intensity-duration-frequency (IDF) regression equations developed in Section 3.4.5 and presented by catchment in Appendix 6 of Drainage and Hydrology Report Vol. II of the SEA (2000).

The rainfall intensity for the alignment catchments based on the calculated t_c is as follows:

Table 7.5a: Rainfall intensity based on regression equations developed during the Highway 2000 SEA (Dessau Soprin, 2000)

Natural Catchment Area					
			t_c derived		
			Rainfall intensity (mm/hr)		
ID	Km	Name	1:10yr	1:25yr	1:100yr
1	36+050	Shutes (Shu) Gully 3	190	245	319
2	36+600	Shutes (Shu) Gully 4	207	266	347
3	36+800	Shutes (Shu) Gully5	168	216	282
4	42+100	Unmamed Gully	142	184	240
5 a	49+300	Dry Gullies of the St Annes Gully	98	126	165
b	49+400	Dry Gullies of the St Annes Gully	99	128	168
6	53+650	Drainage pathway	157	203	265
7	56+800	Drainage pathway	105	136	178
8	57+200 to 58+100	Drainage pathway	157	203	265
9	62+600 to 63+100	Drainage pathway to Milk River	133	158	212
10	68+600 to 69+000	Drainage pathways to Milk River	124	147	198
Typical Road Section					
Typical section	n/a	Represents 100m of aligment	441	555	723
			331	385	514

Table 7.5b: Pre-Highway and Post-Highway Runoff Comparison

			PRE-CONSTRUCTION	POST-CONSTRUCTION		
ID	Km	Description	Pre-highway 1:25yr peak flows (m^3/s)	Anticipated runoff from contributing highway	Total post-highway 1:25yr peak flows (m^3/s)	% change
Major Crossings						
1	34+650	Shutes (Shu) Gully 1	16.2	2.78	18.98	17%
2	35+650	Shutes (Shu) Gully 2	4.3	1.04	5.34	24%
3	39+200	Webbers Gully 1	45.3	10.07	55.37	22%
4	39+480	Webbers Gully 2	4.9	0.69	5.59	14%
5	43+850	Rio Minho Bridge	2576.7	7.64	2584.34	0%
6	48+150	St Ann's Gully	135.5	6.94	142.44	5%
Minor Crossings						
7	*36+050*	*Shutes (Shu) Gully 3*	4.3	0.81	5.10	19%
8	*36+600*	*Shutes (Shu) Gully 4*	1.0	0.35	1.38	34%
9	*36+800*	*Shutes (Shu) Gully5*	2.1	0.52	2.62	25%
10	*42+100*	*Unmamed Gully*	1.8	-	1.79	0%
11	*49+300*	*Dry Gullies of the St Annes Gully*	3.2	0.35	3.53	11%
12	*49+400*	*Dry Gullies of the St Annes Gully*	13.0	0.35	13.30	3%
13	*53+650*	*Drainage pathway*	10.3	0.35	10.62	3%
14	*56+800*	*Drainage pathway*	13.8	1.91	15.67	14%
15	*57+200 to 58+100*	*Drainage pathway*	38.3	0.35	38.67	1%
16	*62+600 to 63+100*	*Drainage pathway to Milk River*	12.0	0.35	12.34	3%
17	*68+600 to 69+000*	*Drainage pathways to Milk River*	11.2	0.35	11.50	3%
Typical 100m Road Section						
19		*Typical 100m Road Section*	0.35			

In general terms, the rate and volume of surface water runoff from the post-development situation should not exceed the surface water runoff from the existing site. An increase of 5-10% is normally deemed acceptable. Overall the appraisal suggests that drainage should not be a significant problem at most of the water crossings post-highway with the exception of the Shutes (Shu) Gullies, Webbers Gullies and the drainage pathway at km49+300 and km56+800.

At these drainage areas mitigation considerations need to be given by the design engineers to incorporating detention structures (swales, dry wells) between the toe of the road embankment and the land acquisition limit of the ROW corridor. Approximately, some 3000 m^2 of open land, between the embankment toe and the fenceline, exists within a typical 100m length on either side of the roadway. If appropriately engineered this could theoretically provide up to 1,800 m^3 of potential runoff storage and provide sufficient detention capacity to reduce the quantity of water discharged to these drainage systems. Ultimately this would reduce downstream quantities and exit velocities.

It must be borne in mind that a 1:25 yr or a 1:100 yr event simply means that there is a 25% or 1% chance of such an event occurring in any one year. It does not mean that these events occur every 25 or 100 years. Also several significant events can occur in one year as evidenced by the 2002 torrential rainfall events which by most estimates were greater than 1:25 yr events; and three occurred that year in southern Jamaica.

Appendix IX presents the EXCEL/Crystal Ball reports and catchment details for the results represented in the table above.

7.6. Groundwater Rise and Possible Mitigation Measures and Possible Pollution

Groundwater surface breaches (i.e. high groundwater table coupled with low land surface elevations) have been demonstrated within the area traversed by the alignment. Though no comprehensive scientific evaluation exists, the WRA has estimated that groundwater flows rates at these springs have ranged between 0.1 – 1.5 m^3/s during the June-July 2002. Also of these emergent springs occurred between 130 - 180m asl. Most of these emergent flows

occurred within existing depression/sinkholes (such as Berrydale and Harmons), along topographic lows created by faults (Porus, Scotts Pass, Berrydale) and along fault fracture zones (Melrose Bypass). Given that these events have occurred in the recent past and are likely to occur again in the future it is recommended that a hydrogeological evaluation be considered for areas of the alignment that cross areas with a history of emergent groundwater springs. The analysis should provide a means of predicting flow rates and seepage velocities under different environmental conditions. This will allow the best probability of designing subsurface drainage features that will perform as intended.

Excessive and uncontrolled subsurface water has been responsible for large numbers of pavement failures, slope failures, and unsatisfactory projects across the globe. Subsurface drainage is essential for economical, long term performance of roads and highways. This was clearly demonstrated along the Porus road after the 2002 as it was impassable due to pavement failures.

Mitigating measures that can be considered are underdrains or subsurface drains. Subsurface drains are effective in controlling groundwater problems when designed and constructed properly. Many pavement and slope failures can be prevented with effective drainage of subsurface water. Underdrains are used to intercept subsurface seepage before it enters the structural material supporting the pavement and are also used to lower the water table.

Pipe underdrains consist of a perforated or slotted pipe placed near the bottom of a narrow trench backfilled with permeable backfill material. This backfill is typically wrapped in a filter fabric to prevent clogging of the drain from migration of fines into the permeable material. A french drain is an underdrain that consists of a trench backfilled with highly permeable material but without the perforated or slotted pipe.

