ENVIRONMENTAL IMPACT ASSESSMENT

FOR THE PROPOSED HYDROPOWER ENERGY PROJECT MAGGOTTY ST. ELIZABETH IN JAMAICA

January 2011

Environmental & Engineering Managers Ltd.

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ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED HYDROPOWER ENERGY PROJECT MAGGOTTY ST. ELIZABETH, JAMAICA

1.0 Introduction

The Jamaica Public Service Company Ltd. proposes to expand the existing 6 MW hydropower plant at Maggotty by an additional 6.4MW. This project is consistent with the company's goals of increasing its use of renewable energy to supply electricity throughout the island. It is also in keeping with the Government's policy of promoting the use of renewable energy sources thereby reducing Jamaica's dependence on fossil fuels.

The implementation of the 6.4MW Maggotty Hydro Expansion Project involves engineering, procurement and construction of all components of the Project necessary to generate hydroelectric power.

This Environmental Impact Assessment (EIA) has been prepared in accordance with Terms of Reference (TOR) at Appendix 1.

2.0 Project Rationale

Jamaica Public Service Company Limited (JPS) is the sole distributor of electricity in Jamaica. The company is a limited liability operation, incorporated in 1923 under the Companies Act of Jamaica with the expressed purpose of generating, transmitting and distributing electricity.

The company is 80% privately owned: Marubeni Corporation 40% and Abu Dhabi National Energy Company (TAQA) 40%. The Government of Jamaica has a 19% stake and 1% of the company's shares is owned by a number of individual and institutional investors. The company generates approximately 70% of the electrical energy it supplies to consumers and is the sole retailer of electric power in Jamaica, operating under a 20 year All-Island Electric License granted in 2001.

Jamaica is highly dependent on oil imports to meet its energy requirements. Analysis of data contained in the Planning Institute of Jamaica (PIOJ) Economic and Social Survey of Jamaica 2008 (ESSJ, 2008) indicated that about 98.6 % of energy demand is covered by imported fuel and only 1.4% was served from indigenous sources which consists of hydropower, wind, coal, bagasse and fuel wood/charcoal. Other indigenous energy resources such as peat, lignite, and solar energy are considered to contribute to the national energy supply, but will take time and capital input to be developed. Based on data in the ESSJ 2008, the bauxite/alumina sector used the most imported fuel at 34%, followed by the electricity generation and transportation sectors with 23% and 21% respectively.

Information in the ESSJ, 2008 also indicated that the total electricity generation in 2008 was 4,123.3 gigawatt hours (GWh[1]). While total fuel consumption declined by 3.1% in 2008 when compared to

[1] 1 Gigawatt hour = 1 million kilowatt hours

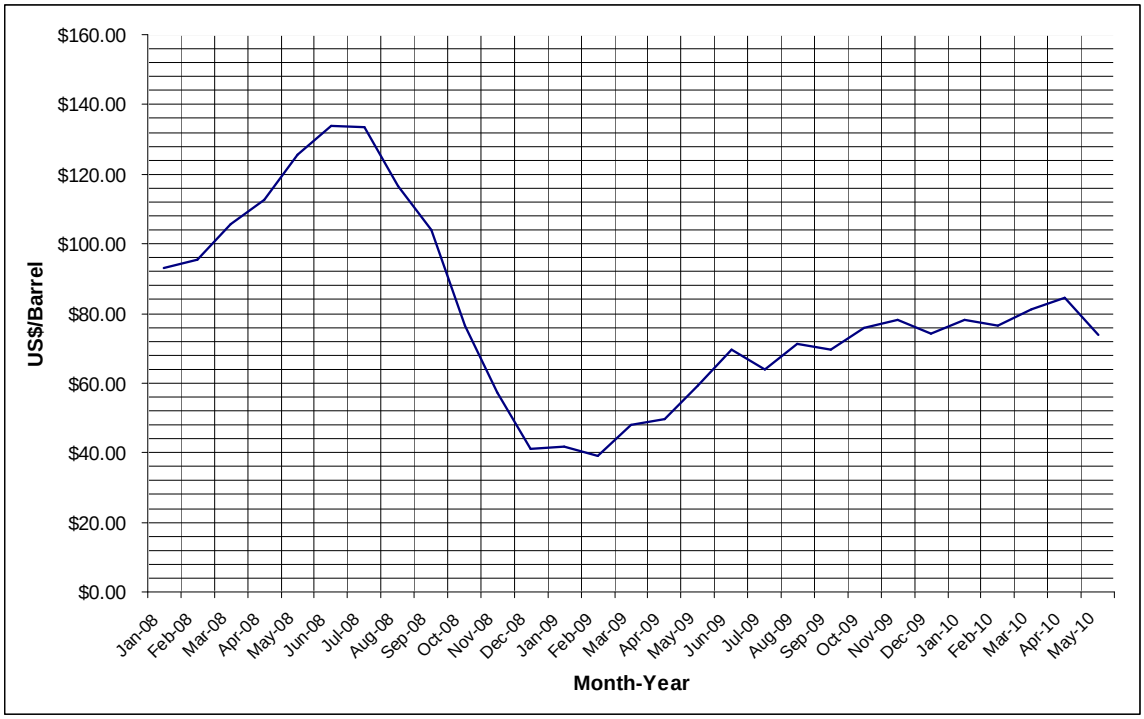
2007, total fuel cost rose by 42.8% to J$37.7 billion, reflecting higher crude oil prices on the international market as well as depreciation in the local exchange rate. The bulk of this cost was passed on to consumers through monthly adjustments in electricity rates. Table 1and Figure 1 show the variation in crude oil prices for 2008 through to part of 2010 based on the West Texas Intermediate Crude Oil Prices to which Jamaica's fuel prices are linked.

Table 1 - Spot Oil Price: West Texas Intermediate January 2008 – May 2010

Month/Year	US$/barrel
Jan-2008	$92.95
Feb-2008	$95.35
Mar-2008	$105.56
Apr-2008	$112.57
May-2008	$125.39
Jun-2008	$133.93
Jul-2008	$133.44
Aug-2008	$116.61
Sep-2008	$103.90
Oct-2008	$76.65
Nov-2008	$57.44
Dec-2008	$41.02
Jan-2009	$41.74
Feb-2009	$39.16
Mar-2009	$47.98
Apr-2009	$49.79
May-2009	$59.16
Jun-2009	$69.68
Jul-2009	$64.09
Aug-2009	$71.06
Sep-2009	$69.46
Oct-2009	$75.82
Nov-2009	$78.08
Dec-2009	$74.30
Jan-2010	$78.22
Feb-2010	$76.42
Mar-2010	$81.24
Apr-2010	$84.48
May-2010	$73.84

Source: Economagic.com

Figure 1- Spot Oil Price: West Texas Intermediate January 2008 – May 2010



Source: Graph generated by Environmental & Engineering Managers Ltd. from Table 1.1

In order to diversify Jamaica's energy sources by using more indigenous sources and to reduce the demand for foreign exchange, the Government in its Energy Policy 2009-2030 developed by the Ministry of Energy and Mining, has set a target for renewable sources to make up at least 20% of the energy production by 2030.

Proposed targets for renewable energy sources (Jamaica's Energy Policy 2009-2030):

- **11% by 2012**
- **12.5% by 2015 and**
- **20% by 2030**

JPS has embarked on this initiative to provide electricity using renewable energy in keeping with the Government of Jamaica's (GOJ's) policy to reduce the country's dependence on imported fossil fuels as an energy source.

In March 2008, the Office of Utilities Regulations (OUR) issued a public tender for renewable projects as part of the Government of Jamaica's (GOJ's) policy initiative (at the time) to achieve 15% of electricity generation from renewable sources by 2015. In response to the tender JPS prepared submissions for both wind and hydropower renewable energy plants. JPS engaged the services of US-based Wind Energy Consulting & Contracting Inc. (WECC) to undertake wind studies to determine the most suitable sites for the development of wind generation facilities. The sites assessed included Palisadoes, Kingston; Munro, St. Elizabeth and Hellshire, St. Catherine. Additionally hydropower sites at Maggotty, St. Elizabeth and Great River, Hanover were also under consideration by the JPS. A Rapid Environmental Assessment (REA) was conducted of these wind and hydropower sites by Environmental & Engineering Managers Limited which formed a part of the submission to the OUR. JPS was advised by the OUR in October 2008, that two (2) of its

proposed projects were successfully evaluated, namely the *3MW Wind Farm Development in Munro and 6.4MW Maggotty Hydropower Plant Expansion.* The timeline for the bidding and award process is outlined in Table 2.

Table 2 - Timeline for OUR Bids

Activity	Date
OUR invited proposals for alternative energy electricity generation	March 25, 2008
JPS responded to the RFP	July 24, 2008
Formal bid opening and notification from OUR to JPS regarding result of bid	July 24, 2008
Letter from OUR to JPS confirming bid results	Letter dated September 24, 2008
Letter of award	October 28, 2008

JPS views its role as it relates to renewable energy from the following perspectives:

1. To practically and publicly demonstrate its commitment to renewable energy development in Jamaica.
2. To increase public awareness of the possibilities and benefits of renewable energy
3. To strategically position itself for future exploitation of renewable wind energy by continuously conducting research into the identification and development of locations with renewable energy potential.
4. To contribute to lower heat rate and lower fuel cost to the consumers

The use of hydro power to generate electricity has tremendous benefits since water is abundant, renewable, clean and reduces net greenhouse gas emissions on the island. Most importantly is the fact that there are no associated fuel costs with the operation of hydropower plants. The proposed expansion of the hydropower plant at Maggotty is in keeping with Jamaica's National Energy Policy and will be beneficial to Jamaica.

3.0 Regulatory Framework

The regulatory framework highlights the legislation and policies that are applicable to Hydro power projects.

3.1 Applicable Policies

National Policies applicable to this project include the following:

1. National Watershed Management Policy managed by the National Environment & Planning Agency
2. National Energy Policy

National Watershed Management Policy

Part I of the document provides an overview of watershed problems, past interventions, current international trends in watershed management. Part II highlights the major challenges facing the country with respect to watershed management and Part III the key principles and strategies being employed by the policy to address these challenges. Options for obtaining funding for policy implementation are also suggested in this section. The requirements of the policy in terms of the development of watershed legislation are also noted. Finally, Part IV of the policy document sets out the essential elements of the institutional framework required for the attainment of policy objectives. The full policy document is available at NEPA's website www.nepa.gov.jm.

The National Energy Policy, 2009-2030

Jamaica needs an Energy Policy because of the country's:

- Heavy oil dependence
- High demand for foreign exchange
- Underdeveloped indigenous energy sources
- Inefficient use of energy
- Increasing pollution contributing to climate change

The policy seeks to, among other things:

- Manage the energy supply,
- Diversify the energy base,
- Encourage conservation and efficiency in energy production and use,
- Make electricity available and affordable to customers
- Establish the regulatory framework to protect consumers, investors, and minimize environmental effects and pollution.

The National Energy Policy 2009-2030 has as its vision:

"A modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies with long-term energy security and supported by informed public behaviour on energy issues and an appropriate policy, regulatory and institutional framework"

The long term strategic vision is built on ten (10) fundamental elements one of which is:

An energy sector that is environmentally sustainable with significantly increased use of economically viable renewable energy sources while fully protecting the environment

Goal #3 of the policy specifically applies to renewable energy as follows:

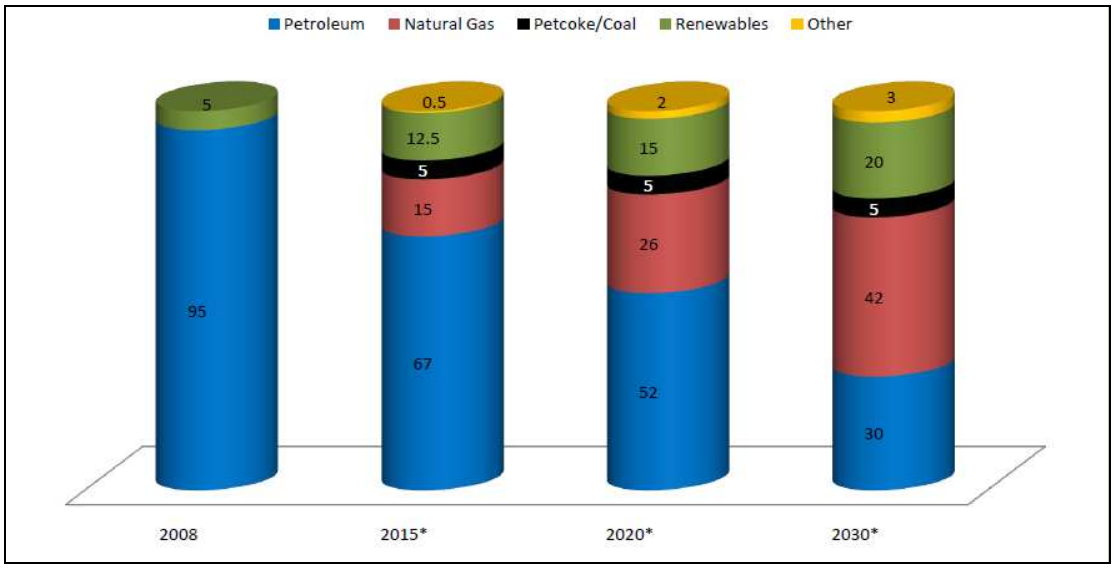
Jamaica realizes its energy resource potential through the development of renewable energy sources and enhances its international competitiveness, energy security whilst reducing its carbon footprint

Opportunities for further development of indigenous renewable energy resources such as solar, hydro, wind and biofuels will be explored with the goal of increasing the percentage of renewable sources in the energy supply mix to 20% by 2030. This will reduce the country's dependence on imported oil. Increased use of renewable sources will also result in lowering the level of air pollution, a smaller carbon footprint for Jamaica and better enable compliance with international conventions on climate change.

The projected targets for increasing the percentage of renewable sources in the energy supply mix are as follows:

- 11% by 2012,
- 12.5% by 2015 and
- 20% by 2030

Figure 2- Energy Supply Matrix 2008-2030 (%)



3.2 Applicable Legislation

The legislation applicable to this project include:

- The Office of Utilities Regulation Act, 1995
- The Natural Resources Conservation Act, 1991
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996
- The Natural Resources Conservation (Permits and Licences) Regulations, 1996
- The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004
- The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996
- National Solid Waste Management Act 2001
- Town and Country Planning Act, 1957
- Water Resources Act, 1995
- The Watershed Protection Act, 1963
- Forestry Act, 1996
- The Wildlife Protection Act, 1945
- Jamaica National Heritage Trust Act, 1985

The Office of Utilities Regulation Act, 1995

This Act indicates that the functions of the Office of Utilities Regulation (OUR) include:

a. Regulating the provision of prescribed utility services by licensees or specified organisations;
b. Receiving and processing applications for a licence to provide a prescribed utility service and make such recommendations to the Minister in relation to the application as the Office considers necessary or desirable;
c. Conducting such research as it thinks necessary or desirable for the purposes of the performance of its functions under this Act;
d. Advising the responsible Minister on such matters relating to the prescribed utility service as it thinks fit or as may be requested by that Minister; and
e. Carrying out, on its own initiative or at the request of any person, such investigations in relation to the provision of prescribed utility services as will enable it to determine whether the interests of consumers are adequately protected.

This project requires the approval of the OUR.

The Natural Resources Conservation Act, 1991

This Act gives the Natural Resources Conservation Authority [NRCA](now embodied within the National Environment and Planning Agency [NEPA]) the power to take the necessary steps for the effective management of the physical environment of Jamaica so as to ensure the conservation, protection and proper use of its natural resources among other things. In performing its functions it may among other things, formulate standards and codes of practice

to be observed for the improvement and maintenance of the quality of the environment generally, including the release of substances into the environment in connection with any works, activity or undertaking. Based on the powers and functions of the NRCA, this proposed project falls within their jurisdiction.

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

This regulation requires that effective January 1, 1997, a permit is obtained for the construction and operation of certain types of projects.

The Natural Resources Conservation (Permits and Licences) Regulations, 1996
The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004

Completed Permit Application and Project Information Form are to be submitted to NEPA in accordance with this regulation for the construction and operation of the listed activities, which comprise these projects. An Environmental Impact Assessment may be requested by NEPA for the proposed activities.

- Power generation plants, including hydroelectric plants and installation for the harnessing of wind power for energy production and nuclear reaction above 1 MW is a category listed in this Order as requiring a permit from NEPA. Since the proposed project plans to expand the hydroelectric power at Maggotty by greater than 1 MW, a permit will be required from NEPA.
- Approximately 1500 m of 2.5 m diameter Glass Reinforced Pipeline (GRP) will be installed (underground) to convey water from the existing dam to the power plant. This activity falls within the category of *pipelines and conveyors, including underground cables, conduits gas line and other such infrastructure with diameter of 10 cm or greater* and therefore requires a permit from NEPA.

The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996

These regulations set the acceptable limits for common air pollutants in ambient air. Since this project proposes to excavate trenches to lay approximately 1500 m of GRP, controls would be required to ensure that fugitive dust and heavy duty vehicular emissions during the construction phase do not contribute negatively to ambient air quality.

National Solid Waste Management Act 2001

This Act gives the National Solid Waste Management Authority (NSWMA) the power to take all steps as are necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, stored, transported, recycled, reused or disposed of in an environmentally sound manner and promote safety standards in relation to such waste. Solid waste generated as a result of construction activities would need to be collected and stored and appropriately disposed of at an approved municipal site in accordance

with the Act. In particular provisions will need to be made for the safe disposal of the wood and steel straps generated as result of the dismantling of the wood stave pipeline that is to be removed to facilitate the laying of the new pipeline.

The Town and Country Planning Act, 1957

This legislation stipulates that in areas for which a Development Order has been prepared, planning permission is required from the Local Planning Authority before "development" as defined by the Act can be undertaken. In those areas for which no development orders have been prepared no planning permission is required to undertake development. The Development Order is therefore the legal document guiding development in Jamaica. These orders are prepared by the Town and Country Planning Authority in consultation with the Local Planning Authority (Parish Councils & KSAC). The Town and Country Planning Authority, which is a body established under the Act can "call in" an area for which a development order has been prepared. In this instance the Town and Country Planning Authority has the jurisdiction to oversee all development applications if it so desires within the area. This Act is currently administered by NEPA and will be applicable to all the proposed projects.

The Water Resources Act, 1995

The principal water law in Jamaica is the Water Resources Act (1995), enacted in April 1996, making the Water Resources Authority (WRA) responsible for regulation, control, allocation, and management of the water resources of the nation. This Act allows the WRA to declare a water quality zone to protect water quality in the public interest. A Licence would need to be obtained from the WRA for the non-consumptive use of the Black River for hydroelectric power.

The Watershed Protection Act, 1963

This law governs watersheds and is administered by the NEPA. The primary focus of the Act is the conservation of water resources by protecting land in or adjoining the watersheds. The Act is intended to ensure proper land use in vital watershed areas, reduce soil erosion, maintain optimum levels of ground water, and promote regular flows in waterways.

Forestry Act, 1996

The Forest Act, 1996 provides the legal basis for the organisation and functioning of the Forestry Department. It specifies mandatory requirements for:

- Declaration and purpose of forest reserves and forest management areas;
- National and local forest management planning;
- Inventory and classification of forest lands;
- Appointment and function of forest management committees;
- Determination of allowable cut;
- Establishment of nurseries and provision of seedlings;
- Enforcement of forest protection measures.

Wildlife Protection Act, 1945

The Act makes provision with respect to the management of wildlife, including fish, in Jamaica.

The Act makes provision for the protection of animals and birds and the protection of fish. Other provisions deal with appointment of officers, regulations, power to enter lands, power of search, arrest without warrant, persons found offending, penalty for assaulting game warden, fishery inspector or constable, penalty for offences generally, jurisdiction over offences committed at sea, power to exempt from provisions of the Act, and forfeiture of things seized.

The Act specifies Game Sanctuaries and deals with hunting, etc. in a Game Sanctuary, prohibits the hunting of protected animals and protected birds, prohibits the hunting of animals and birds in and taking of eggs from the exclusive economic zone without a licence. Taking or killing of immature fish is declared an offence, and the use of explosives or other noxious materials in fishing is prohibited. It seeks to protect waters containing fish from trade effluents and industrial waste. Every person who knowingly buys sells or has in his possession fish taken, killed or injured in contravention of the provisions of this Act or of any associated regulations shall be guilty of an offence against this Act.

The Wildlife Protection Act and Regulations are administered by the National Environment and Planning Agency.

Jamaica National Heritage Trust Act, 1985

The Jamaica National Heritage Trust (JNHT) is a branch of the Ministry of Tourism, which enforces its mandate under the Jamaica National Heritage Trust Act. The Act serves to protect and control the development of national monuments and national heritage.

The JNHT mission statement states: "*to inspire a sense of pride through the promotion, preservation and development of our material cultural heritage*…" The primary functions of the JNHT are:

- To promote the preservation of national monuments and anything designated as protected national heritage for the benefit of the Island;
- To conduct such research as it thinks necessary or desirable for the purposes of the performance of its functions under the Jamaica National Heritage Act;
- To carry out such development as it considers necessary for the preservation of any national monuments 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;
- To promote the sustainable utilization and management of our material cultural heritage resources

Any artefacts discovered during land clearing and excavation associated with this project must be reported to the JNHT.

Table 3 shows a summary of the applicable policies and legislation for this project.

Table 3 - Summary of Applicable Policies & Legislation

SUMMARY OF APPLICABLE POLICIES & LEGISLATION
National Energy Policy 2009-2030
Watershed Management Policy
The Office of Utilities Regulation Act, 1995
Natural Resources Conservation Act, 1991
The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, 1996
The Natural Resources Conservation (Permits and Licences) Regulations, 1996
The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004
The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996
National Solid Waste Management Act, 2001
The Town and Country Planning Act, 1957
The Water Resources Act, 1995
The Watershed Protection Act, 1963
Forestry Act, 1996
Wildlife Protection Act, 1945
Jamaica National Heritage Trust Act, 1985

4.0 The Application Process

NEPA requires the submission of a permit application for the project. This is to be submitted along with a project information form and a project brief. After review by the agency, they will advise on whether an Environmental Impact Assessment (EIA) is required or not. Projects of this nature usually require an EIA.

Once an EIA is required, the first step is to agree on the Terms of Reference (TOR) for the EIA. Draft TOR are to be submitted to NEPA for approval and once approved, the EIA can be done. It may be necessary to advertise the TOR and await comments from the public.

There must be stakeholder consultations throughout the process of conducting the EIA. Once the draft EIA is completed, a Public Meeting is usually required to present the findings to stakeholders and to solicit feedback. The Public Consultations must be done in accordance with NEPA's guidelines which can be viewed at:
http://www.nepa.gov.jm/business/guidelines/general/GuidelinesforPublicPresentations2007.pdf

There are critical timelines that must be adhered to for the Public Meeting. There must be at least three weeks notice of the Public Meeting, advertised in the printed press in a format approved by NEPA. Special invitations can be sent to stakeholder groups. The public has 30 days from the date of the Public Presentation to submit comments to NEPA. Revisions to the EIA may be required but once all matters are satisfactory addressed it is likely that a permit will be granted with conditions. **The Public Consultation for this project will be scheduled in collaboration with NEPA after the EIA Report has been submitted.**

The approval process for the water abstraction licence from the Water Resources Authority (WRA) takes about 9-12 weeks as there is a requirement for advertising the intent to abstract water on at least two occasions, one week apart. The WRA provides the advertisement in the required format to the project proponent for placement in the print media. This is followed by a 21 day waiting period where the public can submit comments/objections.

The applications for building approval will need to be submitted to the St. Elizabeth Parish Council. The Parish Council will only approve the project after NEPA has granted their approval. This process can take an additional 8 weeks after NEPA grants approval.

Table 4 summarises the approvals that will be required for this project.