Underdrains can be effectively used in the following situations:

• Longitudinal (parallel to roadway) underdrains can be used in regions of high groundwater to intercept subsurface water before it can reach and enter the materials supporting the pavement (along the Melrose Bypass);

• In sloping terrain, where slope stability is not a problem, a trench may be excavated along the uphill side of the roadbed near the toe of cut slope (where the alignment intersects depressions as in Berrydale);
• In areas where the ground is nearly level, longitudinal pipe underdrains may be necessary along both sides of the roadway bed near the toe of cut slope (between McGilchrist Pen and Clarendon Park);
• Longitudinal underdrains are also placed along the toe of fills to intercept high groundwater;
• Transverse underdrains should also be placed at transitions from cut to fill to prevent saturation, settlement and instability in fill sections.

Sewage disposal system expected in zones with low soil overburden atop the limestone aquifer should have at least 2m of low permeability natural soil between the base of the sewage disposal system and bedrock. No soak-away sewage systems should be sited on limestone bedrock.

Groundwater monitoring results for several wells along the alignment are included in the WRA database included in AppendixVI. The minimum groundwater depth recorded in 4.11 m bgl at Porus #1 and 4.41m bgl at Denbigh Farm #1.

7.7. 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.

7.7.1. Drainage Control during Construction

During construction, features such as, site access, storage of materials, site drainage during construction and protection of surfaces from erosion, sedimentation and overcompaction require particular attention. To achieve a balance, construction planning has to incorporate erosion and sediment control measures together with the need for maintenance inspections. However, in Jamaica construction practices and general workmanship have made implementation of such measures 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 alignment crosses several streams, dry gullies and gullies and rivers so erosion and sediment control will be of paramount importance during construction in order to reduce discharges to these water courses. In order to mitigate any deleterious impact the following guidelines are recommended in developing the erosion and sediment control plans:

- Determine the extents of clearing and grading along the alignment. This has been evaluated in the cut-and-fill budget.

- Determine temporal and permanent drainage features/pathways and define the limits of roads and drainage catchments.

- Determine the extent of any temporary channel diversion for the existing drainage features.

- 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 and site camps.

- Select erosion controls based on the duration of soil exposure and the characteristics of its sub-catchment. These can be selected based on the construction programme.

- Consideration should be given to the potential water level rise within the existing drainage features during construction due to heavy rainfall events during the lifespan of the construction. Options such as the construction of temporary earthen berms or similar grade elevating devices should be considered.

- Any groundwater wells that need to be relocated will have to be done by well drilling contractors. Any existing well that will require closure will need to be grouted with bentonite/cement slurry from base to surface and sealed with a 100mm thick concrete pad extending 300m beyond the diameter of the well.

The objectives of the erosion controls during construction should:

- 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 stabilization 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.

Road construction will intensify the effects of natural soil erosion due to vegetation removal, soil disturbance, and exposure of bare soil surface. The most severe problems will be associated with embankment construction in the plain area, road sections with heavy cuts and fills, borrow and spoil sites, as well as bridge and culvert construction sites, particularly on

rainy days. If appropriate measures are not taken, the increased erosion loss could be significant over the 4-year construction period.

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 post-construction.

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

- Temporary sediment traps/basins to reduce velocities.

- Silt basins will be used, where appropriate, to intercept water runoff and allow solid matter to settle before entering gullies and river courses. After completion of road construction these basins will be graded and revegetated. Installation of settling basins at bridge and interchange construction sites to collect sediment from construction wastewater before its discharge; appropriate disposal of removed sediment and spoils from drilling operations at the bridge construction sites should be considered.

- Silt dikes and runoff ditches will be installed where appropriate to prevent silt from leaving sensitive areas (borrow sites, spoil sites, etc.) and entering farmland or water bodies.

- Temporary groundcover (matting, grass bales, sandbags, etc.) will be used on disturbed and exposed areas to control erosion and retard runoff, particularly during rainy periods. Geotextiles and erosion control fabrics in difficult areas. Such as fractured slopes or slopes with thin erodible soils.

- Provide construction and site camp roads with stabilisation comprising stones/sand bags etc. 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.

7.7.2. Drainage Control during Operation

Drainage control during operation for all phases of Highway 2000 is to be designed to operate satisfactorily under the severe weather conditions of a 100-year storm. All bridges and culverts over 5.0 metres in total opening width are to be designed to pass the 100 year storm with a minimum freeboard of 1.0 m between the lowest point of the bridge (soffit) and the 100-yr high water level. Culverts of fewer than 5.0 metres in total opening width are to pass a 25-year storm without surcharge (overload) and to provide a minimum of 600 mm of freeboard between the edge of road and the high water level during a 100-year storm event.

Development of the surface drainage during operation works is a two-tier system. First, the minor drainage system collects runoff that results from the more frequent storm events and conveys the runoff to the outlet at the receiving system. The minor drainage system usually consists of curbs, gutters, catchbasin inlets, storm sewers, minor swales and roadside ditches. The major drainage system is the route that is followed by runoff when the capacity of the minor drainage system is exceeded.

The minor storm sewers on arterial roadways are to be designed to convey the 10-year storm without surcharge and to pass the 100-year storm via the overland system (major drainage) with maximum permissible flooding of 300 mm above roadway surfaces, without affecting the highway. The roadside ditch system will also be designed with the 10 year storm and freeboard, as measured from the edge of through traffic lanes to the design high water level in the ditches, should not be less than 1.0 m for the 100 year storm. Velocities should be checked for erosion and scour for 100-year events, with appropriate scour protection measures provided as necessary.

The major drainage system must provide a continuous overland route for the parts of the runoff produced by the100-year runoff event that cannot be conveyed by the minor drainage system. The system should be checked to ensure that it is not inadvertently cut off by alignment profiles and that it can convey the major storm (100-year) without affecting the highway. Overflow routes from road sags to the receiving system must be provided to ensure that water does not pond to excessive depths (> 300 mm) on the highway surface for the 100-year event.

The major drainage system will be checked to prevent undue hazards to the public and damage to property adjacent to the highway.

Finally, if the discharge from a surface drainage system is likely to significantly increase erosion in the receiving system, consideration should be given to protecting the water course through the application of in stream erosion control measures.

All outfalls to receiving systems will have scour-protection using gabion mattresses or rip-rap. Trash screens will also be installed were appropriate to reduce off-site conveyance of garbage.

Measures to mitigate against flooding (holding ponds) should be adopted where necessary. The proposed drainage systems with outfalls to Shutes Gully and Webbers Gully may not be able to deal with peak flows and will need to have holding ponds or swales considered for constructed in accordance with Concessionaires Specifications to reduce the volumes to these systems.

7.7.2.1. Pollution Control Measures during Operation

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

- Trash Screens to prevent large detritus from entering system and cause blockages. Routine maintenance will be incorporated.

- Oil/water interceptors should be installed on the primary minor drainage systems that discharge to any water courses/gully or stream, in order to minimize hydrocarbon discharge to water course. Additionally these minor drainage systems will collect hydrocarbon runoff after collisions before they reach the secondary larger drainage system. It is unlikely that the larger, secondary drainage system will require oil/water separators.

- Catchpit manholes may be installed to provide areas of sediment control and flow controls were the available ROW is restricted in width and swales cannot be reasonably installed.

- Wash-out chambers will be installed to enable cleaning and maintenance

- Reed beds for polishing of discharge at outfalls via the reduction of hydrocarbons and sediment loads will be considered for perennial water courses and were practicable to do so. The longitudinal ditches which flank the highway will also be looked at as polishing areas prior to discharge to perennial water courses, such as the Rio Minho and Milk River.

- No water discharge shall be made to any sinkhole or depression.

- Planting on the verges to reduce soil erosion and suspended matter being carried in the run-off.

- Closed drains shall be used in areas where aquifer vulnerability is considered as high. As the alignment traverses one of the more productive limestone aquifers, it is considered a high value aquifer. As the geotechnical study has shown that overburden depths can be shallow or bedrock as surface, areas with less than 1m cover or exposed bedrock would be considered as high vulnerability areas. In any such are where, after final graded levels, the limestone is covered by less than 1.5m of natural slow draining soils of there is exposed limestone then closed drains must be incorporated.

8. Positive Impacts

Several positive impacts are expected from the development of Phase 1B for Highway 2000: Sandy Bay to Williamsfield, as proposed. These positive impacts are given below:

8.1. Generation of Employment/Supply of Goods and Services in the Construction Phase

During the construction phase employment will be generated for skilled and unskilled labourers as well as some professionals. Employment opportunities should continue for the duration of the project. Opportunities will be created for the supply of various types of construction materials which is expected to be 34 months.

8.2. Improved Transportation Network

The construction of the section for Sandy Bay to Williamsfield will significantly reduce the current travel time between these two destinations. With a design speed of 90-110 kph, the travel time is expected to be 25 minutes and the journey will not go through the congested towns of May Pen, Porus and others. The journey time from Kingston to Williamsfield will be approximately 50 minutes which is a significant reduction from the pre- Highway 2000 travel time of approximately 1hr 45minutes.

8.3. Land Use Planning

The Highway 2000 Corridor Development Plan recognizes that the implementation of Highway 2000 will result in development adjacent to, in close proximity to and benefiting from the Highway alignment. It is important that this Corridor Plan is expanded to include those sections of Clarendon and Manchester not presently covered. Such a development plan is critical to ensuring that the development potential of the highway is optimized within a sustainable framework.

While current land use has been generally described in each of the four sections of the alignment discussed in Section 5.3 a more detailed land use mapping was undertaken in the Highway 2000 Project Preliminary Design Phase Strategic Environmental Assessment by Dessau Soprin International Inc.(June, 2000). The land use maps from

this report have been included as Appendix X. In interpreting these maps, it should be noted that the boundary of the study area is the 1km boundary of the centre line of the alignment.

8.4. Aesthetics/Scenic Values of the Highway Alignment

The highway alignment is a new alignment. The alignment will open up new vistas along this section of the south coast. The previously completed section of Highway 2000 (from Kingston to Sandy Bay) has provided vistas of fields of sugar cane under cultivation, wooded areas, thorny scrubland and heritage elements, in the form of the aqueduct on the southern side of the alignment.

No heritage elements have been identified in close proximity to Phase 1B, but the scenic vistas are expected to be just as pleasing, with similar aspects of cultivation, wooded areas and thorny scrubland.

8.5. Safety

A report on the Summary of Police Activity on the Toll Road dated July 9, 2007 indicates that with speeds of up 110kph the Highway can be regarded as safe when compared with the accident and incident counts on normal road surfaces island-wide. Monthly reports are submitted to the Toll Authority by Police Traffic Headquarters.

8.6. Public Perception

During the community surveys, community attitudes to the project were determined along the entire alignment. The project received strong support and most persons indicated that the project was necessary of very necessary. The public acceptance of the project should be viewed as a positive impact as this indicates the public's perception of the benefits of the highway.

9. Cumulative Impacts

In addition to both positive and negative the potential impacts identified. Cumulative impacts have also been identified.

9.1. Increased Traffic Flow

The existing route from Sandy Bay to Williamsfield passes through several small towns where congestion occurs. The new alignment with the highway design speed will significantly reduce travel time; result in increased efficiency of the movement of goods and services from Kingston through to Mandeville; and saving time and money for commuters. This is a long term cumulative impact as all sections of the highway become complete.

9.2. Land Use Options

The alignment passes through agricultural lands, pasture, scrublands, residential communities and across existing transportation networks. The land use within these areas are modified by the highway alignment. However, the implementation of the Highway will open up access to some previously inaccessible areas, and is likely to result in increased development pressure along the alignment. Targeted land use planning is required to ensure sustainable development options.

In a review of the general alignment, the Jamaican Institute of Engineers (JIE) stated that "the routing for a limited access highway network is self-selecting in that the railway engineer's saw the obvious best route from Kingston to Montego Bay and the Highway 2000 generally follows the railway" (Algrove, 2001).

This is a long term development impact which would be directly catalyzed by the Highway 2000 alignment.

9.3. Employment

The construction phase for Phase 1B is scheduled for 34 months. Various levels of skilled and unskilled labour will be required during the period as well as the provision of goods and services. The other phases of Highway 2000 have created job opportunities, and this would be continued over the sort to medium term.

10. CONSIDERATION OF ALTERNATIVES

10.1. Alignment

The alignment for Phase 1B: Sandy Bay to Williamsfield is the alignment that was presented in the Strategic Environmental Assessment (SEA) (Development Bank of Jamaica, 200).

Developing the preparation of the Outline Design for the entire Highway alignment 2000, several considerations were given to the alignment.

For this section Phase 1B: Sandy Bay to Williamsfield four (4), alternatives were considered for specific areas along the alignment:

5. Rio Minho
6. Four Paths
7. Milk River
8. Porus/Melrose Pen

The alternatives presented in the SEA are given below.

Rio Minho (43-46km) (Functional Planning Drawing P003)

Alternative A: From the proposed May Pen interchange in the area of Halse Hall, through Coates Pen, crossing the Rio Min ho and westerly to St. Anne's Gully.

Alternative B: From the proposed May Pen interchange in the area of Halse Hall, north of Coates Pen and south of Denbigh, crossing the Rio Minho and westerly to St. Anne's Gully. Approximately 1km north of Alternative A. Initially rolling and rocky terrain up to the entrance of the Rio Minho flood plain, with a crossing over the flood plain which is 2km wide at this point, and entering flat terrain with occasional depressions.