Table 4- Approvals Required

	Activity	Agency
1.	Prepare and submit environmental permit application	NEPA
2.	Prepare and submit abstraction licence application	WRA
3.	Prepare and submit Terms of Reference (TOR) for Environmental Impact Assessment (EIA)	NEPA
4.	Approval of abstraction licence from WRA	WRA
5.	Approval of TOR for EIA	NEPA
6.	Prepare and submit EIA and have public meeting	NEPA
7.	Await comments on EIA from public meeting	NEPA
8.	Revise and resubmit EIA if necessary after comments are received	NEPA
9.	Approval of EIA	NEPA
10.	Prepare and submit building application	St. Elizabeth Parish Council
11.	Parish Council Building Approval	St. Elizabeth Parish Council

5.0 Baseline General

5.1 Climate, Temperature and Wind

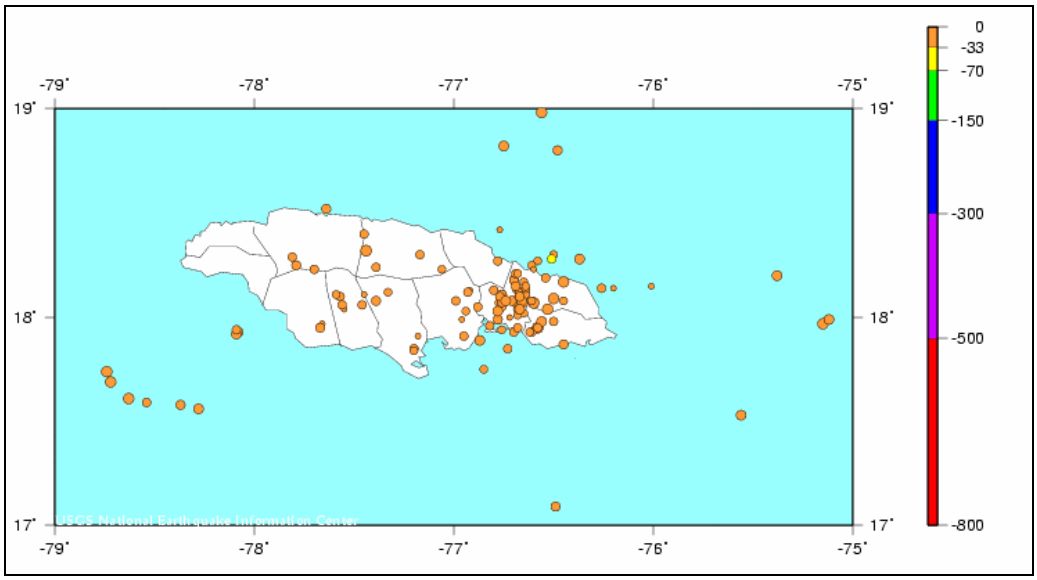
Jamaica, because of its location is said to have a tropical maritime climate. Jamaica experiences an average temperature of 33 degrees Celsius. Temperatures are coolest in January at about 24 degrees Celsius and reach its maximum in the month of June at between 31-33 degrees Celsius.

The north-east trade winds are the dominant winds in Jamaica. They tend to be at their strongest during the cooler months between December and March. Although the North East trade winds dominate most of the year, a greater proportion of the winds appear to come from the East and South East between May to August (the summer months).

5.2 Natural Hazards

Earthquakes occur periodically in Jamaica and can be quite severe (Figure 3). In addition to the destruction of buildings, earthquakes can trigger landslides on steep slopes and cause hillside roads to fail. Dams and other protective flood barriers can also become destabilised as a result of an earthquake event. The vast majority of Jamaica's earthquakes (source) have been confined to the eastern section of the island. St. Thomas, Portland and Kingston have experienced the most earthquake activity, with the Blue Mountains and John Crow mountains experiencing more frequent earthquake events. There are no recorded earthquake events, which have originated in the parishes of Westmoreland or Hanover, and their origination in the parishes of St. James, St. Elizabeth and St. Mary in the east is quite scarce.

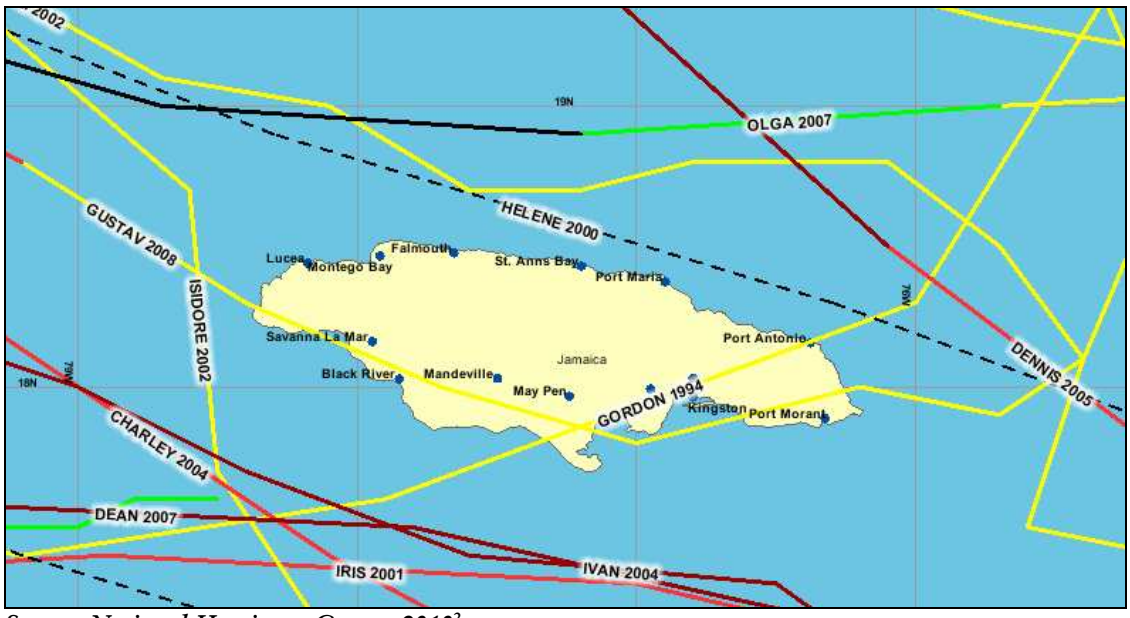
Figure 3 - Earthquake events affecting Jamaica 1973-2010



Source: NEIC (rectangular grid search): http://neic.usgs.gov/cgi-bin/epic/epic.cgi

Hurricanes are comparatively rare events that can have major impacts on the coastline. There occurrence usually leads to widespread destruction of physical infrastructure, including roads, buildings and pipelines. Biological habitats are usually threatened by hurricane events, particularly in the coastal zone where storm surges rise up to 2-3 metres. Areas having dense vegetation covering are sometimes destroyed because of the impact of wind on plant species. Since 1957, only Hurricane Gilbert (1988) has passed directly over the island. Ivan (2004) and Dean (2007) passed just south of the island (Figure 4). The parishes of St. Elizabeth, Clarendon, Kingston and Manchester are the most susceptible to the impacts of hurricane events. Flooding (coastal), landslides, heavy rainfall are usually the main impacts felt in these parishes.

Figure 4 - Storms (including Hurricanes, Tropical Storms and Depressions) Affecting Jamaica between 1990-2009



Source: National Hurricane Center, 2010[2]

The hazards that affect these proposed sites include flooding, hurricanes and landslides.

[2] http://maps.csc.noaa.gov/hurricanes/viewer.html

6.0 Hydropower Project Description

Hydropower facilities intercept the water on its downward path, converting its mechanical energy into electricity. Because the cycle of water evaporating from the heat of the sun and falling back to earth is continuously renewed by the sun's energy, hydropower is often considered a renewable energy resource. However, the construction and operation of hydropower dams impact natural river systems and fish and wildlife. How specific hydropower projects create unacceptable environmental damage requires a case-by-case review.

There are several types of hydropower facilities:

1. "Storage" projects impound water behind a dam, forming a reservoir. Water is released through turbine-generators to produce electricity. The water storage and release cycles can be relatively short, for instance, storing water at night for daytime power generation, or, the cycles can be long, storing spring runoff for generation in the summer when air conditioner use increases power demand. Some projects operate on multi-year cycles carrying over water in a wet year to offset the effects of dry years.

2. "Run-of-river" projects typically use relatively low dams where the amount of water running through the powerhouse is determined by the water flowing in the river. Because these plants generally do not hold back water behind storage dams, they tend to affect upstream water levels and downstream stream flow less than storage projects. Electricity generation from these plants will vary with changes in the volume of water flowing in the river.

3. "Pumped-storage" projects use off-peak electricity to pump water from a lower reservoir to an upper reservoir. During periods of high electrical demand, the water is released back to the lower reservoir to generate electricity.

The existing hydropower facility that is to be expanded by JPSCo. is a "Run-of-river" facility.

Small run-of-river projects are free from many of the environmental problems associated with large-scale dam hydropower projects because they use natural river flow, thus producing relatively little change in the stream channel and flow.

Run-of-river hydropower diverts some of a river's flow to a channel, pipeline, or pressurized pipeline (penstock) that delivers it to power electricity-producing turbines, returning the water to the river downstream of the turbines. The moving water rotates the wheel or turbine, which spins a shaft. The motion of the shaft can be used for mechanical processes, such as pumping water, or it can be used to power an alternator or generator to produce electricity. Turbines are not installed in the river itself. Each project requires significant infrastructure, and always includes the following:

- A small dam to create a 'headpond.' This headpond does not store water; it merely floods a sufficient area to ensure that the intake to the penstock is under water.
- Pipes, known as 'penstocks,' deliver water from the headpond to the lower-elevation turbines. Penstocks are often more than a kilometre long.
- A powerhouse building that contains one or more turbines.
- A 'tailrace' channel through which the diverted water is returned to its river of origin.

- Access roads to the headpond and powerhouse.
- Transmission lines from the powerhouse to the nearest JPSCo. transmission line.

The construction costs of run-of-river projects can be significant, as are their terrestrial and aquatic 'footprints.' The section of river between the dam and the powerhouse is sometimes called the 'diversion reach,' because significant quantities of water are diverted from this section of river. When done properly, with care given to footprint size and location, these projects can create sustainable green energy that minimises impacts to the surrounding environment and nearby communities.

In this case much of the infrastructure is already in place and a new footprint will not be established as a result of this project.

6.1 Project Location and Siting

The proposed hydropower project comprises developing additional capacity at an existing JPS hydropower facility at Maggotty (St. Elizabeth). The project's main design feature is to return the existing plant to 6 MW and increase the generating capacity by an additional 6.4 MW. The existing Maggotty Hydropower plant is located some 5 km north of the town of Lacovia on the A2 highway between Kingston and Montego Bay. (See Location Map at Figure 5 and Figure 6)

The coordinates for Maggoty are:

- Power House- 18 08' 15.36 N, 77 45' 05.982 W
- Dam- 18 09' 18.46 N, 77 45' 30.26 W

Refer to 1:12,500 map at Appendix 2 and Google maps Figure 10 to Figure 13.

The hydropower plant at Maggotty was constructed in 1957 and the electro mechanical equipment underwent a major overhaul in 2002. The wood stave and steel penstock, which has a total length of 2300m, has reached the end of its useful life and needs to be replaced.

The plant presently operates at only 60% of its rated output during the months of January to April and spills water regularly in the wet season. Since there will be a major interruption to the plant operation during that period the penstock is being replaced, JPSCo. plans to take the opportunity to, at the same time, expand the capacity of the plant to capture the additional available flow in the wet season and increase the plant utilisation in the dry season.

The main reasons for this project are to increase the plant capacity by 6.4MW and to improve the reliability of the water supply by replacing the existing wood stave pipe with Glass Reinforced Pipes (GRP).

Figure 5 - Location Map - Maggotty

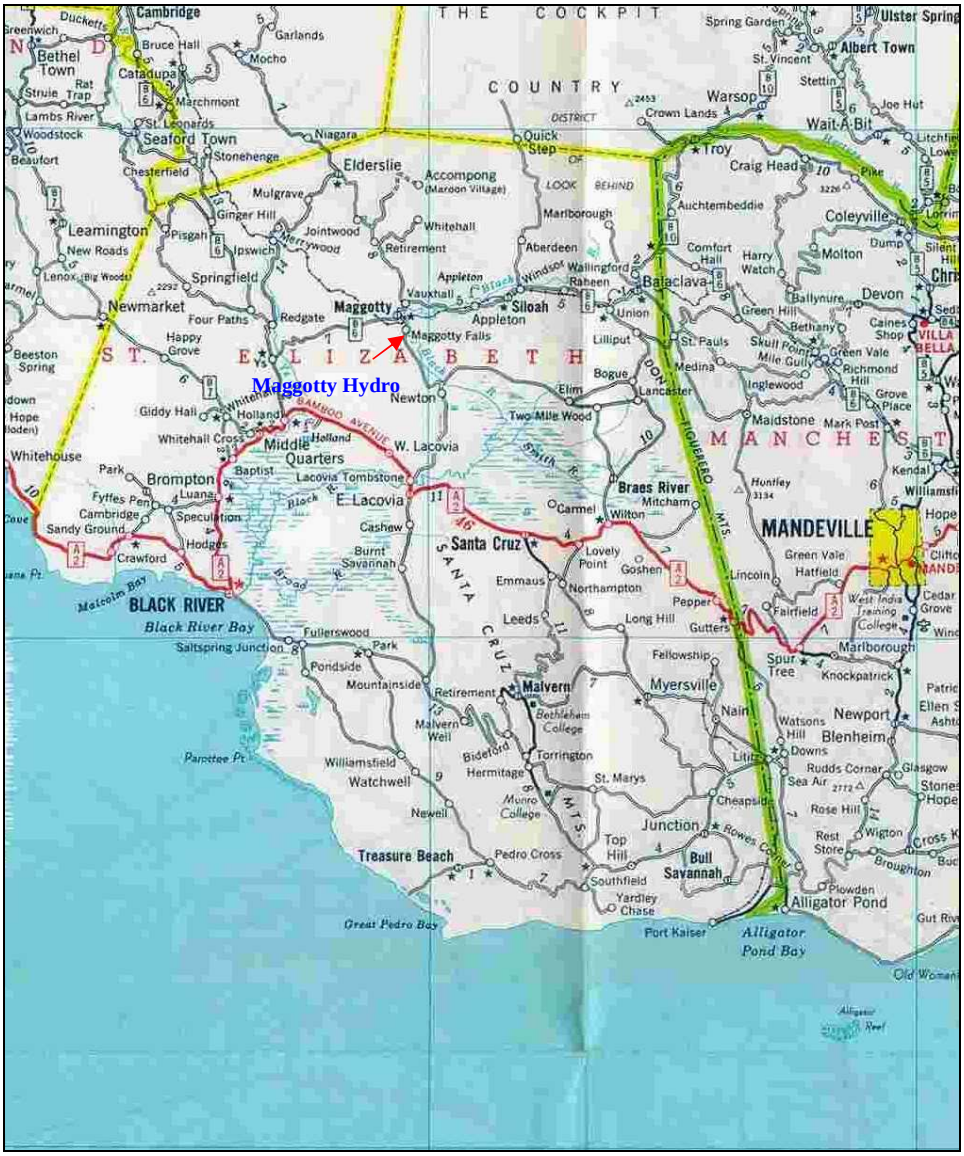


Figure 6 - Location Map - Maggotty Hydro Power Plant

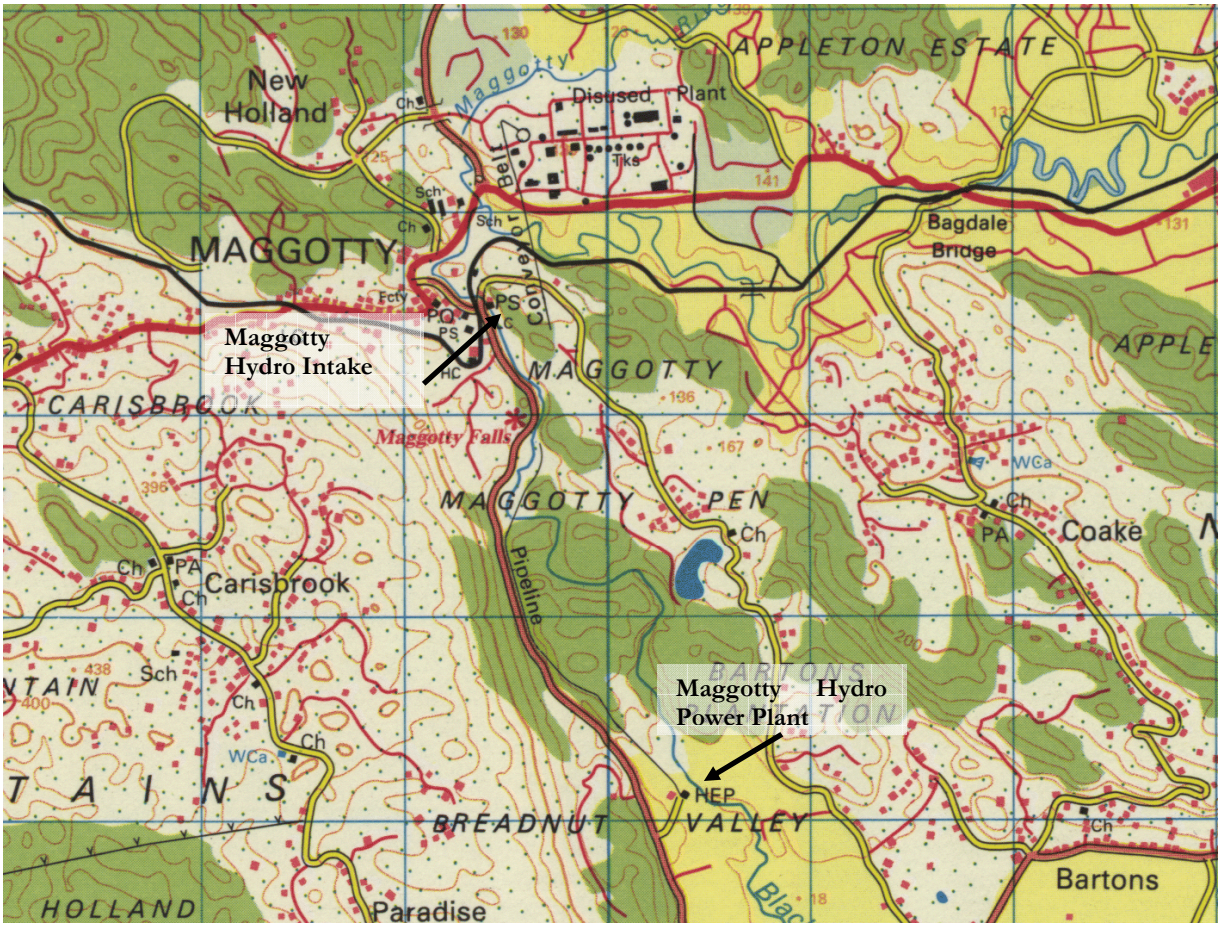


Figure 7 – Existing Intake Works and Dam - Maggotty Hydropower Plant

Figure 8 - Existing Intake Works - Maggotty Hydropower Plant

Figure 9 - Existing Power Plant - Maggotty Hydro

6.2 Existing Wood stave Penstock and Power Plant

Table 5 describes locations throughout the project site starting at the Maggotty Hydropower intake works and ending at the power station. The proposal is to have four (4) sites (staging areas) where the pipelines and other construction material can be stored for easy access throughout the project.

Table 5– Description of locations throughout the project site

Location ID#	Coordinates	Comments
286	N 18° 9.337' W 77° 45.462'	Maggotty Hydro Plant intake works
287	N 18° 9.641' W 77° 45.642'	Entrance to Maggotty Hydro Plant intake works
288	N 18° 9.341' W 77° 45.337'	Entrance to Maggotty Pass (Parochial road) leading to Locations #289 and #290
289	N 18° 9.102' W 77° 45.329'	Squatter seen; sweet potato; cassava; yam sorrel seen
290	N 18° 9.164' W 77° 45.485'	Possible staging area #1. Heavy vegetation along a section of the pipeline; two major leaks seen.

Location ID#	Coordinates	Comments
291	N 18° 9.559' W 77° 45.652'	Maggotty Police Station
292	N 18° 8.985' W 77° 45.584'	Farmer with goats; pipe crosses river on a bridge; possible staging area #2. Area just before 300ft concrete lined tunnel.
293	N 18° 8.818' W 77° 45.558'	Possible staging area (#3) just past area where tunnel ends. Pipe runs under a footbridge.
294	N 18° 8.632' W 77° 45.468'	Leaking pipe; possible staging area (#4); location is downstream of 2nd footbridge
295	N 18° 8.252' W 77° 45.092'	Possible site for powerhouse on JPS land. Old trees, possibly termite infested.
296	N 18° 8.284' W 77° 45.102'	Possible location of new transformer
297	N 18° 8.325' W 77° 45.138'	Sinkhole; upwelling of water
298	N 18° 8.250' W 77° 45.103'	Possible location of power plant (private land, Mr. Cowan willing to sell)