Preferred alignment: Alternative B. Terrain presents less engineering challenges.

Four Paths (49-52 km) (Functional Planning Drawing P003)

Alternative A: After a bridge over St. Annes' Gully, the highway goes northwesternly.

Alternative B: The highway turns west near Km 51 and follows the southern side of the existing railway up to Clarendon Park, crosses the railway, continuing northwest.

Preferred alignment: Alternative B. This alternative provides a better location for Four Paths interchange.

Milk River (58-62km) (Functional Planning Drawing P004)

Alternative A: From the railway crossing at Clarendon Park, south of Scott's Pass, Westerly through Encombe to Spring Grove.

Alternative B: From the railway crossing at Clarendon Park, through of Scott's Pass, westerly and north of Encombe Spring Grove.

Preferred alignment: Alternative B. The Highway partially joins with the alignment proposed for the Porus Bypass at Km 61, and reduces the length of the Milk River Bridge.

Porus/Melrose Pen (64-67 km) (Functional Planning Drawing P004)

Alternative A: Most southerly option.

Alternative B: Most northerly option, crossing the main road into Porus.

Alternative C: West of Porus and connecting to the newly built Melrose Hill Bypass at Km 66.

Preferred alignment: Alternative C. Facilities best connection with the Melrose Hill Bypass which was constructed after the completion of the 1996 Pre-Feasibility Study and with the proposed Porus Bypass alignment. The existing Melrose Hill rest stop will be incorporated into the centre median of Highway 200. The existing parallel road will be upgraded.

10.2. Crossings

Twenty-nine (29) crossings have been identified for the alignment including over passes and under passes for roads, railways, gullies, rivers and agricultural field connectors.

All over passes and under passes have pedestrian access which are in close proximity to existing paths used by communities. The crossings designed therefore will facilitate pedestrian traffic in areas close to existing social rights-of-way.

10.3. Construction Camp

The exact location of the construction site camp has not yet been determined.

10.4. Sourcing of Materials

Earth materials for the previous construction of Highway 2000 were obtained from the Hill Run Quarry in St. Catherine. Only licensed quarries should be used for the supply of earth materials. Several areas of the alignment require cut and fill, and the cut material will be utilised as fill where geotechnical characteristics are met.

10.5. No Action Alternative

The 'No Action Alternative' looks at the option of not constructing Phase 1B of the highway 2000 alignment. This would break the continuity of the alignment that has been completed from the Portmore Causeway through Bushy Park and to Sand Bay, which is expected to be linked from Williamsfield to Montego Bay.

11. DETERMINATION OF POTENTIAL IMPACTS AND MITIGATION MEASURES

11.1. Impact Matrix

This section identifies the potential impacts and suggested mitigation measures as related to the Phase 1B: Sandy Bay to Williamsfield segment of Highway 2000. Findings of the assessment are presented according to site preparation, construction and operation phases. The impacts have been determined as significant positive or negative, direct or indirect, long term or short term. The Impact Matrix presented in Table 11.1 identifies the inter-relationships between the project activities and the physical, biological and social environmental factors.

As indicated in the Terms of Reference the impact analysis has included the following:

- The Alignment
- Hydrology and Drainage
- Traffic Flow
- Location of Interchanges and Toll Plazas
- Social right- of- way and dislocation issues
- Land Acquisition
- Sourcing, Transport and Deployment of Earth Material
- Noise and Air Quality
- Water Quality
- Modification of Habitats
- Soil erosion
- Natural Hazard Risk
- Proposed Developments

Table 11.1 Impact Matrix

Table 11.1 Impact matrix page 2

Some potential impacts of the entire Highway 2000 Project, and recommended mitigation measures, were determined in the Strategic Environmental Assessment (Development Bank of Jamaica, 2000) and are presented in Appendix VIII for reference. Some of these recommendations are generic to all sections.

11.2. Impacts and Mitigation Measures

The alignment for Highway 2000 was determined using several criteria and utilising the least constraining methodology. Optimisation of the alignment was carried out through the consideration of alternatives during the Functional Planning stage (Government of Jamaica, 2000 – Volume III). The selected alignment is the optimal alignment given the physical constraints. Potential impacts and proposed mitigation measures are described in Table 10.2.

Table11.2 a: Alignment - Potential Impacts and Mitigation Measures

	Potential Impacts	***Mitigation Measures***
• **Over gullies**	The Highway results in five (5) gully crossings: the Shu Gully (1 and 2), Webbers Gully (1 and 2), and St. Ann's Gully. These are at chainage 34+650; 35+650; 39+200; 39+ 480 and 48+150, respectively.	Drainage structures will be designed to ensure continuous flow thus preventing ponding and flooding. A 100-year return period is recommended for major structures and the overall drainage system has been designed to accommodate flash floods and catastrophic events which characterize the area.
• **Over rivers**	The Highway results in two major river crossings. These are the Rio Minho at chainage 43+850 and the Milk River at chainage 61+250.	As for the gully crossings, the drainage structures will be designed to ensure continuous flow thus preventing ponding and flooding. A 100-year return period is recommended for major structures and the overall drainage system has been designed to accommodate flash floods and catastrophic events, which characterize the area.
• **Over railway lines**	The Highway results in four (4) crossings of the railway line. These are at Content at chainage 46+000; Clarendon Park at 57+500; at Porus at chainage 64+500 and at Williamsfield at chainage 70+400.	In the SEA of 2000, the recommendation was made that the Highway should not result in the sterilization of the railway at any point. These four crossing will maintain the railway alignment as underpasses of the highway.
• **Through existing**	Vegetative stands are all modified vegetation including four	

vegetative stands	types of habitats. These are disturbed Dry Limestone Woodland/ Abondoned Sisal Plantation; Cane Fields and Pasture; Rural Settlement and Cultivation and Roadside Scrub. There are no stands of primary vegetation along the current alignment.	Landscaping could include trees, grasses and shrubs as appropriate in order to maintain airshed purification functions and soil stabilization.
• **Land Acquisition**	Land acquisition for the required acreage is the responsibility of the National Roads Operating and Constructing Company (NROCC).	The land required for the Phase 1B: Sandy Bay to Williamsfield alignment includes privately owned lands that are in residential, commercial and agricultural use, as well as Crown Lands.
• **Existing local roads and access**	Points have been identified where the Highway will cross or intersect with existing local roads. Underpasses and overpasses will facilitate these crossings. Fourteen (14) Local Road crossings have been identified. Three areas have been identified where agricultural field connectors are required.	Underpasses or Overpasses are provided at the following points: ❖ Sandy Bay ❖ Savannah Cross ❖ Hunts Pen ❖ May Pen Interchange ❖ Coates Pen ❖ Content ❖ Denbigh ❖ Four Paths ❖ Belle Plain ❖ Ludford Rocks ❖ Berry Dale ❖ Spring Grove ❖ Red Berry