Figure 10 - Google Map showing Maggotty Hydro Intake Works

Figure 11 - Google Map showing Staging Areas 1 & 2 and penstock crossing river

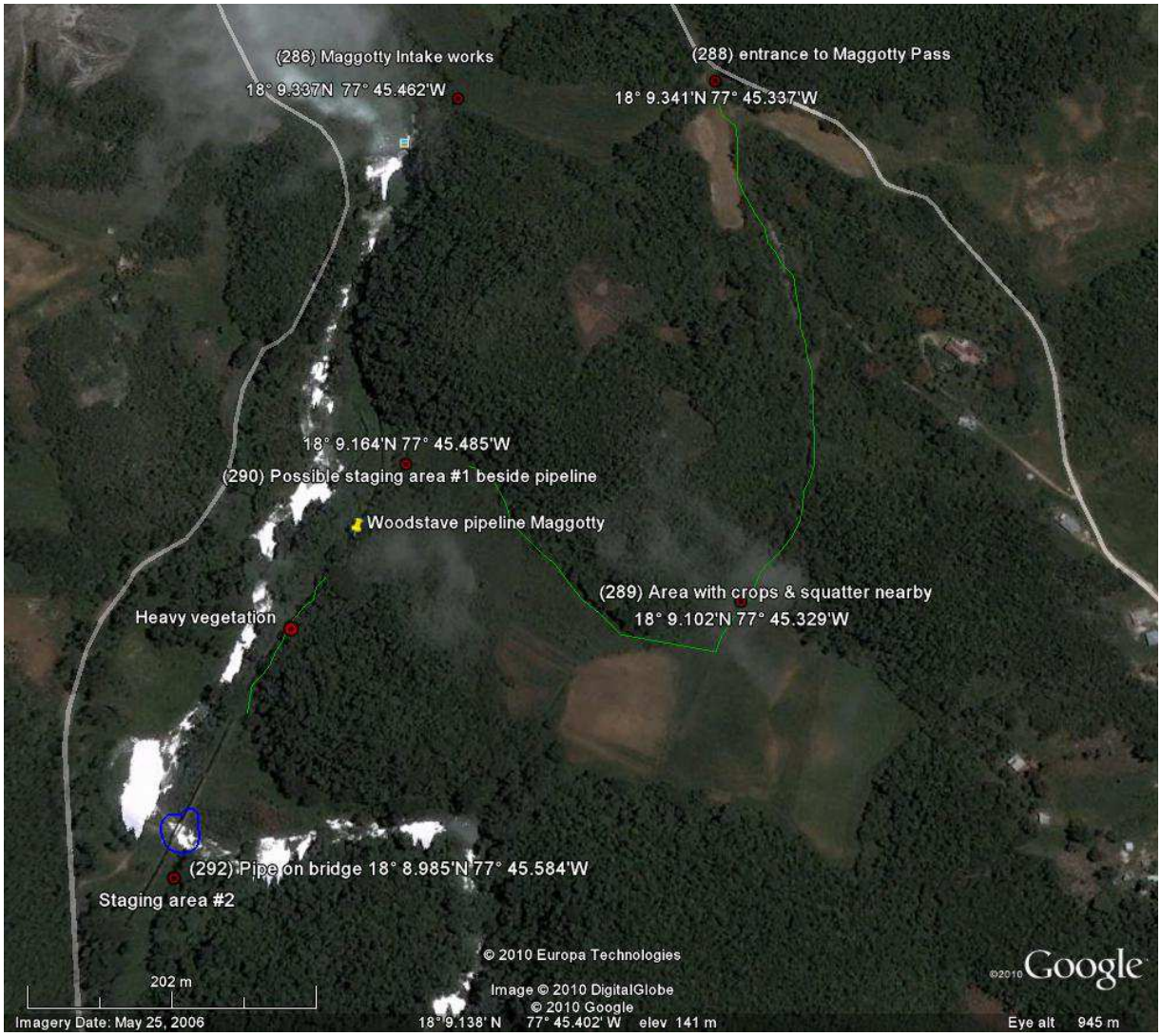


Figure 12 - Google Map showing Staging Areas 3 & 4 and location of footbridges

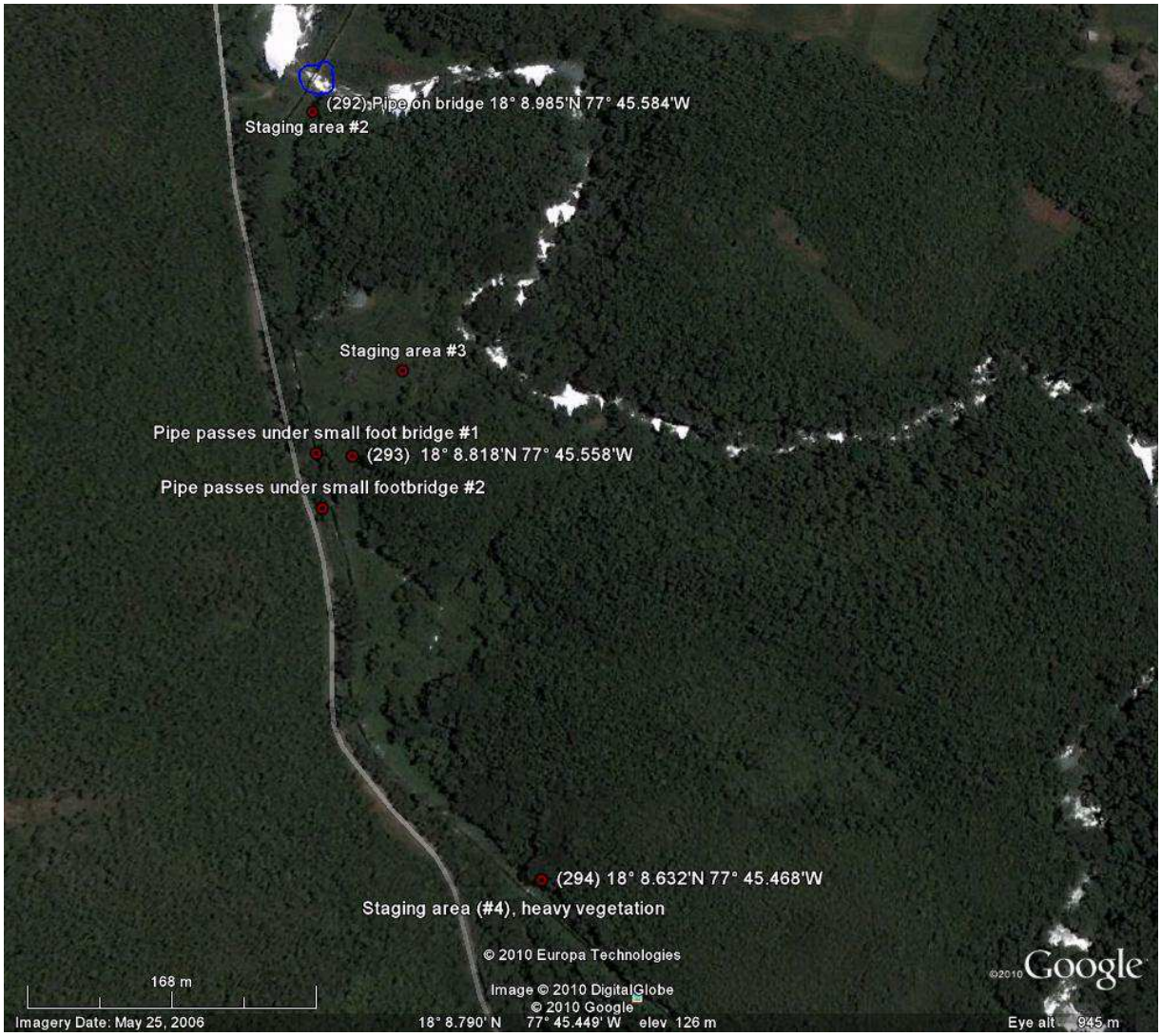


Figure 13 - Google map showing Power Plant at Maggotty

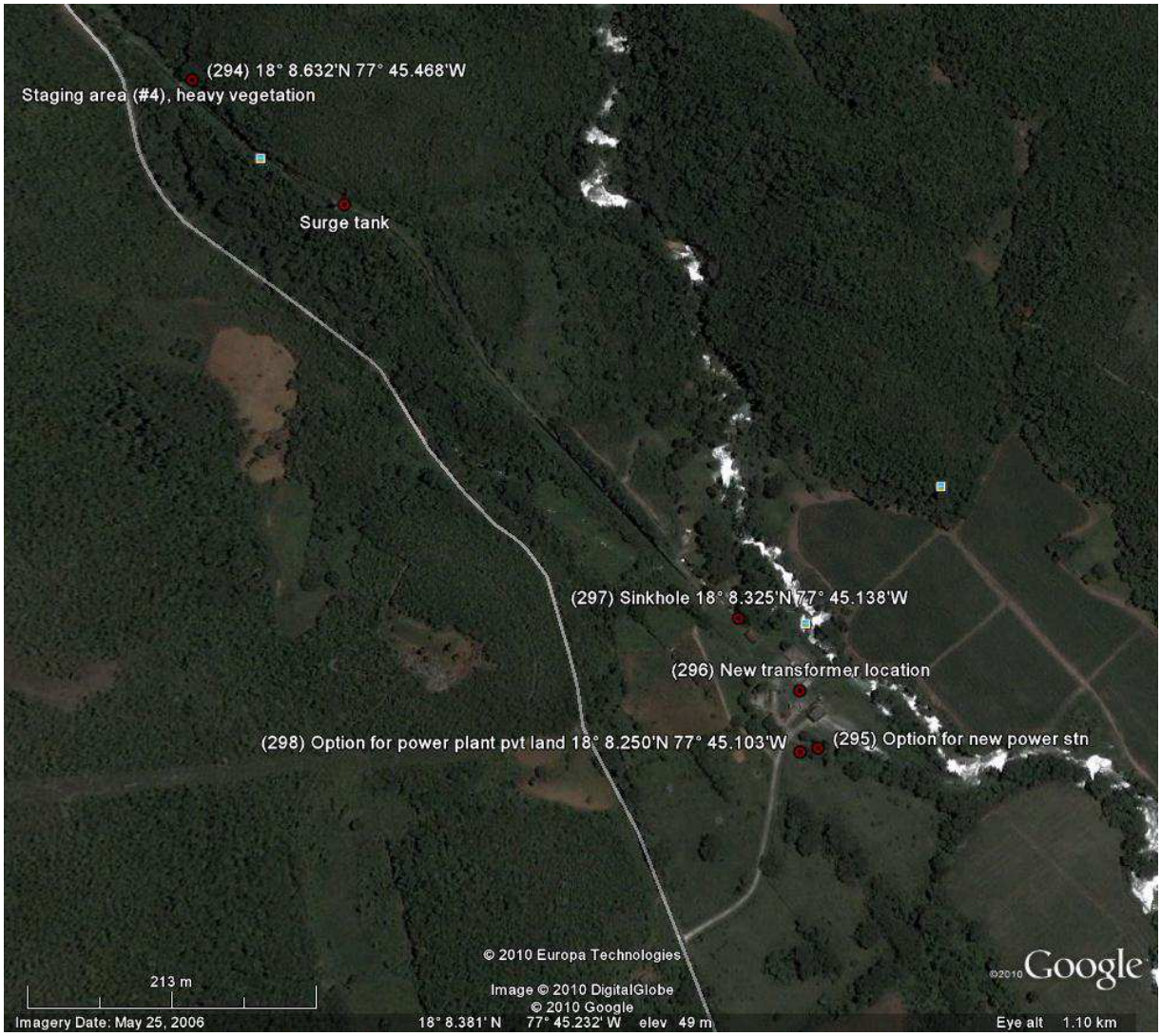


Figure 14- Access Road to Intake Works

Figure 15 – Location # 286 - Intake Works

Figure 16 - Location # 286-Intake Works

Figure 17 - Location # 286 - Intake Works

Figure 18 - Access at Intake Works

Figure 19 - Location # 286 - Intake Works

Figure 20 - Location #289 - Squatter's home in clearing along Maggotty Pass

Figure 21 - Location #289 - Yam cultivation along Maggotty Pass

Figure 22 - Location #289 Along Maggotty Pass; Sweet Potato and Sorrel cultivation

Figure 23 - Location #290 - Penstock after leaving the intake (looking downstream)

Figure 24 - Location #290 - Penstock after leaving the intake (looking upstream)

Figure 25 - Location #290 - Possible Staging Area #1 beside penstock

Figure 26 - Location #290 View upstream of pipe exiting concrete culvert after intake

Figure 27 – Location #290 View of Black River from on top of the wood stave penstock

Figure 28 - Location #290 View downstream of penstock with possible Staging Area #1 in the foreground

Figure 29 - Location #292 Possible Staging Area #2

Figure 30 - Location #292 Steel section of the penstock crossing the river on a bridge

Figure 31 - Location #292 Steel section of the penstock crossing the river on a bridge

Figure 32 - Location #292 View of wood stave penstock looking downstream & Possible Staging Area #2 in foreground

Figure 33 - Location 293 Possible Staging Area #3 near footbridge #1

Figure 34 - Location #293 Standing on footbridge #1 looking upstream to where wood stave penstock exits 300 ft. concrete lined tunnel

Figure 35 - Location #293 Standing on footbridge #1 looking downstream

Figure 36 - Location # 294 View of wood stave penstock looking downstream towards surge tank

Figure 37- Location # 294 View of wood stave penstock looking upstream

Figure 38 - Location #294 View of possible Staging Area #4

Figure 39 – Location # 296 - Proposed location of new transformer at the power plant

Figure 40 – Location # 295 - Termite infested tree at proposed location for new power station on JPS property

Figure 41 – Location # 295 - Proposed location for new power station on JPS property

Figure 42 - Location where tailrace of new station will merge with existing tailrace

6.3 Flora and Flora Survey

The flora and fauna assessment was conducted by Marlon Beale who has extensive fieldwork involving censuring of land birds (residents, endemics and migrant species) and other faunal species across the island as well as extensive fieldwork involving assessments of vegetation and habitat types across the island.

The methodology used for the **Avifaunal Census** was the **Fixed Radius Point Count Census Method.**

This Point Count method is based on the principle of counting birds at a defined point or spot and determining the distance of each bird censured. A point is selected and then all bird contacts (seen and heard) are recorded, with a determination of distance given (< 25m or >25m) for each contact. This is done for a predetermined time, usually 10 minutes, before moving to another point at a specified distance away (Bibby et al. 1998). Points for this survey were 60m – 100m apart.

Advantages of this method include:

1. Greater concentration on the birds and habitats without having to watch where you walk (Bibby et. al. 1998).
2. More time available to identify contacts (Bibby et. al. 1998)
3. Greater opportunity to identify cryptic and skulking species (Bibby et. al. 1998)
4. Easier to relate bird occurrence to habitat features (Bibby et. al.1998).

Other faunal surveys were done, through basic direct observation of species within a randomly selected area. The use of burrows, nests and tracks were also included to ensure a complete assessment of all the fauna.

For tree assessment, a **Point-Centred Quarter (P.C.Q.) Method** was used. In addition detailed vegetation descriptions were done from (randomly) selected points. A species list of tree and plant species inclusive of all plant life forms, endemics and native plants was generated.

As with all survey techniques, there are weaknesses, which influence overall results. Below are given factors which affected census techniques used.

1. Time of Day – the best time for conducting a census is in the morning from sunrise until about 10am in the lowlands. It is recognized that as the day continues it gets hotter and the ability to detect birds decreases due to lack of movement. (Wunderle 1994).
2. Time of Year – the change in behaviour of birds during the breeding and non-breeding seasons affect detection. However for this report, the assessment was done in the breeding season, when birds are more vocal. (Wunderle 1994).
3. Weather – things such as wind, rain, fog or if the day is too hot, affect conducting a census (Wunderle 1994).
4. Summer Counts versus Winter Counts – the counts conducted within the area were done within the early winter period, therefore incorporating both residents and early arriving migrant birds, however such habitats are known to be utilized by summer migrants, and these winter counts tend not incorporate these birds, as well as summer residents which may have left the location.

Table 6 - Results of Vegetation Assessment at Selected Areas

Location ID# & Coordinates	Comments
286 N 18° 9.337' W 77° 45.462'	**Maggotty Hydro Plant Intake Works** The vegetation to the western (hilly) side of the intake works is noted to be dense, with tree height ranging from 10m – 30m. Tree species include Cabbage Bark Tree, Trumpet Tree and two species of Sweetwood. Observed shrubs included Search mi heart and Quick Wilt. Ground/Runners included Leaf of life and Maiden Hair Fern. Of note was the presence of Water Hyacinths (*Eichhornia crassipes*) on the edges of the Black River.
287 N 18° 9.641'	**Entrance to Maggotty Hydro Plant Intake Works** Area has a high density of trees which range in height 9m – 25m. It was

Location ID# & Coordinates	Comments
W 77° 45.642'	noted that there was no distinct shrub layer and that about 80% of the vegetation floor was covered with grasses or other plant life-forms. Species which formed the vegetation floor included "Rat-ears", Maiden Hair Fern, Coleus sp. and Three Finger. Others included Wild hops and Leaf of Life. Tree species observed included Red Birch, Milkwood, Cotton and Red Bead Tree.
288 N 18° 9.341' W 77° 45.337'	**Entrance to Maggotty Pass (Parochial road)** This site is noted to be disturbed vegetation with farming activities in close proximity. Also the area is used as a dump site for garbage including old car parts etc. Dominance of grass, coppiced trees and shrubs. There was a high density of vines and creepers in the area. Trees observed included Cobywood, Trumpet Tree, Logwood and Fig. Other plants observed included Smilax sp., Wild Sage and Quick Wilt.
289 N 18° 9.102' W 77° 45.329'	**Maggotty Pass (Parochial Road)** The area is best noted as a clearing between three hillocks which have fairly dense vegetation. Tree heights range from 8m – 20m, on limestone rocks and outcrops in some areas. Dominant trees included Prickly Yellow, Guango, Red Birch, Bastard Cedar and Sweetwood. Noted also was that most trees exhibited branching above half the height of the tree. The ground plants, Dog Blood, Sida sp. and Lantana (Wild Sage) were observed.
290 N 18° 9.164' W 77° 45.485'	**Possible staging area #1** Area of heavy secondary vegetation along a section of the pipeline. Trees observed were Trumpet Tree, Fig, Cabbage Bark Tree and Allophylus sp. Trees in this area displayed branching below half the height of the tree. The dominant shrub was Pepper-Elder, with other ground species such as Shame weed and Passiflora sp.
292 N 18° 8.985' W 77° 45.584'	**Possible staging area #2** The area is disturbed due mostly to the presence of livestock and agricultural practices occurring at this area. Trees observed were about 15m (or less in height) primarily along the bank of the River. Tree species observed included Guango, Sweetwood and Trumpet tree. Runner species included Duppy Potato, Coleus and Thatch Palm.

Location ID# & Coordinates	Comments
	Agricultural species of note are sugar cane, banana and breadfruit.
293 N 18° 8.818' W 77° 45.558'	**Possible staging area #3** This site is best described as disturbed with past anthropogenic activities including farming of cash crops and livestock. Cash crops include Cabbage, Ochra and Sweet Potato. Ground species also included Coleus sp. Peltomorphe sp. and Sida sp. Trees range is height of 9m – 30m and included Prickly Yellow, Ackee, Trumpet and Logwood.
294 N 18° 8.632' W 77° 45.468'	**Possible staging area #4** Tree species observed were Sweetwood, Red Bead Tree, Guango, Bastard Cedar and Cabbage Bark Tree
295 N 18° 8.252' W 77° 45.092'	**Site for powerhouse** This is JPS land, with several tree species observed, including Coconut, Logwood and Guango. Several trees have clear evidence of termite infestation. Tree heights ranged from 10m – 15m
298 N 18° 8.250' W 77° 45.103'	**Alternate location for powerhouse (if necessary)** Privately owned land which currently has cash crops.

Table 7 - Observed Tree Species

	Common Name	Scientific Name
1.		*Acacia sp.*
2.	Ackee	*Blighia sapida* (Introduced)
3.	African Tulip	*Spathodea campanulata*
4.		*Allophylus comina*
5.	Almond	*Terminalia catappa*
6.	Bamboo	*Bambusa vulgaris*
7.	Banana	*Musa* sp.
8.	Bastard Cedar	*Guazuma ulmifolia*
9.	Blue Mahoe	*Hibiscus elatus*
10.	Breadfruit	*Artocarpus altilis* (Introduced)
11.	Broadleaf	*Terminalia latifolia* (Endemic)
12.	Bull Hoof	*Bauhinia divaricata*

	Common Name	**Scientific Name**
13.	Cabbage Bark Tree	*Andira inermis*
14.	Capberry Sweetwood	*Nectandra patens*
15.	Cobywood	*Matayba apetala*
16.	Cotton Tree	*Ceiba pentandra*
17.	Fig	*Ficus* sp.
18.	Guango	*Samanea saman*
19.	Guava	*Psidium guajava*
20.	Hog Plum	*Spondias mombin*
21.	Logwood	*Haematoxylum campechianum*
22.	Mango	*Magnifera indica* (Introduced)
23.	Maiden Plum	*Comocladia pinnatifolia*
24.		*Miconia sp.*
25.		*Miconia quadrangularis*
26.	Milkwood	*Sapium jamaicense*
27.	Pimento/Allspice Tree	*Pimenta dioica*
28.	Poinciana	*Delonix regia*
29.	Prickly Yellow	*Zanthoxylum matinicense*
30.	Red Bead Tree	*Adenanthera pavonina*
31.	Red Birch	*Bursera simarouba*
32.	Small-leaved Sweetwood	*Nectandra coriacea*
33.	Star Apple	*Chrysophyllum cainito*
34.	Trumpet Tree	*Cecropia peltata*
35.	Tar Pot	*Clusia flava*

Table 8 - Observed Shrubs/Herbs

	Common Name	**Scientific Name**
1.	Blue Pea Vine	*Clitoria ternatum.*
2.	Chainy Root	*Smilax balbisiana*
3.	Leaf-of-life	*Kalanchoe pinnata*
4.	Maiden Hair Fern	*Adiatum pedatum*
5.	Maroon Bush	*Pilea grandifolia* (Endemic)
6.	Quick Wilt	*Tecoma stans*
7.	Rat Ears	*Peperomia hispidula*
8.	Search-me-Heart	*Rytidophyllum tomentosum* (Endemic)
9.		*Sida* sp.
10.	Susumber/Gully Bean	*Solanum torvum*
11.	Wild Hops	*Flemingia (Moghania) strobilifera*
12.	Wild sage	*Lantana camara*
13.	Bromeliad	*Vriesea* sp. and *Tillandsia* sp
14.	Mistletoe	*Rhipsalis baccifera (Cactus Family)*
15.	Botton weed	*Borreria laevis (coffee Family)*
16.	Dogberry/Dogblood	*Rivina humilis*

	Common Name	**Scientific Name**
17.	White Grass	*Rhynchospora colorata (Sedge Family)*

Table 9 - List of bird species observed from conducted counts and transects

	Common Name	**Scientific Name**	**Status**
1.	Jamaican Vireo	*Vireo modestus*	E
2.	Cattle Egret	*Egretta alba*	R
3.	Vervain Hummingbird	*Mellisuga minima*	ES
4.	Northern Mockingbird	*Mimus polyglottos*	R
5.	Caribbean Dove	*Leptotila jamaicensis*	ES
6.	Black-Whiskered Vireo	*Vireo altiloquus*	SM / SR
7.	Jamaican Oriole	*Icterus leucopteryx*	ES
8.	Common Ground-Dove	*Columbina passerina*	ES
9.	Bananaquit	*Coereba flaveola*	ES
10.	Jamaican Tody	*Todus todus*	E
11.	Greater Antillean Bullfinch	*Loxigilla violacea*	ES
12.	Smoothed-Billed Ani	*Crotophaga ani*	R
13.	White-Chinned Thrush	*Turdus aurantius*	E
14.	Turkey Vulture	*Carthartes aura*	R
15.	Black-Faced Grassquit	*Tiaris bicolor*	R
16.	American Kestrel	*Falco sparverius*	R
17.	Greater Antillean Grackle	*Quiscalus niger*	ES
18.	Red-Billed Streamertail	*Trochilus polytmus*	E
19.	Jamaican Lizard Cuckoo	*Saurothera vetula*	E
20.	Olive-Throated Parakeet	*Aratinga nana*	ES
21.	Jamaican Woodpecker	*Melanerpes radiolatus*	E
22.	Sad Flycatcher	*Myiarchis barbirostris*	E
23.	Jamaican Euphonia	*Euphonia jamaica*	E
24.	Antillean Nighthawk	*Chordeiles gundlachii*	SM/SR

	Common Name	**Scientific Name**	**Status**
25.	Loggerhead Kingbird	*Tyrannus caudifasciatus*	ES
26.	Red Tailed Hawk	*Buteo jamaicensis*	R
27.	Nutmeg Mannikin	*Lonchura punctulata*	I
28.	White-Eyed Thrush	*Turdus jamaicensis*	E
29.	Jamaican Crow	*Corvus jamaicensis*	E

Key
Status: E – Endemic; ES – Endemic Sub-species; R – Resident; SM/SR – Summer Migrant / Summer Resident; I – Introduced

Table 10 - Observed Neotropical (Winter) Migrants

	Common Name	**Scientific Name**
1.	American Redstart	*Setophaga ruticilla*
2.	Black-Throated Blue Warbler	*Dendroica caerulescens*
3.	Prairie Warbler	*Dendroica discolor*
4.	Worm-eating Warbler	*Helmitheros vermivorus*
5.	Ovenbird	*Seiurus aurocapillus*
6.	Black and White Warbler	*Mniotilta varia*
7.	Louisiana Waterthrush	*Seiurus motacilla*
8.	Common Yellowthroat	*Geothlypis trichas*
9.	Arrow-headed Warbler	*Dendroica pharetra*

Potential Nocturnal Species

- Barn Owl (Resident Species) – *Tyto alba*
- Antillean Nighthawk (Summer Migrant/Resident) - *Chordeiles gundlachii*

Waterbird Observed

- Common Moorhen (Resident) – *Gallinula chloropus*

Table 11 - Butterfly Species Observed

	Common Name	Scientific Name	Status
1.	Zebra	*Heliconius charitonius simulator*	R
2.	Cloudless Sulphur	*Phoebis sennae*	R
3.	Julia	*Dryas iulia delila*	R
4.	Church's Jamaican Skipper	*Chioides catillus churchi*	ES
5.	Common Tailed Skipper	*Urbanus proteus*	R
6.	Cadmus	*Historis acheronta Cadmus*	R
7.	Jamaican Admiral	*Adelpha abyla*	E
8.	Cuban Swallowtail	*Papilio andraemon*	R
9.	Buckeye	*Junonia genoveva*	R
10.	Tropical Silverspot	*Agraulis vanillae insularis*	R
11.	White Peacock	*Anartia jatrophae*	ES
12.	Malachite	*Siproeta stelenes stelenes*	R
13.	Jamaican Mestra, Dorcas	*Mestra dorcas*	E
14.	Jamaican Albatross	*Appias Drusilla Castalia*	R

Status: E – Endemic; ES – Endemic Sub-species; R – Resident

Observed Anoles

Anolis lineatopus
Anolis grahami
Anolis garmani
Anolis opalinus
Note: All are Endemic species

Other Mammals / Animals

Mongoose – *Herpestes sp.* (Introduced)
Snails – Three species found (Family: Punctidae), with the possibility of all being endemic

6.4 Summary of Floral and Faunal Assessment

Vegetation

- A total of 36 tree species were observed of which there was 1 endemic specie.
- Fourteen (14) herbs and/or shrubs were observed from surveys of which 2 species were Endemic.

Avifauna

A total of 38 bird species were observed. The breakdown is as follows:

- 10 Endemics
- 9 Endemic Subspecies
- 7 Residents
- 1 Introduced Species
- 2 Summer (Breeding) Residents
- 9 Winter Migrants

Butterflies

A total of 14 species were observed:

- 2 Endemics
- 2 Endemic Subspecies
- 10 Natives

6.5 Potential Impacts on Flora and Fauna

1. Much of the vegetation around the existing penstock shows signs of disturbance
2. Tree removal due to the digging of trenches to install the new pipeline will result in limited loss of vegetation both in trees and other shrubs and ground life-forms. The new pipeline will have the same footprint as the one being removed.
3. This loss of trees, shrubs and ground plants will not result in noticeable habitat loss. There will be displacement to a small scale of birds, and anoles, however for slower moving organisms such as snail and some butterflies there will be loss of numbers, but with minimal effect to overall population especially for snails.
4. Vegetation loss at point 295 (Power Plant) will be of negligible impact as trees are currently infested with termites and serve more aesthetic value than ecological significance for other organisms.
5. Excavation of trenches could result in siltation of the nearby Black River, reducing flow and reducing habitat for fish and vegetation at the fringes of the river.

7.0 Project Design Elements and Footprint

The generating capacity of the project will be a total of 6.4 MW at the high voltage side of JPS's step-up transformers and will be delivered to the national grid at a transmission voltage of 69 kV. It

will increase the overall generating capacity of the Maggotty Hydropower plant to 12.4 MW. The project will operate solely as a run-of-river plant. Permanent access roads already exist and provide for all necessary transport, year-round, during construction, operation and maintenance of the Works.

The water conveyance system will provide water for the operation of turbines at the power plant to generate electricity.

Provisions are already in place for regular inspection and maintenance of the existing Works, however these will be improved during the service life of the Project. The exterior of the powerhouse and other buildings will blend with the natural surroundings and will have an architectural appearance consistent with their function and setting and with good quality design practice.

The expansion of the existing site will include the following general (major) construction activities:

- Demolition of a part of the existing diversion weir and construction to expand/extend same
- Demolition of existing and installation of new surge tank
- Replacement (below ground) of 1500m of existing (above ground) wood stave penstock with 2.5 m diameter Glass Reinforced Pipe
- Construction of a tailrace
- Construction to expand the existing Maggotty Hydropower substation

No transmission lines will be installed at this project.

The design of the civil and structural features for the expansion is for a 100-year service life, while the electrical and mechanical system is designed for a service life of at least 50 years. The design service life of a structure or equipment is the period for which it is to be used for its intended purpose.

7.1 Seismic Design Requirements

All designs of the Permanent Works will consider earthquake loadings such that performance of Works is not adversely impacted under the Maximum Design Earthquake (MDE). The design earthquake will yield peak horizontal ground acceleration (PHGA) of approximately 0.51g. In accordance with ASCE (2010), this value will be reduced by a factor of ⅔ for use in pseudostatic structural design. Therefore, the PHGA for design will be taken as 0.34g.

The Contractor will be responsible to undertake site-specific, detailed seismicity studies to determine the appropriate design earthquakes for the Works. Seismic design events will be determined based on accepted international practices for probabilistic and deterministic earthquake analysis. At a minimum, seismic design events for Detailed Design will include:

- Maximum Design Earthquake (MDE) equivalent to the Maximum Credible Earthquake (MCE) for which critical components of the Works such as the weir and

other reservoir retaining structures will not cause release of the reservoir as a result of such an event.

- Operational Basis Earthquake (OBE) for which performance of the Works is not interrupted.

7.2 Modifications to Existing Structures

The drawings with the proposed modifications to the existing structures are presented in Annex A. The structures at the existing headpond comprise a concrete weir, a side intake structure and concrete channel conveying water to a gated concrete box type intake structure leading to a section of concrete culvert connected to a wood stave pipeline. A gated sluicing structure alongside the intake flushes sediments accumulated behind the weir.

Modifications to the intake comprise a new intake constructed adjacent to the existing intake downstream and on the left side (facing downstream) of the existing overflow section. The intake will be of a similar design to the existing intake with three (3) openings equipped with trashracks, oriented laterally to the flow leading to a tapering concrete channel connected to a gate structure. The gate structure will contain a vertical lift control gate and a set of stoplogs located upstream of the gate to allow for maintenance of the gate. The gate will be operated by an electrically operated hoist.

The deck elevation will be set at about El. 116 m. A new forebay wall will be constructed to create a tapered channel to lead water into the new intake bays. The existing sluiceway will be abandoned and a new bottom outlet constructed in the modified overflow section.

The existing intake will remain in service at the conclusion of the construction. The new intake will be constructed as much as possible downstream of the existing weir. A sheet pile wall will then be erected in the forebay to allow a section of the weir to be demolished to open up the forebay. The last section of the new weir will then be tied into the existing weir. A new section of flume will be constructed from the gate structure to connect into the existing flume.

The town of Maggotty lies immediately upstream of the headpond. Consequently the design of the overflow section of the modified structure will have the same capacity as the section removed so that the headwaters do not encroach on the upstream community.

7.3 Water Conveyance System

The existing water conveyance system comprises mainly wood stave and steel pipes, constructed above ground except for:

- a section along the narrow section of the river bank immediately downstream of the intake where a concrete flume and concrete pipe have been constructed insitu.
- a section upstream of the powerhouse which is buried.

The various sections of the existing conduit are summarised in Table 12 below.

Table 12- Sections of the Existing Penstock

No.	Feature	Material	Start (m)	Stop (m)	Length (m)	X section	ID (m)
1	Intake	concrete					
2	Square A-A	concrete	0.00	48.77	48.77	square	2.13
3	Transition	concrete	48.77	51.21	2.44	Square to round	2.13
4	Round B-B	concrete	48.77	118.25	69.49	round	2.13
5	Bridge	steel	118.25	134.73	16.48	round	2.13
6	Round B-B	concrete	134.73	207.51	72.77	round	2.13
7	Transition C-C	Conc. & steel	207.51	210.25	2.74	round	1.98
8	pipe	wood stave	210.25	568.48	358.23	round	2.13

The existing wood stave and steel pipelines will be dismantled and removed from the site and supporting structures demolished with the exception of the pipe bridge supports which will remain in place.

The water conveyance system will be designed and constructed so that the hydraulic, capacity, and energy requirements are met.

7.4 Powerhouse and Connection to Existing Switchyard

The powerhouse will be a surface type. The powerhouse layout will take into account the requirement for removal of the runner and generator for maintenance inside the powerhouse. Stoplogs will be provided at the tailrace.

In addition to the machinery hall, the powerhouse will be provided with an assembly bay and an electrical room containing a control room, battery room and a small office. A toilet, and first aid facility, and a maintenance room including necessary tools and equipment will be located in the erection area, etc. The assembly bay shall have a minimum length equivalent to 1.5 times the spacing between generating units.

The powerhouse will have a fire protection system. It will be connected to the existing switchyard which is located adjacent to the powerhouse. The main power transformer (generator transformer) will be located outside of and adjacent to the powerhouse structure, and one 69 kV overhead circuit will connect the high voltage terminals of the main power transformer with the bus in the switchyard through a new breaker to be installed in the switchyard. A covered cable trench will be provided for control, protection, and telephone cables will be routed between the powerhouse control room and the switchyard facilities.

The existing switchyard will be expanded to contain one additional 69 kV line bay for the 69 kV connection from the new main power transformer. Overhead conductors will be used to connect the main power transformer (generator transformer) and the switchyard. If required, intermediate towers will be used to support the conductors and maintain the required clearances.

7.5 Mechanical and Electrical Installations

The mechanical and electrical equipment for the Project will include, but not be limited to, the following:

1. Hydromechanical equipment (gates, valves, trashracks, stop logs, bulkead gates, and hoist equipment) at the intake and powerhouse. Over velocity devices will be installed at the intake and at appropriate locations in the pipeline to detect pipeline breakages and relay this to an alarm system at the powerhouse.
2. Powerhouse overhead crane
3. Turbines, governing systems, and inlet valves.
4. Generators and excitation systems.
5. Generator step-up transformers.
6. 6.9 kV cabling to the step-up transformers.
7. 6.9 kV generator switchgear.
8. Mechanical auxiliary equipment and systems.
9. Electrical auxiliary equipment and systems.
10. Control centre.
11. Extension to the 69 kV switchyard, adjacent to the powerhouse.
    a. Modification of the existing – switchyard.
    b. 13.8 kV distribution lines.

.

All gates and valves, even at remote locations, will be able to be operated remotely from the control room in the powerhouse.

The mechanical auxiliary equipment and systems will include as a minimum the following:

1. Station drainage system.
2. Cooling water and service water systems.
3. Sanitary drainage and sewage treatment system (septic tank).
4. Water level monitoring and sensing system.
5. Station service compressed air system.
6. Lubricating oil system.
7. Oil recovery system.
8. Fire protection systems.
9. Ventilating and air conditioning systems.
10. Emergency generating systems.

The powerhouse will be fully equipped with necessary air conditioning and ventilation suitable for the local conditions. Emergency diesel generators will be provided at the powerhouse.

The electrical auxiliary equipment and systems will include as a minimum the following:

1. Station service switchgear.
2. Batteries, battery chargers, UPS.
3. Fire detection system.

4. Lighting system and ac distribution systems.
5. Grounding system.

7.6 Control Centre

There will be a complete control centre situated in the powerhouse control room. The turbines will be controlled from a central location using a PLC or PC-based automatic control system. The system will be designed to be controlled locally from the central location at the power plant, at each unit control system and with capability for remote control from a central dispatch. Local, manual, hardwired control means will also be provided in each unit, for testing and maintenance purposes and to allow emergency operation in case of failure of the PC-based system.

The control system will consist of a computer control system, communications equipment and security equipment for complete control and monitoring of the Project.

The control system will be used to control and monitor the two generating units and all the power plant apparatus, including the switchyard and the gates and valves at the intake site.

A wired communication system will be provided within the different areas of the plant. Adequate communication facilities with the regional control centre for voice and data transmission will also be provided, as required.

7.7 Water Level Monitoring System

There will be water level monitoring and sensing systems at the following locations:
1. Headpond.
2. Powerhouse tailrace.

7.8 Ancillary Works

Other ancillary works that are necessary for the proper operation and maintenance of the Works include:

- Local power supply, local communication system, etc.
- Fencing and lighting for security at the Intake and Powerhouse and switchyard.

7.9 Spare Parts

Mandatory Spare Parts and Maintenance Equipment

The Contractor will be responsible for providing all spare parts and maintenance equipment specified by JPS or required for start-up and testing of the Plant.

Optional Spare Parts and Maintenance Equipment

As part of the Basic Design, the Contractor will provide a list of recommended spare parts and maintenance equipment.

8.0 Project Schedule

Planning and environmental approval for the project is slated for March/April 2011. The bid for contractors should be awarded by June 2011. Construction is estimated to last for two (2) years.

9.0 Resource Usage

The construction and operational footprints for both projects are described below. Due to the non-consumptive water use by the hydropower, the operational footprint is very small.

Table 13 - Resource Consumption

Phase	Resource Consumption
Construction Phase Footprint	1. Masonry consisting of cement, gravel, sand, water, steel 2. Human Resources 3. Fuel for transportation 4. Land resources 5. Utilities (water & electricity) 6. Pipelines
Operational Phase Footprint	1. Human Resources 2. Utilities (water & electricity)

9.1 Risks of Hazards and Accidents

The listed risks and accidents are associated with the project.

Construction Phase

1. Construction site accidents e.g. fuel spills, injury to workers from heavy equipment movement and other accidents on the job

Construction and Operation Phases

1. Hurricanes
2. Flooding

Earthquakes are not a major risk in the project area.

10.0 Hydropower Environmental Description

10.1 Black River Watershed - Hydrology, Drainage and Aquatic Ecology

The Black River Basin is located in the southwestern part of the country and occupies an area of 1,460 km^2. The Black River is the island's largest river system that originates in the Cockpit Country and mainly drains this basin. It is fed by three rivers, the YS, Middle Quarters and Broad Rivers. It is navigable for 28 kilometres (17 miles) from the mouth of the river. The middle and upper reaches of the Black River have small to moderate amounts of fresh water perennially available. The Black River Basin is about 67,341 ha in extent and includes a "well developed karstic terrain in the upper region (Cockpit Country), the gently sloping Pedro Plains, and the morasses of the coastal areas". The Black River is the primary source of surface drainage.

From its origin in the Cockpit Country, it runs underground before emerging north of Siloah on the southern fringe Cockpits. Passing through Maggotty, the river runs alongside the road and goes down several small waterfalls and the Black River Gorge located in the Apple Valley Park. Running past Newton, the river flows into the Upper Morass merging with Smith River and other smaller tributaries, where thick rushes flourish. In the Elim area, a fish farm cultivates the 'Jesus fish', a variety of African perch, so called because of its reputation as a prolific breeder. The Jacana is also known locally as the 'Jesus bird,' as it gives the impression of walking on water when it wades among the floating leaves of aquatic plants.

Lacovia is located between the Upper Morass and the Lower Morass. Here it joins the YS River making it the largest (5,700 hectares) swamp environment in the Caribbean. Middle Quarters is famous for its crayfish known locally as 'hot pepper shrimps.'

The Lower Morass consists of shallow estuaries, marshland and mangrove swamps providing a rich ecological environment for a broad range of fish, birds and other creatures including lobsters, mangrove snappers, snook and mullet. Saltwater crocodiles inhabit the swamps but the population has declined due mainly to loss of habitat as heavy draining for agricultural or tourist purposes destroy their nesting places. Other birds include egrets, herons and ospreys. The mangrove trees are sometimes spectacular with aerial roots sent out like spiders' legs, sometimes dropping 12 m (40 feet) into the river.

The Maggotty Falls on the Black River was sacrificed for the development of the JPSCo. hydropower plant in the late 1950s. It only regains its original majesty when the Black River is in spate.

10.2 Hydrologic data for project design

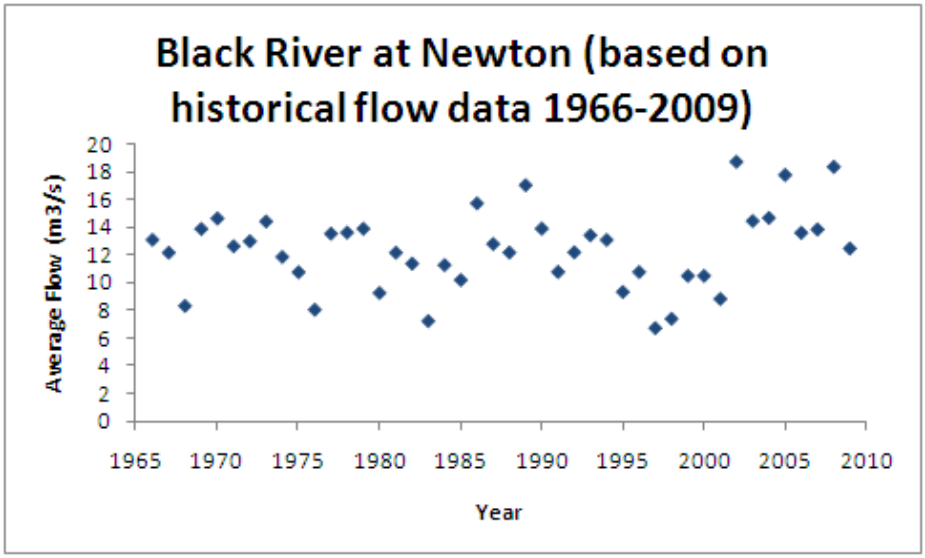
The following define the hydrologic data used for design of the project.

10.2.1 River Flow

Daily flow data for Black River at Newton are available from the Jamaica Water Resources Authority (http://www.wra.gov.jm/) for the period starting in 1966, with some records missing. The Newton gauge is located at 18°07'29"N and 77°44'31"W at an elevation of 15.0 m above mean sea level. The drainage basin area at Newton is 402 square kilometres.

Based on these data, the average flow is about 12.4 m^3/s. Visual inspection of the annual average flows (Figure 43 below) does not show any dramatic trend in the record period. However, flows in recent years appear to be somewhat greater than those in previous years.

Figure 43 - Annual Flow Average Time Series - Black River at Newton



The average monthly flows are shown in Figure 44 below:

Figure 44 - Average Flow by Month (1966-2009) - Black River at Newton

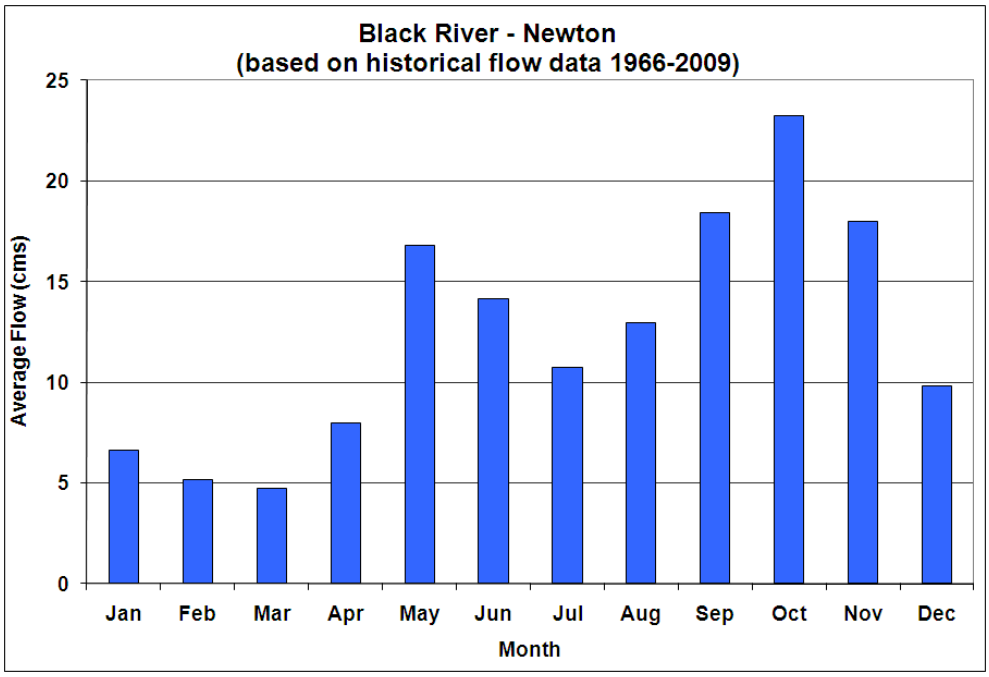


Table 14 below presents a monthly summary of the flow data.

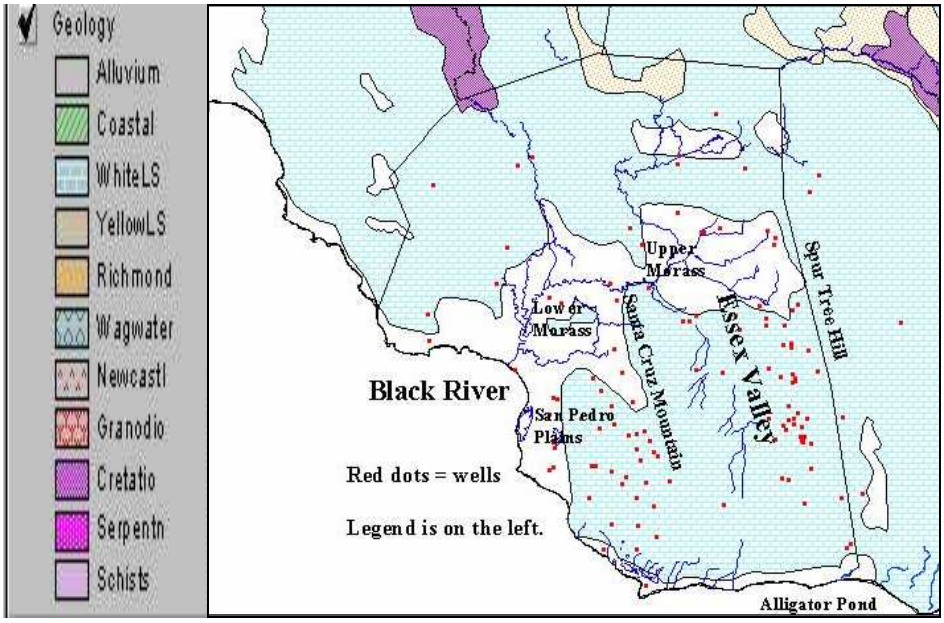
Table 14 - Mean Monthly Streamflow – Black River at Newton

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
1966	7.13	4.14	3.98	5.51	16.86	19.31	26.81	14.45	14.67	18.26	17.20	9.01	13.11
1967	5.76	4.74	5.47	12.68	16.11	13.31	10.36	7.45	12.28	23.41	24.13	10.51	12.18
1968	5.59	3.87	3.01	3.31	4.33	3.83	5.85	10.30	14.19	18.74	17.63	9.16	8.32
1969	5.51	3.47	2.96	9.39	31.99	23.44	11.45	12.55	18.66	25.13	14.67	7.58	13.90
1970	7.20	5.40	4.36	5.53	16.53	25.14	14.81	15.39	16.77	24.78	26.95	13.00	14.66
1971	7.84	5.62	5.35	6.56	22.66	19.88	9.66	16.01	15.56	16.13	17.21	9.29	12.65
1972	5.89	5.09	6.53	15.75	17.53	7.51	8.22	16.10	19.35	29.99	14.91	9.13	13.00
1973	6.06	4.17	6.03	4.69	10.24	14.50	9.06	19.92	15.80	42.79	26.67	13.37	14.44
1974	8.82	5.98	7.28	9.19	7.42	7.92	9.32	11.89	20.63	23.24	21.26	9.44	11.87
1975	5.12	3.90	3.81	2.64	10.92	9.74	10.26	16.72	19.89	20.03	17.61	8.53	10.76
1976	6.03	4.04	3.60	2.28	4.20	4.05	2.94	9.11	17.82	24.91	11.01	6.47	8.04
1977	3.88	3.26	2.12	11.50	26.36	15.72	13.49	13.43	16.94	28.01	17.29	10.77	13.56
1978	11.82	7.03	6.10	10.96	17.63	17.89	15.13	11.52	12.61	25.64	17.86	9.47	13.64
1979	5.39	4.34	4.76	6.36	11.58	30.98	19.22	18.86	20.00	22.27	15.26	8.02	13.92
1980	5.87	3.85	3.22	5.34	12.39	13.12	7.37	10.27	11.54	16.30	13.35	8.47	9.26
1981	4.30	3.18	2.76	2.44	13.34	8.30	17.91	15.19	18.51	31.69	18.56	10.05	12.19
1982	8.04	8.04	4.60	6.45	25.74	12.79	9.49	8.32	17.02	15.71	12.28	8.14	11.38
1983	6.10	5.14	3.83	3.32	11.72	7.90	6.86	9.61	6.37	11.97	8.23	5.60	7.22
1984	4.85	9.17	6.54	4.54	13.42	14.92	11.13	14.82	19.47	20.44	10.84	5.32	11.29
1985	3.41	2.46	2.62	14.14	16.74	7.12	6.97	11.41	13.49	12.25	22.19	9.59	10.20
1986	5.73	5.06	5.43	12.44	34.04	33.10	12.85	10.33	13.61	28.27	17.33	10.85	15.75
1987	6.27	4.57	3.55	4.76	16.88	15.54	10.73	12.57	21.72	23.90	24.24	8.99	12.81
1988	6.71	5.92	4.65	5.05	6.47	5.94	6.89	10.75	23.25	35.21	22.80	12.64	12.19
1989	9.99	7.61	6.78	14.20	23.46	14.92	10.21	22.46	29.03	30.10	22.64	13.51	17.08
1990	8.31	5.18	5.58	16.64	19.62	9.22	6.97	10.07	29.60	26.26	19.99	9.70	13.93
1991	6.33	4.40	3.90	7.67	22.24	17.32	9.82	9.70	12.10	12.47	16.55	6.90	10.78
1992	4.57	3.59	3.97	11.15	13.28	12.46	6.72	10.40	18.39	29.73	22.56	9.67	12.21
1993	6.33	4.22	7.24	13.53	24.55	17.71	8.81	10.31	23.75	20.24	14.86	9.73	13.44
1994	6.89	5.56	8.21	11.76	37.55	13.88	9.08	9.11	12.50	12.34	21.73	8.70	13.11
1995	4.99	4.04	3.90	3.12	13.25	6.30	6.68	15.47	16.49	14.12	11.80	11.82	9.33
1996	6.26	8.36	5.33	8.52	14.50	15.87	10.67	8.33	13.64	16.87	14.28	6.65	10.77
1997	4.76	5.33	3.47	4.82	8.17	6.26	5.13	6.66	11.37	12.36	7.79	4.36	6.71
1998	3.19	2.83	2.81	2.56	6.14	8.71	4.91	13.51	9.64	11.78	14.41	8.15	7.39
1999	5.33	3.93	4.28	6.03	16.37	15.59	7.20	12.16	17.88	15.15	15.16	6.86	10.50
2000	4.49	3.26	3.07	4.37	22.80	10.97	13.84	10.20	13.74	20.12	10.12	9.04	10.50
2001	4.49	2.99	2.85	8.47	20.34	6.89	6.52	7.96	10.17	11.53	16.71	6.99	8.82
2002	4.82	3.35	2.66	5.57	21.84	42.67	21.78	14.18	20.81	51.13	19.97	16.45	18.77
2003	10.96	9.34	6.60	16.61	15.27	11.26	8.30	13.60	20.60	30.49	16.84	13.83	14.48
2004	8.96	5.77	4.84	5.54	12.75	8.92	9.89	13.66	40.90	32.03	20.28	12.94	14.70
2005	9.79	6.17	4.39	4.95	19.33	15.62	35.09	21.64	26.10	38.39	19.84	12.51	17.82
2006	10.27	8.48	6.20	9.13	10.58	13.40	9.29	16.06	23.72	25.03	19.16	12.19	13.63
2007	8.11	6.71	7.90	6.50	13.41	12.04	6.67	14.93	17.98	29.55	29.45	13.10	13.86
2008	8.73	6.52	5.86	18.41	16.31	15.49	10.56	21.86	42.52	26.66	31.81	16.15	18.41
2009	10.67	7.49	6.45	6.28	21.77	14.08	8.61	10.56	20.75	17.69	15.16	10.30	12.49
AVERAGE	6.63	5.17	4.75	7.97	16.79	14.13	10.76	12.95	18.45	23.25	17.97	9.84	12.39

10.3 Geology

The major morphological and topographic features are shown in the geological map of the basin (Figure 45).