		❖ Porus ❖ Trinity Field connectors are crossings designed to maintain the operation of existing agricultural facilities, particularly as relates to the movement of heavy machinery. The field connectors prevent the highway from dividing the property in terms of access and operations. Three field connectors will be provided at: ❖ Sheckles Pasture (45+100) ❖ Ebony Pen (48+700) ❖ Clarendon Park (59+950)
• **Archaeological and cultural resources**	The JNHT had identified areas of potential impact during the SEA (Dessau Soprin International, 2000), within a 1km wide corridor.	5. The Jamaica National Heritage Trust (JNHT) has already been contacted and made aware of the highway alignment. 6. The JNHT has been requested to indicate if there are any areas that are included on their Sites and Monuments List 7. The JNHT should be allowed to conduct a Watching Brief during the site preparation and construction phases, and to perform Rescue Archaeology if appropriate.

		8. The following areas are recommended for particular attention: • Free People • Halse Hall • Belle Plain
Toll Plazas	The Toll Plaza proposed at May Pen will include 8 lanes and 2 small buildings. At Four Paths the Toll Plaza will also be 8 lanes.	The May Pen Interchange will include eastbound and westbound entry and exit slips. At Four Paths there will be a Toll Plaza only with no entry points.

Table 11.2 b: Natural Environment – Potential Impacts and Mitigation Measures		
Environmental Aspect	***Potential Impacts***	***Mitigation Measures***
Hydrology and Drainage	Impacts on hydrology and drainage are both direct and indirect. They relate to all phases of the development and to high volume events (major drainage) as well as to drainage requirements for run-off from more frequent events (minor drainage). Direct impacts involve : ➢ Storm channel outlets ➢ Ponding ➢ Siltation ➢ Pollution Indirect impacts involve: ➢ Pollution ***Site Preparation and Construction Impact***	4. Surface drainage design considers both the major and minor systems. The major system is the route followed when the minor system is exceeded. 5. The engineering design has used the 100-yr. event as design criterion for major drainage, including bridge openings, to accommodate flash floods and catastrophic events, which typify the area. 6. Storm water runoff (more frequent events) will be handled by curbs, channels, catch basin inlets, storm sewer\s, minor swales and roadside ditches. These have been designed to prevent ponding and flooding of the highway and adjacent properties. The guiding principles for the design of the highway in relation to drainage are: ➢ All bridges and culverts over 5.0 m in total opening width are designed to pass the 100

		year storm with a minimum freeboard of 1.0 m between lowest point on bridge and high water level. ➢ Culverts under 5.0 m opening width are designed to pass 25-yr storm with minimum 600 mm freeboard between the edge of the road and high water level during 100-yr storm event. ➢ Scour protection will be provided where necessary. ➢ Highway profiles must be consistent with major drainage to enable free flow.
Groundwater	Groundwater flows can be significant and charged aquifers can result in rise in groundwater levels which can undermine the structural integrity of the highway.	The gullies that currently run under the road must be maintained, and design must ensure that there is no blockage of the existing channels. If these principles are adhered to, the potential for flooding, as a consequence of the highway construction, should be negligible.
Surface Water	Existing surface water, pathways (gullies, dry gullies and rivers) must be left unobstructed to allow for	➢ The engineering design should include under

	continuous flow of water and reduce the risk of flooding. The current design indicates fill areas on some surface water pathways (eg. Clarendon Park, Shu Gully, McGilchrist Pen).	drains to allow free passage of water in the areas specified. ➢ It is recommended that all surface drainage features be kept unobstructed and not filled. Structures should be provided such as box culverts to ensure that these drainage pathways are kept. ***Operation Phase*** During the operation phase the mitigation measures incorporated in the engineering design should prevent problems of ponding on the Highway. Scheduled inspections and maintenance of drainage channels is critical.

Hazard Vulnerability	Impacts during site preparation or construction relate to the effect of flood events and storm-water run-off on the project. Flooding is a major natural hazard to be encountered by construction of the highway, and the major impact is derived from the effect of extreme runoff on the site and the low-lying nature of the topography, and flood history along several sections of the proposed alignment.	1. Design of bridges, culverts and drainage channels have taken account of the 100-year event and the channels are therefore expected to handle the flood flows. 2. Site preparation and construction schedules should take account of the traditional rainy season between May and October, and of the hurricane season from June to November, during which tropical systems sometimes cause flood rains. Extraordinary tropical systems have also caused problems of supersaturated soils, so that schedules should factor this eventuality.

Air Quality	***Site Preparation and Construction Phase*** Analysis of road construction activities indicates that the movement of trucks and heavy-duty equipment to and from the project area will be responsible for the greatest amount of dust emissions. Construction activities will also result in the removal of vegetation that will expose and loosen soil which can become airborne with medium to strong winds. This would add fugitive dust to the area, which is already dust prone because of previous land clearance. The transport of aggregate for road and drainage culvert construction will also contribute to the fugitive dust levels. Construction vehicles will emit air contaminants such as nitrogen and sulphur oxides as well as particulates.	1. Watering of un-vegetated areas and stripped road surfaces along which construction vehicles and trucks travel will control dust emissions by up to 70%. A full-time watering truck should be maintained on site for watering road surfaces as needed to minimize fugitive dust emissions. Over-saturated conditions, which would cause outgoing trucks to track mud onto public streets, should be avoided. Watering would not be necessary on days when rainfall exceeds 2.5 mm (0.01 inch). 2. Stock piling of earth materials for construction should be carried out within temporarily constructed enclosures to limit fugitive dust. Vehicles transporting earth materials should be covered en route. Mixing equipment should be sealed properly and vibrating equipment should be equipped with dust removing devices. Stockpiles of fines should be covered on windy days.

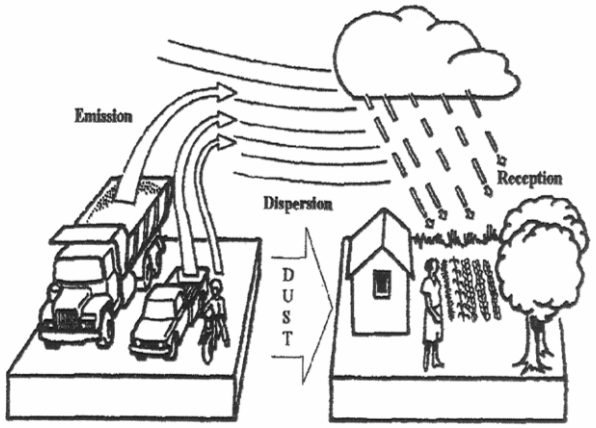


Figure 11.2a: Illustration of Dispersion of Dust Emissions

Operation Phase

The main air impacts during the operational phase will be an increase in the concentration of vehicular emissions as a consequence of the expected increased vehicular throughput. There are currently no vehicular emissions standards for Jamaica. However, improved traffic movement is expected to reduce idling time and therefore the level of carbon monoxide (CO) emissions.