Figure 45 – Map of the Black River Basin Geology



Because the entire basin is underlain by limestone (Newport Formation of the White Limestone Group), surface drainage is found only in the Upper Morass to the north, where a series of springs feed the tributaries of the Black River system. (A small river occurs in the southeast of the basin, flowing from springs a short distance directly to the sea, as the Alligator Pond River.)

The base of this Newport Formation, a unit of the White Limestone Group lies at a depth of more than 1,372m (4,500 ft) below the sites of the mudlakes, below the water table, and below the saltwater interface below the freshwater lens. The lithology of the Newport Formation is mainly soft, friable, even chalky and rubbly limestone, with some primary intergranular porosity, case-hardened at the surface to produce limestones without primary permeability. The limestones have been extensively fractured, ranging from major faults to minor faults and joints, so that the development of extensive secondary permeability is to be expected.

10.4 Soils

A soil arsenic anomaly with concentrations up to 400µg As g^{-1} was discovered near Maggotty, St. Elizabeth, during an island wide geochemical survey of Jamaica. Detailed sampling and chemical analysis of soil samples confirmed the arsenic levels and led to a better definition of the size of the anomaly. The area exceeding the 95th percentile (>65µg As g^{-1}) of the islandwide concentrations has been determined to be at least 10 km^2. The anomalous values may be the result of an ancient hot spring environment which was responsible for the introduction and deposition of iron (Fe)– Arsenic (As)– Sulphur (S) as pyrite and arsenopyrite in the limestone bedrock,

which were subsequently oxidised and weathered to yield the arsenic rich soils. These soils were also enhanced in elements such as Antimony (Sb), Iron (Fe) and Cobalt (Co). Despite the high soil arsenic content, the arsenic concentration in the surface water is low and there seems to be no immediate health risk to the residents. The area, however, does present a potential hazard with changing land use.

10.5 Geotechnical Survey

NHL Engineering Ltd. conducted a geotechnical investigation along the proposed pipeline expansion route in Maggotty St. Elizabeth in May 2010.

The areas investigated included the Intake area, the Surge Tank area, the Power house area and the Pipeline area. NHL Engineering arranged for the field exploration based on the stipulated test location points and the laboratory testing programme necessary to provide a satisfactory basis for evaluating the site for the placement and design of the proposed infrastructure.

Initial visual inspection of the soil material exposed at some locations indicated that the soils on the site were highly variable, ranging from the silty clays, unstable highly weathered limestone, dense calcareous gravels and sands to large porous limestone boulders and the bedded limestone formation.

The investigation sought to establish the following:

a. The insitu density of the soils on site.
b. Soil stratification and distribution across the relevant areas of the site.
c. The design parameters relevant to the evaluation and analysis of the required structural and infrastructural elements on site.

The field investigation entailed the drilling and sampling boreholes. The boreholes were to be taken to refusal or to a depth of at least 12.2 m (40 ft). If refusal was encountered on the auger, coring was to be carried out to a minimum of 3 m into the formation.

The method of drilling and sampling were in accordance with the Standard Penetration Testing and NX Coring drilling Specification.

The borings were made by NHL Drillers using a truck Mounted CME Drill Rig, with a 160 mm hollow stem auger string. The method of drilling and sampling was in accordance with the Standard Penetration Testing and Rock Coring specifications using the Split Spoon Sampling technique and NQ Cores respectively.

The results indicated the following:

a. ***Intake Area***: Two boreholes were done in this area; the soils encountered were weathered limestone, typically calcareous gravels and sand size particles in a clay/silt matrix. Insitu densities varied from compact to very dense.

b. ***Pipeline Areas***: Twelve boreholes were done in this area; the soils encountered were generally silty clays overlying weathered limestone, boulders and in some areas (based on exposed slopes) the limestone formation. Insitu densities varied from stiff/dense to very dense.
c. ***Power House Area:*** Five boreholes were done in this area; the soils encountered were generally silty clays overlying weathered limestone, boulders and in the two additional boreholes the limestone formation, at about 8m below existing ground levels. Insitu densities varied from stiff/dense to very dense. (Presumptive profiles are included at Appendix 3).
d. No Groundwater observation was made during the field data collection works.

Table 15 provides as summary of the soil parameters.

Table 15 - Summary of Soil Parameters

LAYER IDENTIFICATION	TOP 1 SOILS	MID 1 SOILS	BOT 1 SOILS
	Silty Clays	**Cal. Gravels/Sands**	**Soft Limestone**
Bulk Unit Weight	18.2 KN/m^3	17.4 KN/m^3	20.29 KN/m^3
Submerged Unit Weight	8.8 KN/m^3	9.5 KN/m^3	
ReCompression Index	0.041		
Void Ratio	0.78		
Undrained Cohesion (KPa)	46.0		
Drained Cohesion (KPa)	2.0		
Effective PHI/PHI	15.0 deg.	37.3 deg.	40.5 deg.
Relative Density		69.1%	100%
Ka	0.74	0.245	0.351
Kp	1.35	4.075	2.85
Permeability Coef. (k)	1 x 10^{-8}	1 x 10^{-4} cm/s	1 to 8 x 10^{-3} cm/s
Nq Nc Ny	1 5.14 0	44.59 57.24 56.23	

In summary, the following are the foreseeable problems on this site:

a. Foundation bearing failure within the Top 1 Soils (load/foundation configuration dependent)
b. Total and differential settlement in possible unexplored areas with significant Top 1 Soils
c. Foundation excavation problems within the hard rock formation

The use of isolated conventional shallow foundation is structure/load dependent and

is therefore not recommended in all areas particularly those of the bridge, surge tank and power house areas.

It is recommended that:

a. In the case of the surge tank, the foundations can be deepened to the more competent soils. Excavation should be within 2m of the existing ground level.
b. Structure loads/span etc. information of the bridge were unavailable at the time of the soil assessment however, despite the absence of that information, the Top 1 soils are unlikely to be suitable abutment founding soils. The use of short bored or driven piles should be more suitable depending on the load/span.
c. At the power house, the use of driven or cast in-place pile foundation to the rock formation or to a depth sufficient to safely carry the anticipated loads for the buildings is a technically feasible solution. The use of soil replacement (compact granular pad) and a stiffened raft could however prove more economical and this option should be explored.

Settlement Considerations:

The upper 4m of problem areas of this site is comprised of the gravelly clays that are predominantly plastic in behaviour. These soils are moderately compressible under moist conditions and are seasonally susceptible to swelling and shrinkage. Primary settlement prediction under the anticipated steady load conditions was estimated to be approximately 121.92 mm (4.8"). Secondary settlements are expected to be in excess 38mm over 30 years. Total settlement over this period is therefore predicted 160mm (6.3").

Vertical deformation is unlikely to be of major concern on this site if the recommendations are adopted. The effects of soil deformation under steady load conditions should be for the most part, of little structural consequence to the building. Poor detailing and bad construction practices could however result in the formation of cracks (structural and or non-structural cracks) in the walls of the building.

Seismic Considerations

Information obtained from available seismic risk map for Jamaica indicates that the spectral acceleration for short periods/two second periods for the maximum considered earthquake with a 10% probability of exceedance in 50 years, was deduced as S1 =0.3g. According to the IBC code (2003) and the UBC (1997) code, the site can be classified as site class E (stiff plastic soils).

Slope Stability Considerations

During excavation/construction there are likely to be areas on site that will need location specific slope stability analysis resulting from variations in qualities of rock, joints, slopes and embankment construction. The geotechnical engineer is to be

consulted in the case of any such questionable site conditions. Typically, slope should be cut at a maximum slope of 1:3 (hor:vert) unless bedded limestone rock is encountered where vertical slope should be suitable.

Static Pile Capacities/Pile Consideration:

The use of cast-in-place or driven piles is considered the feasible foundation alternative. Piles will minimize/offset the problem of bearing and deformation. Pile capacity information based on pile type and depth at the relevant location will be submitted upon request.

Other Considerations:

a. Construction Considerations:

The anticipated problems associated with construction will begin as early as the contractor mobilizes unto the site. The plastic upper layers will limit equipment access during moist conditions and the boulder/rock formation will limit the choice and suitability of equipment required to carry out the preliminary site preparation. The construction of all the infrastructural elements (particularly buried ones) will require very strict monitoring given the high possibilities of cost overruns. Some of the unexplored areas could require the use of explosives for blasting though unlikely based on the compressive strength of rock encountered during the field work.

b. Fill Material Considerations:

The areas that are predominantly weathered limestone (marl) are minimal and in some cases not shown. Where encountered, they could be used for fill and even road construction. The fines content are variable (ranging from 10% to 30%).

11.0 Socio-Economic Environment

11.1 Major Industries/Sources of Employment

Sugar and Rum: The manufacture of sugar and rum are two of the oldest industries in the parish. Both activities take place at the Appleton Estate which has given its name to the fine blends of rum it produces. Appleton Estate is situated a few kilometres north east of Maggotty.

Tourism: Since the early 1990s, St. Elizabeth has emerged as one of fastest growing tourist destinations on the island. St Elizabeth has significantly increased its room capacity for tourists and is strongly pushing a tourism package with a difference - community tourism which would include eco-tourism. There are indications that over a half of the estimated 1,000,000 tourists who visit the island each year are

interested in what the south coast has to offer. The Appleton rum distillery and the Black River are two of the popular tourist sites within the parish. In recent years the Great Morass has been developed to attract tourists, while popular sea food restaurants, such as Little Ochie have attracted huge local and international tourists.

Mining: The parish of St. Elizabeth has been a major producer of bauxite since the 1950s when bauxite deposits were discovered in the parish and Kaiser Bauxite Company began mining. This operation was later taken over by Alpart which started mining and alumina manufacturing at Nain in 1969. The company produced and exported smelter grade calcined alumina and was up to 2008 a major employer in the parish. The economic recession which started in the last quarter of 2008, resulted in the closure of many bauxite plants across the island; including the Alpart alumina refinery in St. Elizabeth. This led to wide-scale unemployment directly and indirectly which has caused a serious negative impact on the economy of St. Elizabeth. It is expected that with improvements in the global economy, the plant will reopen in the future.

Fishing: River fishing is unequalled in Jamaica and sea fishing is also very good. Middle Quarters is known as the Shrimp Capital of Jamaica. Vendors sell pickled crayfish to passing motorists and the industry is said to earn $3,000,000.00 a year.

Crafts: St Elizabeth is noted for its straw work - hats, bags, baskets, mats, etc. Sisal and thatch are grown locally to support this.

Agriculture: The parish is one of the largest agricultural areas in Jamaica. It is regarded as one of Jamaica's 'bread baskets'. The parish produces large quantities of cash crops such as sugar cane, cassava, corn, peas, tobacco, and a number of vegetable crops including tomatoes, lettuce, carrots etc. Pastoral farming is also carried out on a large scale in the parish. Livestock include goats, sheep, hogs, cattle and horses. In the Maggotty communities, the cultivation of sugar cane for Appleton Estate and cash crops are the main types of agricultural activity taking place. Much of the lands, which are family owned are leased to farmers for crop cultivation and animal rearing.

Food Processing: There is a food processing plant at Bull Savannah for tomatoes, carrots and pineapples. There are pimento leaf oil factories at Giddy Hall, Bogue and Braes River.

11.2 Major Historical/Cultural/Recreational/Ecological Sites

The Great Morass: This is the island's largest wetland which has an area of 324 km^2. The lower morass extends from the Black River to Lacovia and the upper morass is above Lacovia. It is a complex eco-system and a reserve for more than 100 bird species. It is a refuge for about 300 crocodiles. Fed by the Black River the morass has an abundance of crayfish and fish including the God-a-me that can live out of water in mud and moist leaf litter. Sometimes a manatee can be seen near the river

estuary. The morass provides a livelihood for the 'shrimp' sellers at Middle Quarters. There is now evidence of pollution and the Black River and Great Morass Environmental Defence Fund is attempting to have the area declared a national park.

YS Falls: These falls are considered by many to be Jamaica's most spectacular waterfalls. Eight cascades separated by pools ideal for swimming fall for 36.6m. Limestone cliffs and towering lush vegetation enhance the scene. It is private property but is open to the public for a fee. There is a picnic ground and transportation to the falls. The estate raises racehorses and Jamaica Red cattle

Bamboo Avenue: This 4 km 'avenue' of bamboos on the main road between Lacovia and Middle Quarters was planted by the owners of Holland Estate in the 17th Century to provide shade in the heat of the savannah. A former owner was John Gladstone, father of the famous British prime minister. It was a sugar estate and the factory has only recently been closed. Although battered by hurricanes and the occasional fires it is still attractive. It is maintained by the staff of the Hope Botanical Gardens in Kingston.

Font Hill Wildlife Sanctuary: The Petroleum Corporation of Jamaica owns this 1275 hectare wildlife reserve. It has two miles of coastline. Scrubby acacia and logwood thickets cover much of the area. Near to the coastline are interconnected lagoons and swamps. It is a haven for birds. Eight endemic species can be seen there including the pea dove, the white-bellied dove and the ground dove, the smallest dove in the world. It used to be a cattle ranch earlier.

St. John's Parish Church: Although a tablet on the tower notes the laying of a foundation stone in 1837 it is believed that this yellow brick church is much older. The church has a pair of monuments erected in 1828 to the memory of Robert Hugh Munro and his nephew Caleb Dickenson. Munro bequeathed his estate in trust to his nephew and the church wardens and their successors to form a free school for the poor children of the parish. This bequest formed the Munro and Dickenson Trust which opened the Munro and Dickenson Free School in Black River in 1856, fifty-nine years after Munro's death and eventually Munro School for boys and Hampton School for girls, the oldest public educational institutions in the parish. The tombstones outside the west entrance are for Duncan Hook (1741 -1779) and his four children by a 'free mulatto' who lies beside him. He had to have a special act of Assembly passed to give his mistress and their children the same legal status as white people. Without it they could not have been buried in the churchyard.

Lacovia Tombstones: At the junction of the Lacovia main road and one of the roads to Maggoty lay two tombstones. On one is a large marble slab with the inscription "To Thomas Jordan Spencer". The other is unmarked. The story goes that a duel at a nearby tavern resulted in the death of both men. The engraved coat of arms has been traced to Spencer of Anthrop, an ancestor of the late Sir Winston Spencer Churchill of World War 2 fame.

Appleton Estate: Tucked in the Siloah Valley between the Nassau Mountains and the Cockpit Country lies Jamaica's oldest rum distillery on the Appleton Estate. The rums bear the estate's name and have been produced there since 1749. The estate is now owned by J. Wray & Nephew, Jamaica's largest producer of rums.

Pondside Lake: This is the largest fresh water lake in the island situated about six miles from Black River on the road to Mountainside. It is officially known as the Wally Eash Pond. According to legend this pond was once a district which mysteriously disappeared leaving a pond in its place. A man and his dog left the district at night and as he was returning to the spot where the house should be he stepped into water. The district had sunken while he was away and he was the only one saved.

Accompong: Situated on the south side of the Cockpit Country, Accompong is the only remaining village in western Jamaica inhabited by the descendants of the Maroons. It was reputedly named after the brother of the great Maroon leader Cudjoe, and it was a common name among the Akan speaking tribes of West Africa. The settlement was formed after the treaty between the Maroons and the English in 1739. When the second war with the English broke out in 1795, the Accompong Maroons remained neutral and were left untroubled at the end of the war when all the other Maroon settlements were destroyed. On the 6th of January each year a traditional ceremony is held to commemorate the signing of the treaty with the English in 1739 which gave them their freedom. Their head of government is the Colonel who is elected by secret ballot every five years. He is assisted by a council which he appoints. Most of the Maroons have gone to other parts of Jamaica to live but they are still proud of their African heritage.

11.3 Demographics

The Statistical Institute of Jamaica (STATIN) at the end of the 2009 period recorded the total population size of St. Elizabeth at 151,484. This represents a 0.2% increase over 2008 figures, with a total population estimate of 151,121. The growth rate for the parish has remained consistent since 2001. The parish population growth rate of 0.2% is consistent with that of the national growth rate. The parish also continues to account for 5.6% of the total population of Jamaica. Based on the 2001 population census data, the national male population has in recent years experienced a faster growth rate than the female. The Statistical Institute of Jamaica estimates that between 2000 and 2005 the male population grew at an average annual rate of 0.51%, compared to 0.46% growth rate for females. The 2009 gender figures indicates that the male to female ratio is currently 1:1, with women accounting for a slightly higher percentage of the total population at 50.7%.

Located in the parish of St. Elizabeth, the community of Maggotty is found to the northwest of the parish. The area, which is estimated to have a population size of 1900, is one of the smallest communities in the parish (Table 16). Appleton Estate, a community found north east of Maggotty has an estimated population size of 484.

The ratio of men to women is approximately 1:1, with the entire Maggotty community (including the Appleton Estate) having 990 men and 910 women.

Table 16 - Population of Maggotty, St. Elizabeth

Maggotty Communities	Enumeration Districts (EDs)	Male	Female	Total Population
Maggotty	NW 46	130	125	255
	NW 48	114	93	207
	NW 50	176	170	346
	NW 54	162	157	319
	NW 55	146	143	289
Appleton Estate	NW 49	262	222	484
		990	**910**	**1900**

Source: Statistical Institute of Jamaica, 2005

11.4 Housing

In 2001, the parish of St. Elizabeth had 38,948 housing units and 40,701 dwelling units. Many of the units were single-family type housing and dwelling units. The situation remains the same today within the Maggotty area and its surrounding communities where housing and dwelling units are mainly single-family type housing. 'Walk throughs' of various communities such as Barton Hill (Maggotty Pass) and Newton indicated that there has been an increase in the number of dwellings within the area given the number of newly constructed houses and start-up houses observed.

11.5 Land Use and Settlement Patterns

The land area of the parish of St. Elizabeth is estimated to be 1212km^2. Residential, agricultural, and institutional land uses are the major land use types found within the parish. Maggotty and its environs, based on observation have a central business district, located in Maggotty Square that extends approximately 50 m along the Rice Piece main road that connects Maggotty to Lacovia. Residential land uses are found on the outskirts of the town along local roads and other smaller access paths. Residential land uses are laid out in linear patterns along access routes and form small cluster communities e.g. Barton District (Maggotty Pass). The Newton community is the only residential area found along the main road that connects Maggotty to Lacovia.

Agricultural land uses are also in clusters and are found dispersed between residential land uses. Sugar cane farming is a major agricultural activity taking place within the area, undertaken largely to support the activities of the Appleton Estate factory. Small scale and subsistence farming are also practiced.

Residential and agricultural land use accounts for approximately eighty-five (85%) of land use within the surveyed sites, with commercial accounting for ten percent (10%) and institutional and recreational land uses five percent (5%).

11.6 Land Ownership

In order to access some sections of the pipeline, land owned by others will be traversed. Additionally some of the staging areas will be on land owned by others. The main land owner in the area is Mr. Mark Lee owner and operator of the Apple Valley Park situated nearby the Maggotty Hydropower intake works. JPSCo. is in negotiations with Mr. Lee regarding the temporary use of his land to access the pipeline and to store construction material and equipment.

Mr. Lee has indicated that he does not foresee any problems with this arrangement.

11.7 Utilities

Electricity

Electricity to the proposed development areas is provided by the Jamaica Public Service Company through its national grid.

Water

Water is supplied to the communities by the Maggotty Water supply system operated by the National Water Commission (NWC).

Telecommunication Services

Lime (formerly Cable and Wireless) and Digicel are the major telecommunication service providers in the project area. All residents living within the project area have access to cellular service provided by both telecommunications companies. Lime is the major landline service provider in the area.

11.8 Municipal and Health Services

Police

The project area is served by the Maggotty Police Station which is located less than 1km from the Maggotty Hydropower intake works.

Fire

Fire services are provided by the Santa Cruz fire station, located approximately 15 km from the project area.

Health Services

The Black River Hospital is the only secondary health care facility within the parish. The hospital is located approximately 40km from the project area. Primary health care is provided by both public and private service providers. These primary health care providers are found in Lacovia, Maggotty and, Santa Cruz.

12.0 Socio-economic Survey Regarding the Hydropower Project

12.1 Methodology

As a means of gathering detailed information on the perspective of key stakeholders on the potential impacts of the use of a hydropower plant to generate energy for electricity provision, questionnaires were administered in communities located within a 2 km radius of the project site at Maggotty (Table 17). Fifty (50) questionnaires were administered from the overall target number of fifty (50); giving an overall response rate of one hundred percent (100%). The standardized open-ended questionnaires (Appendix 4) consisted of thirty-seven (37) questions covering key areas to determine the overall perspective of stakeholders on the level and types of impact the proposed expansion of the hydropower plant could have on their community and Jamaica.

Table 17 - Communities where questionnaires were administered

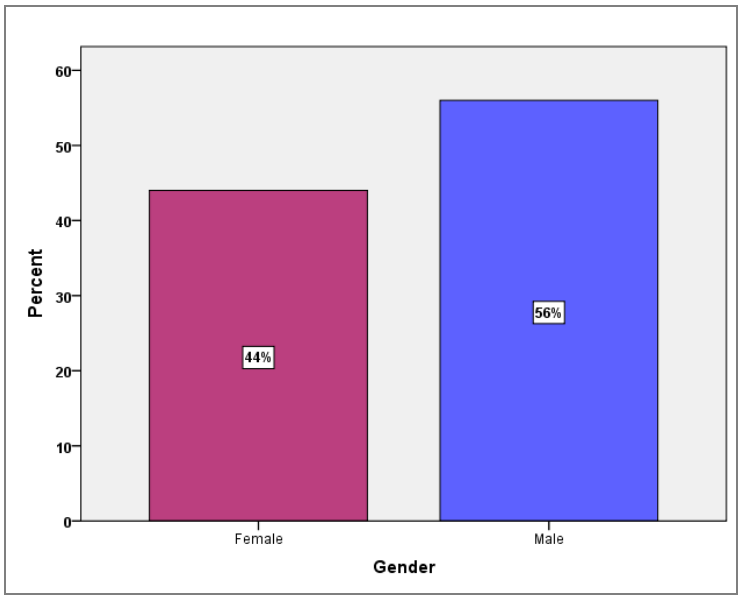
Community	No. of Questionnaires Administered
Maggotty	22
Barton District (Maggotty Pass)	15
Newton	13
Total	**50**

12.2 General Profile of Respondents

Sex Ratio and Age Distribution

Males accounted for fifty-six percent (56%) of total respondents, completing twenty-eight (28) of the fifty (50) questionnaires administered. Females though accounting for only forty-four percent (44%) of the total respondents were found to be more willing participants, completing most of the questions posed in the survey (Figure 46). Sixty-four percent (64%) of all respondents were between the ages of 18-49. Each age group had between 18-22% respondents, except the less than 18 and 60 and over groups which had less.

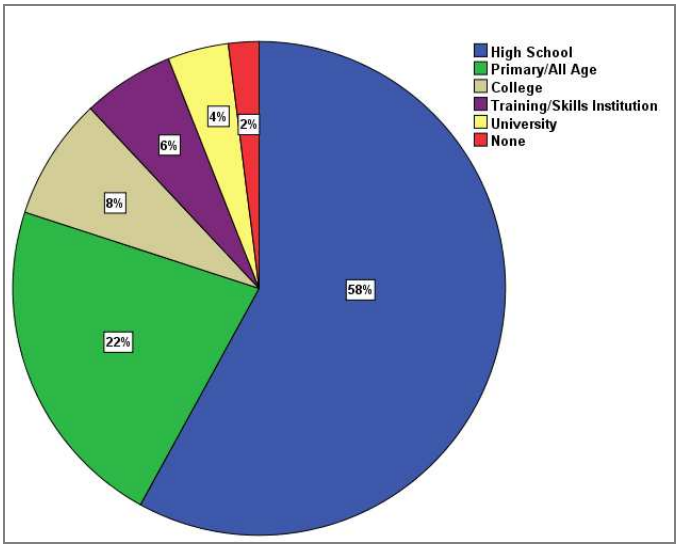
Figure 46 - Gender Profile of Respondents by Percentage



Education

Amongst the total respondents, approximately fifty-eight percent (58%) or twenty-nine (29) had been educated up to the secondary or high school level. This group accounted for the largest overall percentage total. Twenty-two percent of respondents had been educated at the primary level, with only two percent (2%) of respondents indicating they had received no formal education (Figure 47).

Figure 47 - Educational Profile of Respondents by Percentage



Employment and Income

Seventy-two percent (72%) of all respondents surveyed were employed, with twenty-six percent (26%) unemployed and two percent (2%) indicating they had reached retirement. Approximately forty-two percent (42%) of respondents indicated their employment status as "self-employed" and twenty-four percent (24%) indicated being employed full-time. Only eight percent (8%) of respondents were employed part-time. The other respondents were either unemployed or had retired.

Forty-two percent (42%) of the total number of respondents surveyed were unwilling to disclose their income. From the remaining fifty-eight percent (58%), approximately seventy-two percent (72%) indicated earning less than J$10,000 per month, with the remainder earning between J$10,000 and $90,000 per month.

Housing and Land Tenure

Fifty-eight percent (58%) of persons indicated that they owned the houses they occupied, while fifty-six percent (56%) acknowledged owning the lands they occupied. Twenty-eight percent (28%) indicated that both the house and land they occupied belonged to family.
Nine percent (9%) of respondents indicated that the house they occupied was being rented, while eight percent (8%) acknowledged that the land they occupied was part of a rental agreement. No respondent indicated leasing either the house or land they occupied.

Utilities and Municipal Services

All respondents had access to a water source however, not all the water supply sources were formal. Only eighteen percent (18%) of all respondents had water piped into their dwellings and twenty-four percent (24%) had water piped into their yards. The majority of respondents, approximately thirty-eight percent (38%), indicated having private tanks which was their main water supply source. Public standpipes and river/spring sources were the other water supply sources indicated by respondents.

Ninety-two percent (92%) of all respondents indicated they had access to telephone services. All respondents who acknowledged having access to telephone services noted that access was via cellular phone services. Only six percent of the total number of persons surveyed indicated they had residential telephone service.

Community members acknowledged that burning was their primary method for garbage disposal. More than eighty percent (80%) of all respondents indicated that burning was their main method for garbage disposal. Fifty percent (50%) indicated that burning was the only way they disposed of their garbage, while forty-six percent (46%) indicated that they used private trucks and burnt their garbage. Two percent (2%) indicated using private collection services and two percent (2%) were unwilling to disclose their garbage disposal method(s).

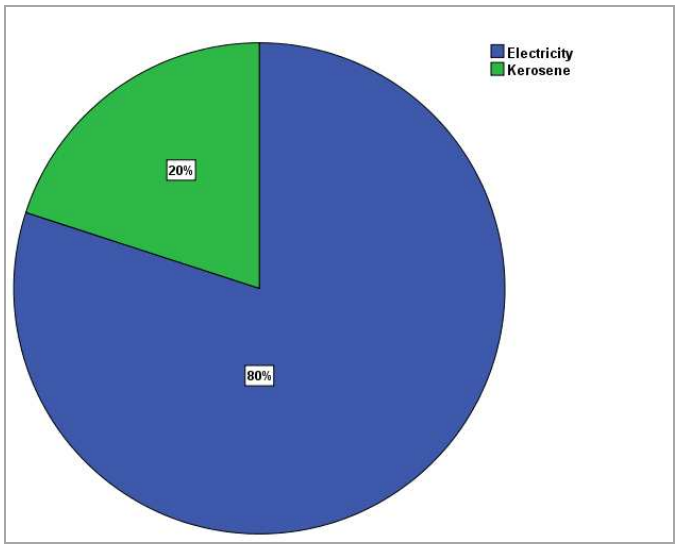
12.3 Electricity Services and Cost

Electricity was the main source of lighting for eighty percent (80%) of all respondents, with the remaining twenty percent (20%) indicating their dependence on kerosene to provide lighting for their households (Table 18 and Figure 48). Twenty-eight percent (28%) of all respondents indicated it cost between JMD $1000-$3000 per month for electricity services, thirty-eight percent (38%) between JMD $3001-$6000, twelve percent (12%) between JMD $6001-$9000 and two percent (2%) above JMD $9001.

Table 18 - Main Source of Lighting for Respondents (Frequency and Percentage Breakdown)

Source of Lighting	Frequency	Percent
Electricity	40	80.0
Kerosene	10	20.0
Total	50	100.0

Figure 48 - Main Source of Lighting for Respondents by Percentage Breakdown



Cost of Electricity Service:

All respondents felt the cost of electricity was too high, and that JPSCo. was over-charging customers for their service. More than half of the respondents indicated that even with the frequent power cuts, there was no price change in their monthly bills.

Service Reliability

Sixty percent (60%) of all respondents found their electricity supply to be very reliable (38%) or reliable (22%); this overall figure represents seventy five (75%) of the total number of persons (40) who indicated they had electricity as their main lighting source. Twelve percent (12%) found their service to be unreliable and eight percent (8%) fairly reliable (Figure 49). Persons who indicated that their service was unreliable or fairly reliable gave the following reasons for their classification:

1. ***Frequency of Power Cuts:*** Respondents indicated that frequent power outages and service disruptions were their primary reason for indicating that the service they received was largely unreliable. Respondents indicated that service disruption occurred at least once per week.

2. ***Recovery Time Period for Power Outages:*** The time period taken for the resumption of electrical service to consumers following power outages within the community was found to be too long. Respondents generally felt that the JPSCo. was too slow in resuming their service and indicated that power outages often lasted for longer than 5 hours or an entire day.

Figure 49 - Respondents View on the Reliability of their Electricity Supply (Frequency)

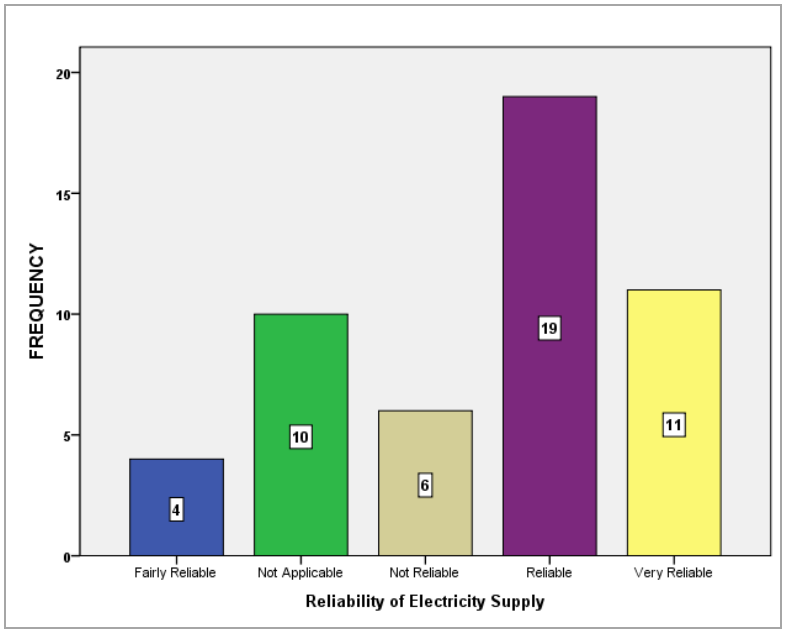
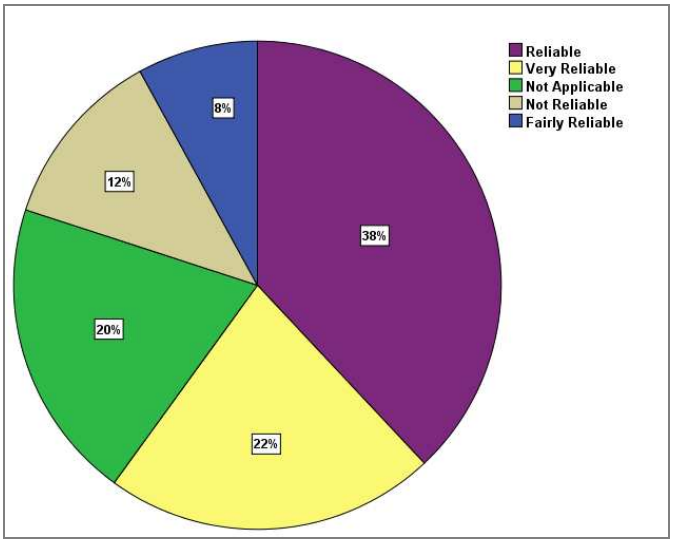


Figure 50 - Respondents View on the Reliability of their Electricity Supply (Percentage)

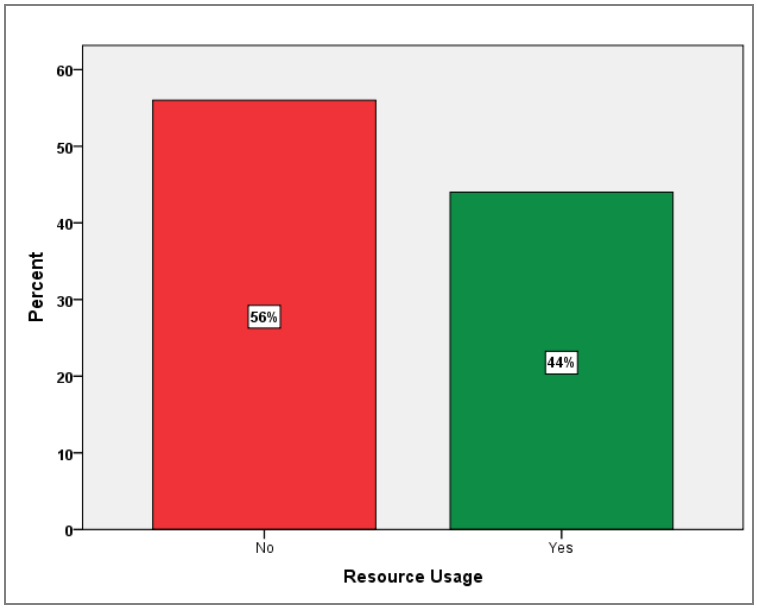


12.4 Resource Use and Management

Within the context of this survey, natural resources include terrestrial, water and aquatic resources. Only forty-four percent (44%) of all respondents noted that they utilised any of the natural resources found within their community (Figure 51). More than eighty-six percent (86%) of respondents did however indicate that they knew of other community members who utilised the natural resources within the area. A total of 21 persons or forty-two percent (42%) of the respondents indicated that water resources from the Black River were used by them or members of their household. This represented approximately ninety-six percent (96%) of the total number of persons who indicated that they utilised the natural resources within their community. Only two percent (2%) of respondents from the total number of persons surveyed indicated using vegetation, a four percent (4%) representation of the total number of persons who indicated utilising natural resources.

For persons who used the water resources of the Black River, approximately forty-one percent (41%) indicated it was used for washing, drinking or some other domestic related purpose e.g. cleaning. Twenty-two percent (22%) used the river for swimming or other recreational activities, twenty-five percent (25%) for fishing and twelve percent (12%) used the water resources to irrigate their farm lands. Only one respondent indicated that their livelihood was dependent on the resources within the project area.

Figure 51 - Percentage Distribution of Respondents Utilising Natural Resources within their Communities



12.5 Resource Quantity and Quality

Despite only forty-four percent (44%) of respondents indicating that they used the resources within the project area, fifty percent (50%) acknowledged that the quantity of available resources had decreased (Figure 52). Thirty-two percent (32%) of respondents likened the decrease to increased pollution, eight percent (8%) identified drought/reduced rainfall and six percent (6%) were unsure. The remaining respondents had no response (Figure 53).

Figure 52 - Percentage Distribution of Respondents Views on the Overall Quantity Availability of Resources

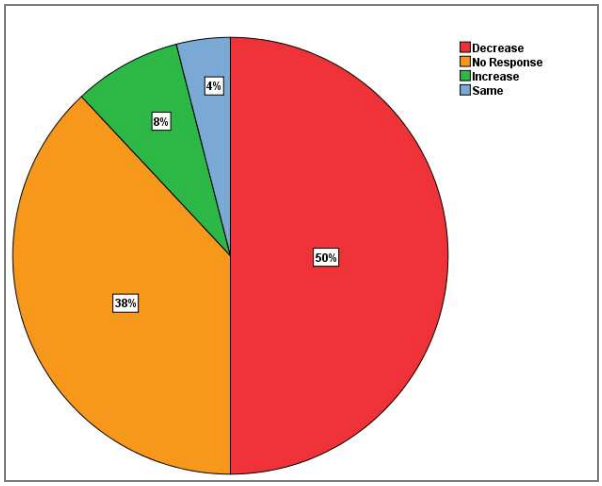
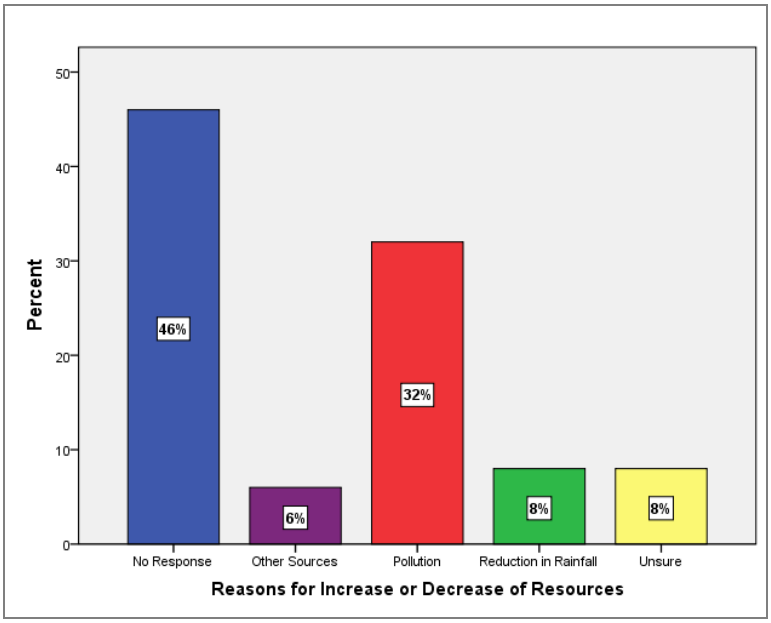


Figure 53 - Respondents Views on Reasons for Potential Change in Resource Availability (Percentage)



Pollution: Major Threats and Sources

When asked about the pollution of natural resources within their community, fifty-four percent (54%) of all respondents conceded that the natural resources within the project area were being affected by pollution. This compares to the twenty-four percent (24%) who indicated that the resources were not being threatened by

pollution, and a further four percent (4%) of respondents indicating they were unaware of any type of pollution affecting the resources (Figure 54).

Thirty percent (30%) of all respondents (or approximately fifty-six percent (56%) of respondents who indicated that natural resources were being polluted), identified the Appleton Estate as the major polluter. Effluent from the factory was noted as the main polluting agent. The indiscriminate dumping of solid waste by community members was said to be the major source of pollution by twenty-two percent (22%) of the total respondents or forty-one (41%) of persons who acknowledged pollution threats to resources. Farming activities was the only other pollution threat identified by the persons surveyed (Figure 55).

Figure 54 - Respondents Views on Pollution Threats to the Black River

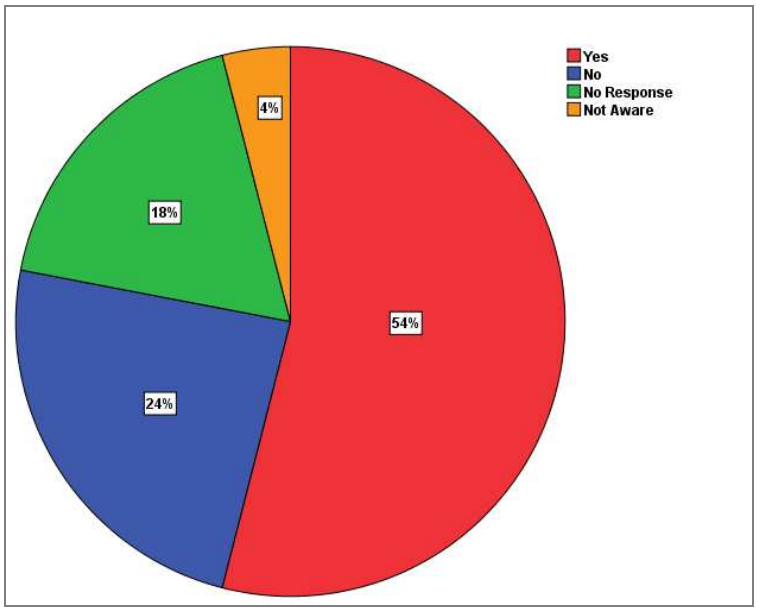
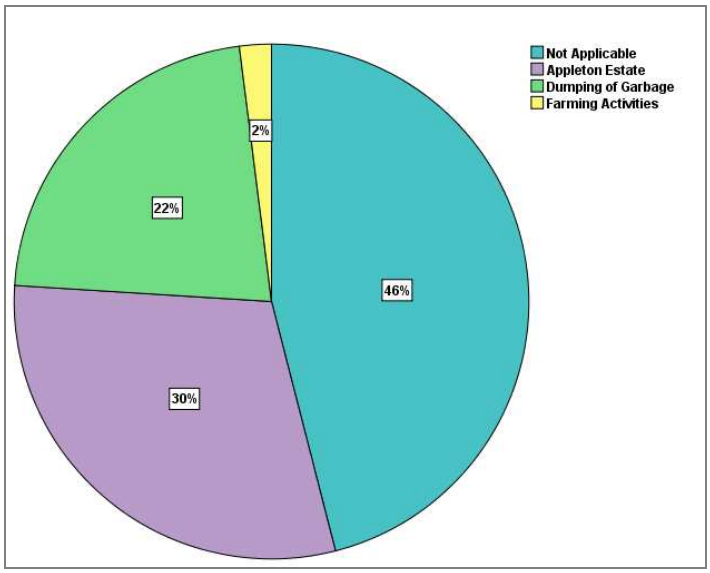


Figure 55 - Pollution Sources Threatening the Black River



13.0 Assessment of Impacts: Community Perspective

The following information has been derived from the survey of persons conducted within a 2 km radius of the proposed expansion to the hydropower plant site at Maggotty, St. Elizabeth. Discussed below are the major issues that have emerged from the survey, i.e. potential negative impacts of the project, but also the positive impacts the project is expected to have from the point of view of community stakeholders.

13.1 Knowledge of Uses of Hydropower Plants and Project Awareness

Seventy percent (70%) of the total number of persons surveyed were able to accurately explain the uses/function of a hydropower plant (Figure 56). All respondents indicated knowing that a hydropower plant existed within or close to their community. Sixty percent (60%) of respondents were however unaware that the Jamaica Public Service Company was in the process of expanding the existing hydropower plant at Maggotty. For the forty percent (40%) of respondents that had some knowledge about the proposed project, the vast majority had heard about the project from a friend or 'word-of-mouth' (Figure 57). Fifty-five percent (55%) of persons aware of the project had heard via 'word-of-mouth, thirty percent (30%) from a JPS employee and fifteen percent (15%) via the print media, television and radio.

Figure 56 - Respondents Knowledge on the Functions of a Hydropower Plant (Percentage)

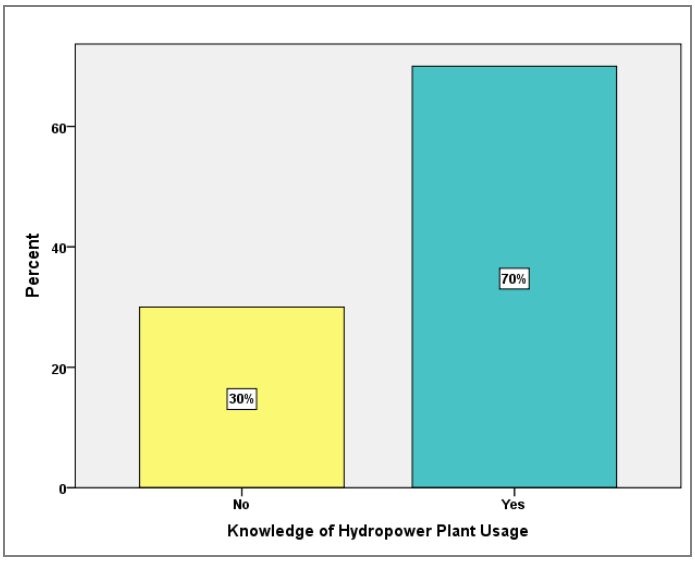
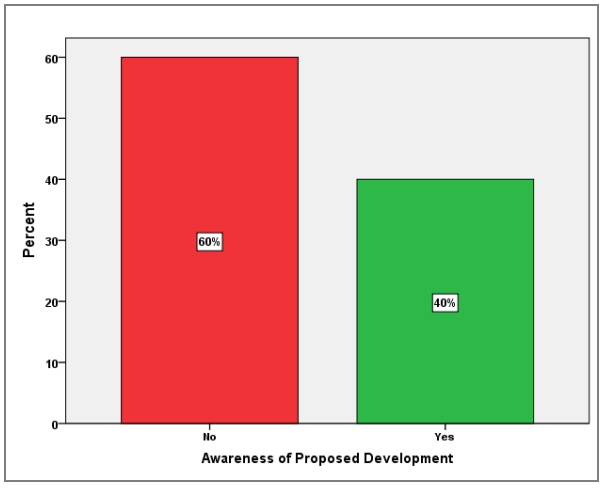


Figure 57 - Percentage Breakdown of Respondents Awareness about the Proposed Project



13.2 Potential Positive Impacts

Respondents were generally enthusiastic about the proposed project and felt it would prove beneficial to both their community and the country in the long-term. In fact, seventy percent (70%) of all respondents described the project as a 'good thing' or the 'best move' the Jamaica Public Service could make in helping to deliver better quality service to their customers. With ninety-six percent (96%) of persons indicating that they valued something positive about their community, the hydropower project as described by one respondent, would only seek to enhance and

support the development of an otherwise 'decent' community. This view point was reflected in the responses given by persons who were surveyed, as ninety-four percent (94%) of respondents felt the project would lead to an overall positive impact on their community.

The following were identified by community members surveyed as the potential positive impacts they anticipate from the proposed project:

1. **Job Opportunities**: Eighty percent (80%) of all respondents felt there would be employment opportunities for workers in the community that would be provided via the implementation of the project. Fifty-six percent (56%) of respondents acknowledged that there were not sufficient job opportunities within their community and therefore a project of this nature would provide, at least short to medium term opportunities for community members, especially the younger members of their respective communities.

2. **Promote and Support Rural and Community Development**: More than seventy-percent (70%) of the total number of persons surveyed felt the project would help to develop their community, through the introduction of job opportunities, as well as improvement to existing utility infrastructure. This they noted was a step in the right direction in helping to promote long-term sustainable rural development. Respondents noted that rural areas were more or less neglected, with little development activities taking place in these areas. This project was therefore seen as a 'step in the right direction' as noted by one respondent.

3. **Reduction in Electrical Bills**: An overall reduction in electricity charges (bills) was identified as the one of the most important benefits for persons within the community. More than fifty percent (50%) of respondents indicated that they expected electricity service costs to be reduced with the implementation of the project, and that consumers should see some form of savings or direct benefits passed on to them. Persons were more or less accepting of the fact that the benefits would be seen over the long-term.

4. **Increase Reliability of Electrical Service/Supply**: Improvement in their electrical supplies and less disruption to their service is one of the positive impacts respondents associated with the proposed project. Approximately sixty percent (60%) of the total number of surveyed persons believed that the project would result in an overall improvement in the services offered by the JPS.

13.3 Potential Negative Impacts

Though only two percent (2%) of respondents felt the project would have an overall negative impact on their community, concerns were raised about the potential negative impacts the project could have on the community. The following were the potential negative impacts identified by community members:

1. **Exploitation of Water Resources:** Though only forty-two (42%) of respondents indicated using the water resources of the Black River, approximately sixty percent (60%) of respondents felt the project would result in the reduction of water levels within the river, reducing the available quantity to community members. This was also a concern for business establishments, such as the Apple Valley Park, that depended on the River to support its business functions. The establishment which provides employment to locals and provides financial support to the communities within the Maggotty area is considered a vital social and economic support for the area.