3. A monitoring programme for dust is recommended to assess the effectiveness of control measures in meeting ambient air quality standards.
4. Provide dust masks to operators in order to protect them from dust impacts.

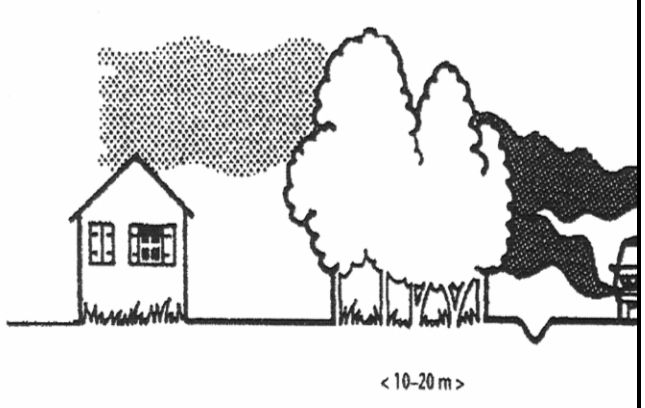


Figure 11.2b: Illustration of the Effect of Vegetative Barriers on Vehicle Emissions

Noise	***Site Preparation and Construction Phase*** The noise level is expected to increase during site preparation and construction with the use of heavy machinery and earth moving equipment. Existing noise levels are not significant along the rural areas and residential communities. ***Operation Phase*** The toll plazas which will have 8 booths are expected to generate an increase in noise in this area.	***Site Preparation and Construction Phase*** **5.** Noise impacting the public from construction activities can be a major impact although only for the short-term. Noise levels can be minimized by limiting noisy construction activities to the hours between 7 am and 6 pm, where construction is in close proximity to residential areas. **6.** Service construction machinery and vehicles at regular intervals in order to keep noise to a minimum. ***Operation Phase*** **1.** The toll plazas will be sited near May Pen and Four Paths which includes residential communities nearby.
Surface Water Quality	***Construction Phase*** The water quality data obtained from the present survey indicates some nutrient loading probably from animals using the two main rivers – the Rio Minho and the Milk River. Generally the water quality in	***Construction Phase*** 1. Measures to control or limit sedimentation of streams and gullies during the construction phase will include storage of earth materials within containment berms

	these rivers is quite good. The major water quality impacts likely due to the proposed road/bridge construction work are: • Increased suspended solid loading (sediments and garbage) to the surface waters (from earth moving activities and terrestrial run-off) • Increased bacterial levels due to indiscriminate disposal of human waste (particularly construction camp activities). • Oil and grease from heavy equipment and trucks. ***Operation Phase*** Of the likely impacts, the most important relate to contaminated storm drainage.	2. The deployment of silt screens as required at gullies and streams during the construction of bridges and culverts. 3. The deployment of sediment traps during filling in the coastal environment. 4. The engineering design has incorporated measures for slope stabilization and reinforcement at the approach to bridges. This serves to prevent slope failure, which not only undermines the bridge approach but also results in the wash down of soil into streams and gullies. 5. The proper removal and disposal of construction spoil, so as not to block drains and gullies. 6. Take all necessary measures to prevent refuse (solid waste) and wastewater produced in construction camps from entering into drains and water bodies. 7. Provision of portable chemical toilets at work sites, with appropriate sanitary arrangements for disposal of the contents.

Restoration and Rehabilitation	Site Construction and preparation activities as well as establishment of the construction camp and associated facilities can result in scaring of the landscape and improper disposal of construction spoil.	1. All construction spoil should be properly disposed of at a site approved by the National Solid Waste Management Authority. 2. Scaring of the landscape must be avoided by landscaping of the Highway where appropriate and confirming construction works within the right of Way. 3. A post permit condition should include the preparation of guidelines for avoiding adverse impacts due to usage of the corridor, restoration and rehabilitation of works site and utilizing environmental attributes within the development.

Earth Materials Sourcing and Transportation	Site construction activites will require the provision of large quantities of earth materials, of a specific grade. Supply of material from unapproved or illegal sources can result in scarring of the landscape, deleterious modification of the topography, alter drainage patterns and increase levels of fugitive dust.	1. Any quarries utilized for supply of earth materials should be approved and licensed entities. 2. As far as possible material cut should be used as fill. 3. Trucks transporting materials should be covered and adhere to maximum laden weights.
Vegetation	***Site Preparation and Construction Phase*** The vegetation identified along the alignment comprises, dry limestone forest, mid-level moist forest, riparian woodlands, cultivated fields, routhg pastures and suburban settlement (including small cultivated plots). No significant rare, threatened, endangered or endemic species are expected to occur in these areas. These areas provide green space, which assists in the purification of the air shed by removal of carbon dioxide and release of oxygen. Additionally, the areas provide host plants for species of insects, reptiles, amphibians, butterflies and birds. Site preparation and construction activities will remove several acres of these vegetative stands	1. Vegetation will have to be cleared to provide land for the proposed road works. Clearing of the vegetative stands should be carried out on a phased basis to reduce the amount of exposed top soil that can be washed down in rainfall events. 2. To continue to provide airshed functions of purification it is recommended that verges be replanted with trees and shrubs where appropriate. 3. Additionally, tree planting should be carried out to form shelter belts, windbreaks, noise buffers, slope stabilization bands, erosion control and for

	removing the airshed purification function and some habitat. Removal of the vegetation, at areas along the Dyke Road, will also expose top-soil which can be washed into streams and gullies during rainfall events.	aesthetic appeal. 4. Selection of plants for landscaping should consider the following: habitat suitability, trees of national interest, flowering trees and shrubs. ***Operation Phase*** *1*. Vegetation planted for landscaping buffers and for aesthetic appeal should be maintained, and a maintenance programme should be established and implemented.

Fauna	***Site Preparation and Construction*** Birds located in the modified vegetative communities will relocate when their habitat is removed. Species along the proposed alignment such as reptiles are also highly mobile and should also relocate to adjacent similar habitats. Insects, snails and other groups with low mobility may suffer from loss of specimens, as a result of heavy machinery and the use of earth moving equipment. ***Operation Phase*** Once the highway is completed there is always the risk of increased access to rural areas resulting in poaching of wildlife	1. Landscaping could result in the replacement of some habitat for selected species. 2. Birds will relocate to adjacent suitable habitats. 3. Encroachment by squatters could result in degradation of areas. As a Toll Road, the highway will be limited access and will be enclosed by fencing thereby reducing the possibility of encroachment from the road way. 4. Plant and animal communities immediately outside the project corridor should not be at risk.