2. **Migration or Influx of Project Workers**: the influx of workers from outside the community to work on the project was a major issue of concern for respondents. With more than eighty percent (80%) of respondents indicating one of the benefits to be had from the project would be the provision of employment opportunities, persons were sceptical about the widespread use of locals on the project site. Respondents generally felt that locals, where the skills were available, were to be given first preference for jobs related to the implementation of the project. However many noted that in the past, jobs for locals were promised, but never materialised, as workers were always brought in, leaving very little opportunity for locals.

3. **Destruction of the Physical Environment**: Respondents were not overly concerned about physical environmental damage, though the issue was raised by thirty percent (30%) of the total number of persons surveyed. Persons seemed more interested about the water levels and how the project would affect their farm lands.

14.0Identification of Environmental Impacts

The purpose of this task is to identify the major environmental and socio-economic impacts of the construction and operation associated with the expansion of the Maggotty Hydropower Plant by an additional 6.4 MW. Adverse impacts need to be identified so that alternative approaches and/or mitigation measures can be implemented. Positive impacts are also noted as this provides justification for the project.

The main activities to be undertaken for this project include:

- Construction Phase
  - Removal of existing wood stave penstock
  - Land clearing for pipe laying
  - Transportation of heavy duty equipment, turbine parts, pipelines and construction material
  - Operation of heavy duty equipment
  - Fuel storage and dispensing for heavy duty equipment
  - Stockpile of pipelines and construction material
  - Commissioning
- Operation Phase
  - Turbine operation
  - Maintenance
- Decommissioning

14.1 Adverse Impacts associated with the Proposed Project

The aspects associated with each of these activities that can cause adverse environmental and social impacts are presented in Table 19.

Table 19 – Project Activities and Associated Aspects

	ACTIVITY	INPUTS	ASPECTS
1.	Construction & demolition • Extension of weir at intake works • Removal of existing wood stave penstock	• Labour • Heavy duty equipment • Fuel	• Sewage • Noise • Vehicular emissions • Use of fuel • Fuel/oil spills • Construction & demolition work • Solid waste (construction debris, wood, steel straps & vegetation)
2.	Transportation of heavy duty equipment, pipeline and construction	• Labour • Trucks • Fuel • Material	• Noise • Fugitive dust emissions • Vehicular emissions • Use of fuel

	ACTIVITY	INPUTS	ASPECTS
	material		• Increased traffic movement
3.	Land Clearing, excavation and laying of pipes	• Heavy duty construction equipment • Fuel • Labour • Land • Water (for construction and welfare) • Construction material (sand & pipelines)	• Noise • Fugitive dust emissions • Vehicular emissions • Use of fuel • Fuel/oil spills • Use of water • Solid waste (top soil, vegetation, construction debris, garbage) • Sewage • Soil erosion • Construction work • Removal of vegetation
4.	Fuel storage and dispensing for heavy duty equipment	• Storage tanks/drums • Fuel	• Spills
5.	Stockpile of material	• Material (sand & pipelines)	• Fugitive dust • Erosion
6.	Hydro plant operations	• Water • Turbines • Labour	• Use of water (diversion of water from the river) • Noise • Land use • Sewage
7.	Maintenance	• Equipment • Labour • Lubricating Oil • Fuel	• Solid waste • Fuel/oil spills • Sewage • Maintenance work • Vehicular emissions • Use of fuel
8.	Decommissioning	• Equipment • Labour • Fuel	• Solid waste • Noise • Fuel/oil spills • Sewage • Vehicular emissions • Use of fuel • Demolition work

The environmental and social impacts associated with the activities and aspects are presented in summary in Table 20 and discussed in detail at Section 14.2 for each phase of the project.

Table 20 - Some Potential Negative Impacts of the Project

	ASPECT	POTENTIAL NEGATIVE IMPACTS
Construction phase		
1.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
2.	Fugitive dust emissions	• Air pollution • Respiratory problems
3.	Vehicular emissions	• Air pollution • Respiratory problems
4.	Solid waste (top soil, vegetation, construction debris, wood, steel straps, garbage)	• Land and water pollution
5.	Sewage	• Land and water pollution
6.	Use of fuel	• Depletion of (oil) resources
7.	Removal of vegetation	• Habitat destruction • Disruption of ecosystems
8.	Soil erosion	• Water pollution - Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil
9.	Construction work	• Accidents causing death or injury
10.	Increased traffic movement	• Traffic congestion • Motor vehicle accidents
11.	Use of water	• Depletion of water resources
12.	Fuel/oil spills	• Land and water pollution
Operation Phase		
1.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
2.	Diversion of water	• Reduction in stream flow • Disruption to aquatic ecosystems • Affects dissolved oxygen in water
3.	Sewage	• Land and water pollution
4.	Land use	• Affects land use in the area
Maintenance		
1.	Use of fuel	• Depletion of resources
2.	Oil spills/leaks	• Land and water pollution
3.	Solid waste	• Land and water pollution

	ASPECT	POTENTIAL NEGATIVE IMPACTS
4.	Vehicular emissions	• Air pollution • Respiratory problems
5.	Maintenance work	• Accidents
6.	Sewage	• Land and water pollution

14.2 Potential Adverse Impacts – Construction

1. Air pollution

It is anticipated that during the site development and construction phase that air quality could be adversely affected by dust generated from land clearing associated with the following activities:

- the removal of the existing wood stave penstock which is located above ground
- creating access to staging sites for the storage of pipes and other material for pipe laying
- excavation of trenches to lay the pipes
- sand stockpiles (used for pipe bedding)

These activities may increase the volume of fugitive dust at the project site. There are no residents within the vicinity of the pipeline so this impact can be considered negligible and it will short term and can be mitigated.

The use of heavy duty vehicles and equipment fuelled by diesel is expected to result in an increase in vehicular emissions during the construction phase of the project. Diesel emissions contain over 40 different components identified as being toxic, e.g. carbon dioxide, nitrogen oxide, sulphur dioxide etc. In addition to causing air pollution, vehicular emissions contain greenhouse gases, a contributor to global warming. While there are no vehicular emission standards, one criterion for motor vehicle fitness is that there are to be no visible emissions. This negative impact will be short term.

2. Loss of flora and fauna

Construction activities associated with pipe laying can alter ecosystems through the clearing of vegetation. These changes can lead to habitat loss and fragmentation for forest-dependent species.

For this project, limited land clearance will be required if the pipeline is laid above ground as it will be in the footprint of the wood stave penstock that will be removed. If the pipeline is laid underground, the footprint will be wider than the existing one and there would be more vegetation removed.

There will also be three (3) staging areas, one of which will require the removal of vegetation.

The project site is already highly disturbed due to the presence of the existing pipeline and other anthropogenic activities. Therefore the project will not noticeably alter the flora in the area. Additionally, few if any trees will be removed so nesting and feeding sites for birds will not be disturbed.

3. Loss of soil

Loss of soil from erosion can occur as a result of tree and vegetation removal and from excavation. Measures can be implemented to minimise this impact.

4. Nuisance noise and hearing impairment

The areas in which the pipeline will be constructed are rural. Due to the proximity of the pipeline to the main road in some locations the noise levels periodically increase due to passing vehicles.

The baseline noise levels within the area are indicated in Table 21. A Quest 2100 Sound Level meter was used for measurements. The calibration certificate is at Appendix 5.

Table 21 - Ambient Noise Level in Project Area

Location # & Name	dBA	Remarks
286 Maggotty Hydropower intake works	62.6 average 63.0 maximum	Sound level is as a result of the Black River flowing over the weir at the existing intake works
292 Bridge crossing	44.0 average	
	51.0	With motor vehicles passing on the road
293 Pipeline passes under footbridge	39.0 average	
	62.0	With motor vehicles passing on the road
295 Power Plant	46.4 average	-

The use of heavy duty equipment for land clearing and pipe laying as well as the dismantling of the existing wood stave penstock will cause an increase in the ambient noise at the project site. The additional noise within the area caused by construction activities will be minor and temporary. There are no nearby residents. The area is sparsely populated and no one should be adversely affected. While truck traffic will likely increase the nuisance noise in the area, there are no residents that will be

affected, the nuisance noise is expected to last for only the duration of the construction period and it is likely to be intermittent.

Persons working on the site are likely to be impacted by the noise from construction related activities. Mitigation measures can be instituted to reduce/eliminate the impact of noise on workers.

Jamaica's noise standards do not suggest any guidelines for these land uses (Table 22).

Table 22 - National Noise Standards

	Jamaica NRCA 1999 Recommended		World Bank (IADB) Thermal Power Guidelines for New Plants (1998)	
	dBA		dBA	
Zone	7 a.m. – 10 p.m.	10 p.m. – 7 a.m.	7 a.m. – 10 p.m.	10 p.m. – 7 a.m.
Industrial	75	70	70	70
Commercial	65	60	70	70
Residential	55	50	55	45
Silence	45	40	-	-

5. Traffic Congestion and Motor Vehicle Accidents

There will be increased truck traffic associated with the delivery of equipment, pipes and construction materials and the removal of the dismantled penstock. The increased vehicular movement will be intermittent and will last for the duration of the construction phase.

The project sites including the pipeline, the staging areas and the hydropower plant are accessed from one major roadway, the Rice Piece Main Road. This roadway is used primarily by private vehicles, taxis, commercial and public vehicles such as delivery trucks moving between Lacovia, Newton, Maggotty and Siloah. There are few if any pedestrians and the road does not have a sidewalk.

There is the potential for increased motor vehicle accidents.

6. Land and Water Pollution

The following aspects could cause land and water pollution:

- Fuel spills from fuel storage and dispensing
- Inappropriate disposal of solid waste which will consist of:
  - Soil from land clearing and excavation

  - A significant quantity of solid waste consisting of wood and metal straps from the removal of the wood stave penstock
  - Garbage associated with administrative and welfare activities
  - Packaging waste
  - Construction debris
- Inappropriate disposal of sewage
- Sediments in storm water from land clearing, erosion and aggregate stockpiles

The Black River runs close by the construction activities. Mitigation measures can be implemented to guard against water and land pollution from the construction activities.

Disposal of wood from woodstave penstock

Woodstave pipelines require special disposal since the wood of these pipes has been preserved using a mixture of wood and coal tar creosote. Recommended options include disposal in a sanitary landfill and burning in an industrial incinerator.

Coal tar creosote is the most widely used wood preservative in the United States. It consists of a thick, oily liquid typically amber to black in colour. These products are mixtures of many chemicals created by burning beech and other woods or coal, or from the resin of creosote bushes. According to the ATSDR[3] Department of Health and Human Services, coal tar creosote is released to water and soil mainly as a result of its use in the wood preservation industry. Coal tar creosote may dissolve in water and may move through the soil to the ground water. Once it is in the ground water, it may take many years for it to breakdown. Coal tar creosote can build up in plants and animals.

Burning releases the carbon sequestered in the wood, as well as the remaining chemical preservatives into the atmosphere. Burning Coal tar-treated wood, for example, releases copper, chromium, and arsenic into the atmosphere. The amount released is dependent on the temperature at which the wood is burned.

JPS will store the components of the dismantled woodstave penstock on their property in a secure enclosed facility with a concrete paved floor. The wood and the metal hoops will be used to repair woodstave penstocks at other locations.

7. Depletion of oil resources

Fuel is essential to operate construction equipment and to transport material and equipment to the site. The contribution to depletion of oil resources is negligible.

[3] ATSDR - Agency for Toxic Substances and Disease Registry, based in Atlanta, Georgia, is a federal public health agency of the U.S. Department of Health and Human Services.

8. Depletion of water resources

The quantity of water used for construction will be small and will not contribute to depletion in water resources. Water will be trucked to the site by a contracted service. Water is essential for construction activities and welfare facilities (drinking water and sanitation).

9. Construction related accidents

Where construction work is being done, the potential exists for accidents. Measures can be instituted to eliminate or minimise these potential impacts.

14.3 Potential Adverse Impacts - Operation Phase

1. Diversion of water for the hydropower plant

The use of water as an energy source is non-consumptive and does not contribute to the depletion of resources. Potential adverse impacts from the operations of hydro power plants associated with the diversion of water include disturbance to the aquatic ecosystem, changes in water quality and stream flow. These changes are however associated with the construction of dams.

The proposed SHP project involves the extension of an existing weir. Weirs unlike dams are a feature of 'run of the river' designs which pose negligible disruption to aquatic resources and have no adverse impact on water quality and stream flow.

This project poses no additional effect on the aquatic ecosystem, water quality and stream flow of the Black River in the vicinity of Maggotty. The current ecosystem is well established since the construction of the hydropower station in the late 1950s about 60 years ago.

2. Nuisance Noise

There will be no increase in the baseline noise which currently exists at the site due to the expansion of the hydropower plant.

3. Land and water pollution - Sewage

The intake works does not have an operator stationed there and the hydro power plant has bathroom facilities for the operator. The existing arrangements for sewage disposal will remain and additional sanitary conveniences will be constructed as a part of the new section of the hydro power plant. The sewage system is designed for 2-3 operators and will be a septic tank and absorption pit system similar to what already exists.

4. Land Use

The land use will not change as a result of the expansion project. However it may be more aesthetically pleasing if the new pipeline is laid underground where it will not be visible.

14.4 Potential Adverse Impacts – Maintenance

1. Depletion of oil resources

Fuel is essential for maintenance and decommissioning activities and its contribution to resource depletion is negligible.

2. Land and water pollution

The following aspects could cause land and water pollution during maintenance:

- Fuel/oil spills from fuel storage and dispensing
- Inappropriate disposal of solid waste
- Inappropriate disposal of sewage

Maintenance associated with the penstock will be limited based on the type of pipeline used. The maintenance activities associated with the expanded hydro power plant will be similar to what currently obtains. Oil for lubricating mechanical parts will be used in small quantities and therefore will not pose a significant threat to the environment. Solid waste will likely consist of electrical and mechanical parts and garbage.

3. Air pollution

Maintenance activities are likely to be centred around the hydro power plant as the penstock will not require much maintenance. No fugitive dust emissions are expected and vehicular emissions will not be above what normally exists during operations.

4. Accidents

Employees and maintenance personnel will work in accordance with JPS's Health Safety and Environment policy. This means that appropriate safety measures will be observed during maintenance activities which will reduce their likelihood of occurrence.

14.5 Decommissioning

This project is designed for a life of 100 years. It is expected that the best approach to decommissioning this facility will be determined in the future. As such no specific decommissioning plan will be outlined as a part of this assessment.

15.0 Significant Environmental and Social Impacts

Negative impacts are undesirable, but not all negative impacts are equal. There are some that are considered significant based on a number of criteria. This section determines the significance of each impact according to the specific criteria presented at Table 23. The significant impact determination is presented at Table 24.

Table 23 - Significant Impact Assessment Criteria

CRITERIA	Minor	Moderate	Severe
Scale - takes into consideration the spatial/ geographic extent of the impact	On site or within project site boundaries	Beyond site boundary but within community/local area around project site (2 km)	Widespread or at a regional//national/inter national scale
Duration is the overall length of time an identified impact is likely to persist	Short term (less than 5 years); less than project lifespan; quickly reversible	Medium-term (5-15 years), over the lifespan of the project; reversible over time	Long-term (more than 15 years); permanent; irreversible
Intensity (Baseline Change) examines the severity of the impact on the physical, biological and socio-economic baseline of the project area and examines the change from the pre-project or current baseline conditions	Disturbance of degraded areas, with little conservation value Minor change in species occurrence or variety Limited or no adverse change to the baseline status of social, economic and environmental receptors	Moderate disturbance of areas that have potential conservation value Complete change in species occurrence Disturbance of community's environmental, social and economic fabric Potential conflict with community's development plans	Significant adverse environmental impacts (quality of land, air and water resources) Widespread disturbance of community's social and economic fabric Substantial increase in solid waste generation, increase in potential for erosion, flooding or leaching. Removal and or destruction of large quantities of flora and fauna, including endangered or threatened species; substantial interference with the movement of migratory species

CRITERIA	Minor	Moderate	Severe
Affected Numbers takes into account the number of individuals or receptor population (organisms, people etc.) that stand to be affected by the project	<5% of the population or habitat is directly exposed	5-10% of the population or habitat is directly exposed	>10% of the population or habitat is directly exposed
Secondary Effects considers the indirect effects of the project	Few indirect impacts	Moderate amount of indirect impacts	Substantial amount of indirect impacts (generational impact)
Reversibility evaluates the extent to which the affected receptor can be returned to its pre-project state after experiencing an adverse impact	Completely reversible (0-5 years); not costly	Reversible (5-15 years); may or may not be costly	Irreversible (damage cannot be reverted to original condition within a 50-100 year period)
Acceptability takes into account the willingness of stakeholders to make trade-offs, given the potential benefits of the project, limited environmental changes or the ability to mitigate adverse impacts	No risk to public health. Modification of landscape without down grading special social, economic and aesthetic values Within legal thresholds and allowable limits Some loss of biological populations and habitats	Conflict with policies or land-use plans Loss of populations of commercial biological species Community stakeholders willing to make trade-offs Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	Large scale loss of productive capacity of renewable resources Increases level of risk to public health Project needs to be redesigned Extinction of biological species, loss of diversity, rare or endangered species and critical habitats Legal thresholds and allowable limits exceeded/ breached Can lead to widespread public outcry

Table 24 - Significant Impact Determination

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		Construction phase	
1.	**Fugitive dust emissions & Vehicular emissions** • Air pollution • Respiratory problems	SCALE - Local area DURATION - Temporary for the duration of construction INTENSITY (BASELINE CHANGE) - No adverse change to baseline status of economic, environmental and social receptors AFFECTED NUMBERS - Potential to affect workers on site; no residents nearby SECONDARY EFFECTS - If excessive could cause respiratory problems for workers REVERSIBILITY - Reversible ACCEPTABILITY – Within legal limits and allowable thresholds; acceptable once mitigation measures are employed	**NO**
2.	**Noise** • Habitat disturbance • Hearing impairment for workers (temporary, permanent)	SCALE - On-site, within project boundaries DURATION - Short term – for duration of construction INTENSITY (BASELINE CHANGE) - No adverse change to baseline status of economic, environmental and social receptors AFFECTED NUMBERS - No one lives near to the project site; workers could potentially be affected The area is disturbed so there is minimal impact on habitat SECONDARY EFFECTS - Not applicable REVERSIBILITY - Not applicable ACCEPTABILITY - Within legal limits and allowable thresholds; acceptable as noise levels should be low and only for the duration of the construction phase	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
3.	**Solid waste (top soil, vegetation, construction debris, wood, steel, garbage)** • Land and water pollution	SCALE - Local area DURATION - Temporary for the duration of construction INTENSITY (BASELINE CHANGE) – Due to the large quantity of wood and steel that will be generated, there is the potential for (a) Moderate disturbance of areas that have potential conservation value (b) Disturbance of community's environmental, social and economic fabric AFFECTED NUMBERS - 5-10% of the population or habitat is directly exposed SECONDARY EFFECTS - Stockpiled solid waste may become an aesthetic and sanitation problem REVERSIBILITY - Reversible ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	**YES**
4.	**Land clearing and excavation** • Loss of habitat; disruption of ecology	SCALE - Local area DURATION - Temporary for the duration of construction INTENSITY (BASELINE CHANGE) - No adverse change to baseline status of economic, environmental and social receptors AFFECTED NUMBERS - Negligible SECONDARY EFFECTS - N/A REVERSIBILITY - Reversible ACCEPTABILITY - Within allowable thresholds; acceptable once mitigation measures are employed	
5.	**Use of fuel** • Depletion of (oil) resources	SCALE - National/international scale as an imported non-renewable energy source is being used DURATION - Short term, for the duration of the project	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		INTENSITY(BASELINE CHANGE) - No adverse change to the baseline status of social, economic and environmental receptors; contribution to global depletion of resources is negligible AFFECTED NUMBERS - Contribution to national and global demand is negligible SECONDARY IMPACTS - Contributes to greenhouse gas emissions; air pollution; to high fuel bill and foreign exchange demand REVERSIBILITY - Permanent ACCEPTABILITY – Within allowable thresholds, acceptable given the type of project; no alternatives available	
6.	**Sewage** • Land and water pollution	SCALE - Onsite within project site boundaries land pollution can occur; potential threat to water resources as the river runs nearby DURATION - Short term, for the duration of the project INTENSITY - Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS - <1% of the population or habitat will be directly exposed SECONDARY IMPACTS – Possible foul odours; may attract rodents and flies REVERSIBILITY - Quantity of sewage small, land pollution reversible naturally over time ACCEPTABILITY – Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	**NO**
7.	**Removal of vegetation** • Habitat destruction	SCALE - Onsite, within project site boundaries; specific areas along existing pipeline to facilitate pipe laying and	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
	• Disruption of ecosystems	for one of the 3 staging areas; acreage of permanently cleared land is negligible DURATION - Short term, for duration of project INTENSITY - Minor change in species occurrence or variety; limited or no adverse change to the baseline status of social, economic and environmental receptors. AFFECTED NUMBERS - <1%; no residents will be affected as no one lives within or near to the project site; the effect on vegetation will be negligible as there are only a few areas where vegetation will need to be removed to facilitate pipe laying and the project area is highly disturbed SECONDARY IMPACTS - Improved aesthetics if the new pipeline is buried REVERSIBILITY - Areas temporarily cleared will be naturally restored over time, at no cost, that is, natural vegetation from the area will cover those areas cleared. ACCEPTABILITY - Improved aesthetics will be welcomed	
8.	**Soil erosion** • Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil	SCALE – Local; sediments may be transported by storm water beyond the site boundary but within the community/local area around the project site (2 km) to the Black River DURATION - Short term, for duration of project INTENSITY - Minor change in species occurrence or variety; limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS - <1%; the aquatic ecosystem could be impacted temporarily by increased runoff SECONDARY IMPACTS REVERSIBILITY - Reversible ACCEPTABILITY - Projected impacts (environmental,	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	
9.	**Construction work** • Accidents causing death or injury	SCALE - Onsite within project boundaries DURATION - Short term for the duration of the project INTENSITY - Has the possibility to disturb the baseline social receptors AFFECTED NUMBERS - <1%, only construction workers will be exposed SECONDARY IMPACTS – N/A REVERSIBILITY - Death and serious injury not reversible ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	**YES**
10.	**Increased traffic movement** • Traffic congestion • Motor vehicle accidents	SCALE - Local area DURATION - Temporary for the duration of construction INTENSITY (BASELINE CHANGE) - No adverse change to baseline status of economic, environmental and social receptors AFFECTED NUMBERS - <1% SECONDARY EFFECTS – N/A REVERSIBILITY – congestion is reversible; loss of life from accidents is permanent ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	**YES**
11.	**Use of water** • Depletion of water resources	SCALE - Beyond site boundary but within community/local area around project site (2 km)	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		DURATION - Short term for the duration of the project INTENSITY - No adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS - Negligible SECONDARY IMPACTS - N/A REVERSIBILITY - Permanent ACCEPTABILITY – Within allowable thresholds; no alternative, water needed for construction and welfare purposes	
12.	**Fuel and oil spills** • Land and water pollution	SCALE - Onsite (within project site boundaries) land pollution can occur; potential threat to water resources as Black River is situated nearby DURATION - Short term, for the duration of the project INTENSITY - Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS - <1% of the population or habitat will be directly exposed SECONDARY IMPACTS - Unsightly appearance of areas where spills occur; quantities are likely to be small but they may be transported to other locations via storm water; land and water pollution associated with waste disposal REVERSIBILITY - Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	**YES**
		Operation Phase	
1.	**Diversion of water** • Aquatic ecosystem	SCALE - Local	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
	• Water quality • Streamflow	DURATION - Permanent INTENSITY (BASELINE CHANGE) - No adverse change to the baseline status of social, economic and environmental receptors; no additional effect on the aquatic ecosystem of the Black River in the vicinity of Maggotty as the area was already adversely impacted in the late 1950s with the construction of the hydropower station. Also run-of river design has minimal impact on water quality and stream flow. AFFECTED NUMBERS - <1% SECONDARY EFFECTS – N/A REVERSIBILITY - Permanent ACCEPTABILITY - No risk to public health; within legal thresholds and allowable limits; minor modification to landscape without down grading special social, economic and aesthetic values	
2.	**Noise** • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	SCALE - Onsite within boundary of project site DURATION - Long term, permanent; for as long as the hydropower plant is in operation. INTENSITY - No change to baseline noise (prior to expansion). Existing noise levels are well within the acceptable limits. AFFECTED NUMBERS – N/A SECONDARY IMPACTS – N/A REVERSIBILITY – N/A ACCEPTABILITY – Within allowable thresholds	**NO**
3.	**Sewage** • Land and water pollution	SCALE - Onsite within project site boundaries land pollution can occur; potential threat to water resources as the Black River is located nearby DURATION - Permanent INTENSITY - No adverse change to the baseline status	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		of social, economic and environmental receptors. No bathroom facilities are required at the intake works as no operator is stationed at there and bathroom facilities already exist at the Hydro power Plant. New sanitary conveniences will be constructed for the expanded hydro power station. AFFECTED NUMBERS - N/A SECONDARY IMPACTS – Possible foul odours; may attract rodents and flies REVERSIBILITY - Quantity of sewage small, land pollution reversible naturally over time; water pollution negligible ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	
4.	**Land use** • Alteration of development and land use in the area	SCALE - Local area around project site DURATION - Long term, permanent. INTENSITY - No change in existing land ownership rights expected AFFECTED NUMBERS - None SECONDARY IMPACTS -Improved aesthetics if the new pipeline is buried REVERSIBILITY – N/A ACCEPTABILITY - Acceptable use of land based on the benefits to be derived	**NO**
		Maintenance	
1.	**Oil spills/leaks** • Land and water pollution	SCALE – Local, potential for oil leaks and spills will only be at the Hydro power Plant DURATION – Short term, each time maintenance at the power plant is required INTENSITY - No adverse change to the baseline status	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		of social, economic and environmental receptors; quantities are small AFFECTED NUMBERS – N/A SECONDARY IMPACTS - Unsightly appearance of areas where spills occur; quantities are likely to be small but they may be transported to other locations via storm water; land and water pollution associated with waste disposal REVERSIBILITY - Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	
2.	**Solid waste** • Land pollution	SCALE – Local; solid waste will only be generated at the Hydro power Plant DURATION - Permanently INTENSITY - No adverse change to the baseline status of social, economic and environmental receptors; facilities already exist for the management of solid waste; quantities will be small AFFECTED NUMBERS – N/A SECONDARY IMPACTS - Garbage may attract rodents; uncontained garbage can affect aesthetics REVERSIBILITY - Completely reversible at minimal cost ACCEPTABILITY – Solid waste management system already in place	**NO**
3.	**Sewage** • Land and water pollution	SCALE - Onsite within project site boundaries land pollution can occur; potential threat to water resources as the Black River is located nearby DURATION - Permanent	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		INTENSITY - No adverse change to the baseline status of social, economic and environmental receptors. No bathroom facilities are required at the intake works as no operator is stationed at there and bathroom facilities already exist at the Hydro power Plant. New sanitary conveniences will be constructed for the expanded hydro power station. AFFECTED NUMBERS - N/A SECONDARY IMPACTS – Possible foul odours; may attract rodents and flies REVERSIBILITY - Quantity of sewage small, land pollution reversible naturally over time; water pollution negligible ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	
4.	**Maintenance work** • Accidents causing death or injury	SCALE - Onsite within project boundaries DURATION - Short term for the duration of the project INTENSITY - Has the possibility to disturb the baseline social receptors AFFECTED NUMBERS - <1%, only JPS workers will be exposed; type of maintenance is unlikely to be high risk SECONDARY IMPACTS – N/A REVERSIBILITY - Death and serious injury not reversible ACCEPTABILITY - Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	**NO**

15.1 Positive impacts of the proposed project

There is no international consensus on the definition of small hydropower plant (SHP). In China, it can refer to capacities of up to 25 MW, in India up to 15 MW. However, a capacity of up to 10 MW total is generally becoming accepted in Europe and supported by European Small Hydropower Association (ESHA) and the European Commission. The expanded Maggotty Hydropower plant can therefore be classified as small since it will generate 12.4MW of power. A well-designed small hydropower system can blend in with its surroundings and have minimal negative environmental impacts.