Table 11.2 c: Socio-Economic Environment– Potential Impacts and Mitigation Measures

Environmental Aspect	Potential Impacts	Mitigation Measures
Land-use and Zoning	***Site Preparation and Construction Phases*** Relocation of residential communities will be required. ***Operation Phase*** During the operation phase the Highway is not expected to have any additional significant negative impacts on aspects of land use and zoning. The impacts identified in the construction phase will obtain for the operation of the highway.	***Site Preparation and Construction Phases*** 1. The relocation of communities, commercial and/or agricultural enterprises is the responsibility of NROCC.
Traffic, Transportation and Access Roads	***Site Preparation and Construction Phase*** Site preparation and construction activities will impinge on traffic flow in the areas where the Highway connects or crosses existing roads.	***Site Preparation and Construction Phase*** 1. Scheduling of construction work should seek to minimise disruption to traffic flow and allow for the movement of material and heavy equipment. 2. Arrangements for parking and storage of material should be made as far off-site as is feasible for

Environmental Aspect	Potential Impacts	Mitigation Measures
		efficient operations. 3. Discussions should be held early with relevant stakeholders to determine their needs and requirements and to advise them of the construction schedule. 4. Public notices by the print and electronic media should also be posted in order to make the general public aware of the construction schedule and to provide construction updates. 5. Properly trained flag persons and road side signs should also alleviate discomfort to commuters.

Environmental Aspect	Potential Impacts	Mitigation Measures
	Site Preparation and Construction Phase The siting of the construction camp may have potential negative impacts related to traffic, transportation and access.	***Site Preparation and Construction Phase*** 1. The location of the construction site camp has not yet been finalized. 2. Proper signage and flag persons will be required to provide traffic management into and out of the camp site. 3. Public notification of the camp site location will be required. 4. Schedule of movement of heavy vehicles should be prepared and made available to the public.
	Operation Phase The operational phase of the highway will see the application of a toll. Application of a toll will be a minor, irreversible, long-term impact.	1. The previous section of Highway 2000, Kingston to Sandy Bay and Portmore Causeway currently operate with a toll.

Environmental Aspect	Potential Impacts	Mitigation Measures
Relocation/ Resettlement	The EIA Report has identified several communities and structures that will be directly impacted by the Highway Alignment. These include business enterprises, agricultural entities, private homeowners, informal residential areas.	1. Identification of all land acquisition and relocation requirements is the responsibility of the Grantor, the Government Agency, NROCC. 2. NROCC has begun the process of identifying lands to be acquired and persons to be relocated. 3. The Concession Agreement requires that the GOJ, represented by NROCC, own the lands with the ROW. NROCC will acquire the lands in accordance with the schedule set out in the concession agreement. 4. The GOJ does not have a Resettlement Plan. NROCC has indicated that it will not be involved in any relocation exercise (Appendix VI).

Environmental Aspect	Potential Impacts	Mitigation Measures
Business Enterprises	***Site Preparation and Construction Phase*** Some businesses have the potential to be affected by the Highway construction. These include: ❖ Clarendon Park Fish Farms ❖ Agricultural lands ***Operation Phase*** Impacts during the operation phase will include increased levels of traffic noise.	***Site Preparation and Construction Phase*** 1. Discussions have been held with relevant stakeholders. 2. Further discussions are to be held with NROCC to determine land acquisition plans. ***Operation Phase*** Mitigation measures as presented for noise should apply.

Environmental Aspect	Potential Impacts	Mitigation Measures
Social Rights –of- way	Several areas were identified for paths and tracks currently used by locals and communities. The 29 crossings provided in the engineering design have pedestrian access and generally meet the needs defined by the Social Rights of Way . However, there are three (3) areas (km 35+500; 40+000 and 60+000 to 61+000) where distances seem far.	1. It is further recommended that community consultations be on going and should include Stakeholders in these three (3) areas, the Social Development Commission and Community Based Organizations.

Environmental Aspect	Potential Impacts	Mitigation Measures
Employment	**Site Preparation and Construction Phase** Employment opportunities will be created during the site preparation and construction phases. This will mostly be unskilled labour for the duration of the construction activities. Additionally, economic opportunities will involve the sourcing of construction material and linkages created with local and regional suppliers and industries.	**Site Preparation and Construction Phase** 1. Casual labour will find employment and this is expected to be a positive impact for surrounding communities. 2. Workers should be briefed on traffic management, solid and liquid waste disposal, dust management, parking, idling of equipment and oil spill control. 3. Opportunities should include contractors and labourers from the parishes of Manchester and Clarendon.
Solid Waste Management	***Site Preparation and Construction Phase*** Solid waste generated from the site preparation and construction activities will include construction debris, vegetation, solid waste from beaches, the demolished bridge and solid waste generated from the construction camp.	***Site Preparation and Construction Phase*** 1. Construction sites generate considerable waste and provision must be made for suitable separation and storage of waste in designated and labelled areas on the site and site camp. 2. Collection of waste by certified contractors and disposal at an approved site, as recommended and approved by the National Solid Waste Management Authority. 3. Any hazardous waste should be separated and stored

Environmental Aspect	Potential Impacts	Mitigation Measures
		in areas clearly designated and labeled, for future entombing and disposal as directed by the National Solid Waste Management Authority. 4. Worker training should include instructions on how to dispose of food and drink containers. 5. Construction camps and work areas along the proposed alignment must be adequately equipped with portable chemical toilets. 6. Portable chemical toilets must be provided, maintained and removed by a certified contractor.
Proposed Developments	There are no major proposed developments along the Highway alignment. However, the NHDC has indicated a proposed development at Unity Farms/ Mid Island Estates that may be on the alignment. The exact location and status of approvals could not be ascertained.	1. Discussions should be held with the NHDC to determine the exact location of the proposed development and status of the project approvals.
Public Health and Safety	***Site Preparation and Construction Phase***	***Mitigation Measures***

	Increased levels of fugitive dust and construction noise are also public health issues as the air quality is already deteriorated in this region and noise and activity levels are high. The risk of forest fires affecting visibility on the highway is expected to be minimal. Animals crossing the Highway Alignment can pose a safety risk for commuters. ***Operation Phase***	1. To minimise risk to the public the construction activities which will directly affect the movement of traffic and pedestrians, should be properly scheduled and standard construction techniques for sign–posting and flagging should be adhered to. 2. Dust control by wetting is essential to prevent aggravation of the already poor air quality. 3. Unnecessary idling of construction related vehicles should be discouraged. 4. Proper sign posting of speed limits and entrances and exits. 5. The Highway Developer/Operator should contact the nearest fire department and report any fires that may affect visibility to motorists. 6. The entire highway corridor will be fenced on both the Southern and Northern perimeters and this will prevent stray animals from crossing the right of way. ***Operation Phase***

	Improper use of Highway ramps, exits and interchanges can result in traffic accidents. Additionally, malfunctions along the Highway such as inoperable tollbooths or structural changes in the road surface could result in project related accidents.	1. An extensive Highway Public Education Programme should be designed and implemented to make commuters aware of proper procedures on the Highway. This should include aspects related to tolling, lane hanging, use of ramps, and access and exits. Enforcement of Highway legislation and procedures will be required. 2. The risk of structural malfunction is minimal as the engineering design has considered the highest standards and drawings has been approved by the relevant agencies. The highway is equipped with telephone services and offices at Toll Plazas for emergency response. In extreme events and large accidents Emergency Response Units (such as police, fire and ambulance) will be able to utilize the highway to get to the emergency.
	It is possible that during the construction and/or the	1. A detailed Emergency Response Plan (ERP) should be

Pollution Prevention	operation phase spill of hazardous materials (e.g. Petroleum products, paints and explosives) could occur, although not the fault of the developer. These materials could result in the contamination of adjacent water bodies or water supply systems (domestic irrigation). Sites currently contaminated could be disturbed by project related activities.	prepared as a post permit condition, to include prevention of contamination of water bodies, irrigation supply and domestic water supply, if these are disrupted as a direct result of the project. 2. No contaminated sites such as hazardous waste disposal sites have been identified along the alignment.
Risk Assessment	With respect to man-made/technological hazards, and malfunctions, accidents can occur as a result of construction activities directly on-site and as a result of activities off-site, such as transportation of equipment and materials. Health and safety aspects must be considered related to workers during the Construction Phase and the motoring public during the Operation Phase.	4. A safety management plan including traffic handling and equipment management procedures should be developed as part of the construction scheduling. 5. A Public Education Programme specifically on highway use should be developed for the general public. 6. The Explicit Safety Review (BYPTJ, 2007c, Appendix I) indicates those aspects of the Design for Approval which may give rise to potential safety or operational hazards. These include aspects such as cross sections, drainage, landscaping, Lay-Bys, visibility, vertical alignment and junctions. BYTPJ (2007c) concludes that the Design for Approval has been checked and the

	Operation Phase During the operation phase the mitigation measures incorporated in the engineering design should prevent problems associated with hazards. Safety is a major consideration and it is strongly recommended that a targeted driver education campaign be mounted to ensure acceptable driving practices, and to meet the requirements of the toll road.	Highway and related works have been designed in accordance with good safety practices.
Archaeological and Cultural heritage	No direct heritage threats were reported during the preparation of the EIA report.	Although no direct heritage threats were discovered it is recommended that the JNHT be allowed to perform a watching brief during site preparation activities, if they so require. The following areas are recommended: 1. The alignment as it crosses north of the existing Halse Hall property in May Pen which was once much more extensive sugar plantation, than its current boundaries or land use would suggests. 2. Curatoe Hill just north of the alignment as it passes through south of the community of Curatoe, is reported to have been a Taino settlement.

11.3. Costing of Mitigation Measures

Some of the mitigation measures are included in the engineering design, such as drainage considerations, and so the costs have already been included in the developer's budget. Other mitigation measures cannot be costed and these include aspects such as ensuring that trucks transporting earth materials are covered and the sensitization of construction workers to environmental issues relevant to the construction activities. The following costs are presented.

Physical Environment

Mitigation measures should include aspects of engineering design, construction phase monitoring and best practices for construction.

- Slope stability and geotechnical considerations (costs included in developer's budget).
- Curbs and channels (costs included in developer's budget).
- Monitoring of Water, Air, and Noise Quality for twelve (12) months (US$64,000).
- Twice daily wetting of construction areas including exposed topsoil and stripped services (costs to be provided by the contractor).

Biological Environment

- Landscaping for air shed purification and soil stabilization (costs included in developer's budget).

Socio-economic Environment

For information sharing and posting of public notices, notification of road closures and detours, it is recommended that the public be made aware through print and electronic media. Examples of print media, quarter page advertisements are:

- Advertisements for public notices (Daily Gleaner -black and white) (US$420)
- Advertisements for public notices (Daily Gleaner -colour) (US$812)

- Advertisements for public notices (Sunday Gleaner -black and white) (US$739)
- Advertisements for public notices (Sunday Gleaner - colour) (US$1,203)

Examples of Morning Prime Time Radio Advertising are:

- Advertising for electronic media -15 seconds, basic rate (US$79)
- Advertising for electronic media -60 seconds, basic rate (US$191)

Fencing along the alignment is required to prevent stray animals crossing the highway and posing a risk to commuters.

- Estimated cost of fencing per linear foot (US$ 8)
- Estimated cost of fencing per linear yard (US$24)

It should be noted that the manager of existing Main Roads (National Works Agency), under the Main Roads Act, is required to maintain any alternative routes to the highway at their own cost.

12. Outline Monitoring Programme and Environmental Management Plan

If a permit is granted for the proposed development, and before site preparation and construction activities begin, a Monitoring Programme should be prepared for submission to NEPA, for their approval. The aim of the Monitoring Plan is to ensure the following:

- ✓ compliance with relevant legislation
- ✓ implementation of the mitigation measures provided
- ✓ conformance with any General or Specific Conditions as outlined in the permit
- ✓ long-term minimization of negative environmental impacts.

The Monitoring Plan should include the following components:

- Inspection protocol
- Parameters to be monitored, which should include
  - Ambient air quality
  - Water quality
  - Perimeter noise
- Construction monitoring
  - Worker health and safety
  - Disposal of solid waste
  - Disposal of hazardous material
  - Disposal of liquid waste
  - Draining and rehabilitation of sewage pond
- Materials handling and storage
- Covering of haulage vehicles
- Transportation of construction materials
- Deployment of flaggers and signposting
- Storage of fines and earth materials

The duration of the monitoring programme should be for the entire construction period, with monthly reporting.

The Monitoring Programme cannot be prepared in detail before the permit is received from NEPA as Terms and Conditions of the permit must be taken into consideration, and included in the monitoring programme as appropriate.

The Environmental Management Plan should also be prepared after the permit is issued and the general and specific terms and conditions are known. The Environmental Management Plan should take into account, but not be limited to the following aspects

- Solid waste management
- Liquid waste management
- Resource efficiency
- Hazard materials management
- Accident and emergency response
- Environmental management systems
- Clean up procedures

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