Features of SHPs

- Most are run-of-river plants, which do not alter the natural flow regime.
- Due to size any alteration of bedload regime is almost negligible.
- The length of the backwater areas is limited.
- The impoundment caused by SHP is in most cases rather low.

Advantages of SHP include:

- Environmental protection through CO_2 emission reduction
- Proven and reliable technology
- Reduces the dependency on imported fuels
- Improves the diversity of energy supply
- Grid Stability
- Reduced land requirements
- Local and regional development
- Good opportunities for technology export
- Assists in the maintenance of river basins
- Technology suitable for rural electrification in developing countries
- High Energy payback ratio

Table 25 presents the positive impacts of the project for both the construction and operations phases.

Construction Phase

1. Employment Opportunities

The Jamaica Public Service Company plans to employ 150-200 workers during the construction phase of the project. It is anticipated that during the construction phase engineers, architects, construction workers, truck drivers, equipment operators, security guards, surveyors, building contractors and unskilled labour, will all benefit from the project.

Local contractors and workers will be utilised as much as possible. However if the required number of workers or level of expertise cannot be found within nearby communities, then contractors and workers will be sourced regionally, nationally and internationally, in that order of priority.

2. Commercial Activity

The increased income for local residents will likely cause an increase in commercial activity in the nearby towns.

Operating Phase

1. Reduction in greenhouse gas emissions

One of the benefits of electricity production from the hydropower plant is that it does not lead to the emission of greenhouse gases or other noxious emissions as is the case with fossil fuels. Hydropower is a clean renewable form of energy that requires significantly less consumption of natural resources, such as land and water.

2. Reduction in Fuel Consumption and Costs

The constant fluctuation and drastic increases in fuel costs has made it increasingly important for developing and non-producing oil nations to discover and utilise alternative and cleaner energy sources. The largest fuel cost associated with production of electricity from hydropower sources is in the construction phase of the project for the transportation of equipment and construction material and the use of heavy duty equipment. These fuel costs are relatively low and short term in duration. Since no fuel is used to generate electricity from the hydropower plant there is a net reduction in fuel consumption per kW of electricity generated by JPS.

3. Reduction in Electricity costs to Consumers

The expanded hydropower plant will generate 26,000,000 kWh annually and will reduce overall annual fuel cost by US$4M at fuel oil between US$80-90/barrel. The cost reduction in overall energy production will result in a small saving for JPSCo. and also for the consumers.

4. Promotion of Alternative Sources of Energy

Non-producing oil nations have led the charge in developing cleaner and more affordable alternative energy sources to reduce (a) their dependence on foreign oil, (b) the percentage of Gross Domestic Product spent on crude oil (c) reduce greenhouse gas emissions (d) reduce the threats of global warming and (e) develop more sustainable approaches towards conserving limited natural resources.

Climate change is the most serious environmental threat facing the world today and clean renewable energy sources like hydropower are a significant part of the solution. Hydro power can be harnessed safely to generate electricity, without producing any dangerous waste or unwanted by-products.

Table 25 -Positive Impacts of Project

	POTENTIAL BENEFITS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**
		Construction phase
1.	Employment Opportunities Increased commercial activity	SCALE - Regional DURATION - Short-term for contracted workers. This is expected to last for the duration of the construction phase of the project INTENSITY (BASELINE CHANGE) - Opportunities that provide employment to members of the public are viewed as a welcome change to present baseline conditions. Increased commerce in neighbouring communities will result in changes to economic baseline AFFECTED NUMBERS - It is anticipated that 150-200 persons will benefit from employment on the proposed project; some likely to be from neighbouring communities SECONDARY IMPACTS - Increased income earning potential for workers; increased standard of living; increased commercial activities for the duration of the project in neighbouring communities; reduction in unemployment REVERSIBILITY - Short term employment ends after project is completed ACCEPTABILITY - Acceptable, persons are in need of employment
		Operational Phase
1.	Reduction in greenhouse gas emissions	SCALE - Regional/National/International DURATION - Long-term INTENSITY/BASELINE - This is a minor change from current baseline conditions. Jamaica, (as part of the entire Caribbean Region) accounts for 1% of total greenhouse gas emissions globally. The reduction in greenhouse gas emissions locally can however make a small, but meaningful contribution in helping to solve the world's growing climate change problem

	POTENTIAL BENEFITS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**
		AFFECTED NUMBERS - Unknown how many persons or ecological species could benefit, but the impact is expected to be global SECONDARY EFFECTS - Reduced global temperatures (negligible impact); improved local conditions (temperature); improved air quality
2.	Reduction in fuel costs and demand for foreign exchange for the importation of oil	SCALE - National DURATION - Long-term INTENSITY/BASELINE - The reduction in fuel costs and consumption will take place incrementally and will therefore be seen as a minor change from existing baseline conditions. AFFECTED NUMBERS - All members of the population will be impacted either directly or indirectly. SECONDARY EFFECTS - Increased potential to reduce dependency on oil (long-term); increased financial resources for other renewable energy projects
3.	Promotion of use of alternative energy	SCALE - Regional/National/International DURATION - Long-term INTENSITY/BASELINE - This will represent a major change from existing baseline conditions, particularly in developing countries AFFECTED NUMBERS - The entire population stands to benefit from such an initiative SECONDARY EFFECTS - Reduces the percentage of GDP spent on oil imports; reduces the severity of climate change impacts; creates employment opportunities; reduces greenhouse gas emissions

15.2 Summary of Significant Negative Impacts

Table 26 presents a summary of the significant negative impacts associated with the construction, operation and maintenance phases of the project. The significant impacts identified are associated with the construction phase. The operation of the hydro power plant has no significant impacts. In all cases the significant impacts can be mitigated.

Table 26 - Summary of Significant Negative Impacts

	Aspect/Impact	Significant
	Construction phase	
1.	**Fugitive dust emissions & Vehicular emissions** • Air pollution • Respiratory problems	**NO**
2.	**Noise** • Habitat disturbance • Hearing impairment for workers (temporary, permanent)	**NO**
3.	**Solid waste (top soil, vegetation, construction debris, wood, steel, garbage)** • Land and water pollution	**YES**
4.	**Land clearing and excavation** • Loss of habitat; disruption of ecology	
5.	**Use of fuel** • Depletion of (oil) resources	**NO**
6.	**Sewage** • Land and water pollution	**NO**
7.	**Removal of vegetation** • Habitat destruction • Disruption of ecosystems	**NO**
8.	**Soil erosion** • Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil	**YES**
9.	**Construction work** • Accidents causing death or injury	**YES**
10.	**Increased traffic movement** • Traffic congestion • Motor vehicle accidents	**YES**
11.	**Use of water** • Depletion of water resources	**NO**
12.	**Fuel and oil spills** • Land and water pollution	**YES**
	Operation phase	
1.	**Diversion of water** • Aquatic ecosystem • Water quality • Streamflow	**NO**
2.	**Noise** • Nuisance to persons	**NO**

	Aspect/Impact	Significant
	• Habitat disturbance • Hearing impairment (temporary, permanent)	
3.	**Sewage** • Land and water pollution	**NO**
4.	**Land use** • Alteration of development and land use in the area	**NO**
	Maintenance phase	
1.	**Oil spills/leaks** • Land and water pollution	**NO**
2.	**Solid waste** • Land pollution	**NO**
3.	**Sewage** • Land and water pollution	**NO**
4.	**Maintenance work** • Accidents causing death or injury	**NO**

16.0 Hydropower Environmental Mitigation Plan

This project involves the expansion of an existing hydropower plant, the removal of the existing wood stave penstock, the laying of a GRP underground to replace the wood stave penstock, the replacement of the existing surge tank with a larger one and additional infrastructure at the existing power plant to accommodate the increased throughput. Most of the potential environmental impacts will occur during the construction phase. The existing hydropower plant is the run-of-river design, which already has less impact on aquatic ecosystems and water quality.

Negative environmental impacts can be mitigated by implementing measures during the construction, operating, maintenance and decommissioning phases to eliminate or significantly reduce them.

Mitigation measures to address the potential negative impacts, significant or not, associated with this project are presented in Table 27.

Table 27 - Mitigation Measures for Negative Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
	Construction phase	
1.	Fugitive dust emissions & Vehicular emissions • Air pollution • Respiratory problems	• Cover haulage vehicles transporting aggregate, soil and cement • Cover and/or wet onsite stockpiles of aggregate, soil etc. • Ensure proper stock piling/storage and disposal of solid waste • Wet cleared land areas regularly • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. dust masks and ensure that they are worn • Operate well maintained vehicles and equipment
2.	Noise • Hearing impairment (temporary, permanent)	• Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn
3.	Land clearing and excavation • Loss of habitat; disruption of ecology	• Bring to the attention of the Jamaica National Heritage Trust and the NEPA immediately and safeguard • Only clear those areas that are absolutely necessary
4.	Solid waste (top soil, vegetation, construction debris, wood, steel, garbage) • Land and water pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville • Landscape project sites with top soil excavated • Store wood and steel straps in a secure area for use to maintain other woodstave penstocks

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
5.	Sewage • Land pollution	• Use a reputable company to provide portable toilets for workers
6.	Soil erosion • Sediments in storm water runoff	• Only clear top soil from areas to be used • Place berms around stockpiles of top soil • Avoid steep cuts and where there are steep cuts they must be shored up • Utilise sediment traps to minimise sediment runoff to the river
7.	Construction work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures
8.	Increased traffic movement • Traffic congestion • Motor vehicle accidents	• Erect signs along main transportation route and in sensitive areas such as schools • Transport heavy equipment and pipelines during off-peak traffic hours (between (2:00 to 4:00 a.m.) with police outriders • Trucks transporting construction material should be advised to comply with the speed limits
9.	Fuel and oil spills • Land and water pollution	• Store fuel with secondary (spill) containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices
	Maintenance	
1.	Solid waste • Land pollution	• Contain garbage and waste from maintenance activities and dispose of at the approved municipal disposal site at Myersville
2.	Sewage • Land and water pollution	• Use a reputable company to provide portable toilets for workers
3.	Maintenance work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures
4.	Fuel and oil spills • Land and water pollution	• Store fuel with secondary (spill) containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices

17.0 Hydropower Analysis of Alternatives

There are three alternatives to the project:

1. "do nothing" alternative
2. wind turbines
3. other hydro power projects

The "do nothing" alternative is not an option in light of the rationale for the project.

Other renewable energy projects that JPS has either explored or undertaken include:

- 3 MW Wind Farm at Hermitage St. Elizabeth which was commissioned in September 2010
- 8 MW Great River Hydro project which is currently the subject of a feasibility study

This expansion project at the Maggotty Hydropower plant is a complementary project rather than an alternative. It will be a cost effective undertaking as most of the infrastructure is already in place and the stream flow can accommodate the expansion. Also since the plant will be out of service for the replacement of the wood stave pipe to the Glass Reinforced Pipe, it is an opportune time for the expansion to be done.

Alternative pipelines

JPS proposes to use a GRP (fibreglass) water conductor because of its ease of installation along the existing right of way, which in some places is located in narrow cut sections, and because of its low maintenance requirements compared with a wood stave pipe. Other materials were considered in previous studies and it was concluded that either the standard diameters were not available in the range of diameters required for the new pipeline or substantial civil costs would be incurred in laying the pipe in the existing right of way.

Alternative pipeline installation

The pipeline could be installed below or above ground. The pros and cons are presented below in Table 28.

Table 28 - Pros and Cons of Below and above ground pipeline installation

		Pipeline below ground	**Pipeline above ground**
1.	Habitat disturbance	More disturbance during construction as the pipeline footprint is larger	Less disturbance during construction as the pipeline footprint is smaller. It would merely be a replacement of what existed before.
2.	Construction Costs	Higher cost for pipe laying due to: • excavation required and • shoring up of the sides of the excavated areas to prevent collapse	Lower costs

		Pipeline below ground	**Pipeline above ground**
3.	Maintenance Costs	Although unlikely, pipe ruptures would require excavation of the pipeline.	Requires a chemical additive (tinuvin) to protect pipes against UV rays only for long-term aesthetic purposes. As a GRP pipe is an inert composite, UV rays do not affect the structural body of the pipe but it causes its external layer to turn into a yellow-brown colour in the long term. Tinuvin could increase the cost (per meter) of the pipe in approximately 1.5%.
4.	Security	More secure	While unlikely, the pipeline could be vandalized

18.0 Environmental Health and Safety (EHS) Management and Monitoring Plan

Safety

In accordance with JPS's health and safety plan, the Contractor executing the installation of the wind turbines must provide JPS with a detailed Safety Programme for the project. JPS's acceptance of the Safety Programme will not in any way relieve the Contractor of full and complete responsibility for the safety of its operations.

The Contractor's written Health & Safety Plan must, as a minimum, address the JPS's safety requirements.

JPS Safety Rules

The contractor shall comply with safety rules and regulations that are enforced at the site in accordance with international safety standards such as Occupational Health and Safety Administration (OHSA) and the provisions of the draft Jamaica Occupational Safety and Health Act (JOSHA).

a. The contractor shall be solely responsible for the safety of his subcontractor's employees. It is mandatory that all personnel required to perform work at the site be fitted with approved PPE such as safety helmet, glasses and boots at minimum while on site. Additional PPE must be worn based on the hazards identified. Failure to comply with this request will result in the expulsion of the offending individual(s) from the site. A pre-start site conference meeting on safety will be held by JPS to advise the contractor of the safety standards and requirements expected.
b. The contractor shall promptly correct any unsafe conditions brought to his attention.
c. In the event of an accident, the contractor shall provide JPS with a written report of all pertinent details of the accident within twenty-four (24) hours of its occurrence. This report shall include recommended actions to prevent future occurrence.
d. The contractor shall provide protection and storage for his equipment, general property, vehicles and personnel during all phases of the work.
e. The contractor shall be responsible for his sub-contractors' compliance with safety regulations.
f. The contractor shall provide a first-aid station and people who can administer first aid on site.
g. The contractor shall ensure that his on-site work force is fully equipped with the required safety gears, e.g. hats, boots, gloves, overalls, goggles, equipment for working at high elevations etc.

Environmental Monitoring and Management Plan

The Environmental Monitoring and Management Plan (EMMP) will guide JPS on the contractual obligations that it must have in place with the EPC contractor who is working on their behalf. JPS is still ultimately responsible for the project and to prevent and minimise adverse environmental and social impacts associated with the project.

JPS will have to monitor the contractor to ensure that contractual requirements related to environmental management and monitoring are implemented. There will be some aspects of the project that JPS will have to monitor and manage themselves. Many of the contents of the EMMP will likely be conditions of the permit from NEPA for this project.

The EMMP is presented at Table 29.

Table 29 - Environmental Monitoring and Management Plan

	Management Plan	Monitoring Programme
	Construction phase	
1.	Fugitive dust emissions & vehicular emissions • Cover haulage vehicles transporting aggregate, soil and cement • Cover onsite stockpiles of aggregate, cement, soil etc. • Ensure proper stock piling and disposal of solid waste • Wet cleared land areas regularly to control fugitive dust • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. dust masks and ensure that they are worn • Operate well maintained vehicles and equipment	• JPS is to ensure that the contractor implements the required mitigation measures by conducting periodic audits • The Contractor's monthly report to provide details of the mitigation measures implemented
2.	Noise • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn	• The Contractor's monthly report to provide details of the mitigation measures implemented
3.	Solid waste (top soil, vegetation, construction debris, wood, steel, garbage) • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville • Landscape project sites with top soil excavated • Arrange for the incineration of the wood from the removal of the penstock	• JPS is to obtain verification that the contractor has disposed of solid waste at an approved municipal disposal site • The Contractor's monthly report to provide details of the mitigation measures implemented • Arrangements for the incineration of wood from the penstock must be in place prior to its removal. Arrangements must include the temporary stockpiling of the wood and the transportation to the incineration site.
4.	Sewage • Contract a reputable company to provide portable toilets for workers	• JPS is to verify that waste is being taken to an approved wastewater treatment facility

	Management Plan	Monitoring Programme
5.	Soil erosion • Place berms around stockpiles of excavated soil and aggregate • Shore up excavations if pipeline is to be buried	• JPS is to conduct periodic audits of contractor operations • The Contractor's monthly report to provide details of the mitigation measures implemented
6.	Construction work • Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures	• Conduct periodic audits of contractor operations • The Contractor's monthly report to provide details of the mitigation measures implemented
7.	Increased traffic movement • Erect signs along main transportation route and in sensitive areas such as schools • Advise contractor of the need to their drivers are to obey speed limits • Transport heavy equipment and pipelines during off-peak traffic hours (between 2:00 to 4:00 a.m.) with police outriders	5. The Contractor's monthly report to provide details of the mitigation measures implemented
8.	Fuel and oil spills • Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site	• JPS is to conduct periodic audits of contractor operations • The Contractor/JPS is to respond and clean up spills in accordance with emergency preparedness and response plans • The Contractor is to report to JPS on emergencies • JPS is to report to NEPA in accordance with permit requirements • The Contractor's monthly report to provide details of the mitigation measures implemented

Reporting

During the construction phase:

1. The contractor will submit monthly reports to JPS outlining work progress including environmental mitigation measures that must be implemented, accidents, incidents requiring activation of the emergency response plans and breaches in environmental requirements, if any.
2. JPS will submit monthly reports to NEPA outlining work progress including environmental mitigation measures that must be implemented, accidents, incidents

requiring activation of the emergency response plans and breaches in environmental requirements.

During the operating and maintenance phase JPS will submit the following reports to NEPA

1. An annual report outlining the monthly generating capacity of the hydropower plant and indicating any anomalies that occur.
2. Reports on accidents and incidents requiring activation of emergency response plans within 48 hours of occurrence.

Consultations:

1. Mrs. Michelle Dunn – HSSE[4] Department, JPS
2. Miss. Azalee Lawson – HSSE Department JPS
3. Mr. Clava Mantock – G.M. Business Support and Administration, JPS
4. Mr. David Cook – Head, Projects and Infrastructure Management, JPS
5. Mr. Val Fagan – V.P. Generation Expansion, JPS
6. Andrea Haiduk – Water Resources Authority

EIA Team:

1. Mrs. Ianthe Smith – Team Leader and Principal Environmental Engineer
2. Miss. Kamille Dwyer – Social Impact Assessment
3. Mr. Marlon Beale – Flora and Fauna Survey

[4] HSSE – Health, Safety, Security and Environment

References:

1. Government of Jamaica Policy Register as at July 2009 http://www.cabinet.gov.jm/files/GoJ Policy Register as at 20July2009.pdf
2. Environmental & Engineering Managers Ltd, June 2008, *Rapid Environmental Assessment for the proposed wind energy projects in Munro, St. Elizabeth, Palisadoes, Kingston and Hellshire St. Catherine in Jamaica & For the proposed hydropower energy projects in Great River, St. James and Maggotty St. Elizabeth in Jamaica*

APPENDIX 1
TERMS OF REFERENCE
ENVIRONMENTAL IMPACT ASSESSMENT FOR
MAGGOTTY PROJECT

1. INTRODUCTION

The Jamaica Public Service Company Limited (JPS) is the electric utility for the island of Jamaica. (JPS) will be developing expanding the Maggotty hydro Power Plant.

These terms of reference are to guide the environmental impact assessment (EIA) that is necessary for the requisite permits in accordance with the national environmental regulations.

2. PROJECT BRIEF

The project will include installation of 6 MW of hydro power plant.

SITE LOCATION - GENERAL

The Maggotty plant is located some 5 km north of the town of Lacovia on the A2 highway between Kingston and Montego Bay. The existing powerhouse is located near the main road in a large compound, together with the switchyard and JPS employee housing. The intake is located adjacent to the main road near the town of Maggotty.

The existing Maggotty facility consists of a diversion weir, an intake and water conveyance system comprising a concrete culvert, a woodstave and steel penstock leading to a powerhouse, containing a single Francis unit with an installed capacity of 6.7MW.

A feasibility study completed in June 2008 by MWH concluded that it would be viable to double the capacity of the existing plant by replacement of the woodstave and steel portions of the existing penstock by a larger diameter penstock and adding another 2 units to be located in a new powerhouse structure alongside the existing powerhouse in JPSCo's property.

The flow from the existing powerhouse discharges into a 340 m long lined canal to the river. The existing project is a run-or-river facility, and operates more or less continuously in coordination with the prevailing river flow. The average annual energy output of the existing unit is estimated at approximately 40 GWh per year. Using nominal capacity value of 6 MW, the existing plant factor is 76%.

PROPOSED PROJECT

Intake

A new intake will be constructed adjacent to the existing intake downstream and on the left side of the existing overflow section. The intake will be of a similar design to the existing intake with 3 openings equipped with trash racks, orientated laterally to the flow leading to a tapering concrete channel connected to a gate structure. The gate structure will contain a vertical lift control gate and a set of stop logs located upstream of the gate to allow maintenance of the gate. An electrical hoist will operate the gate. A new fore bay wall will be constructed to create a tapered channel to lead water into the new intake bays. The existing intake will remain in service at the end of the construction.

The new intake will be constructed as much as possible in front of the existing weir. A sheet pile wall will then be erected in the fore bay to allow a section of the weir to be demolished to open up the fore bay. The last section of the new weir will then be constructed tying into the existing weir. A new section of flume will be constructed from the gate structure to connect into the existing flume.

Pipeline

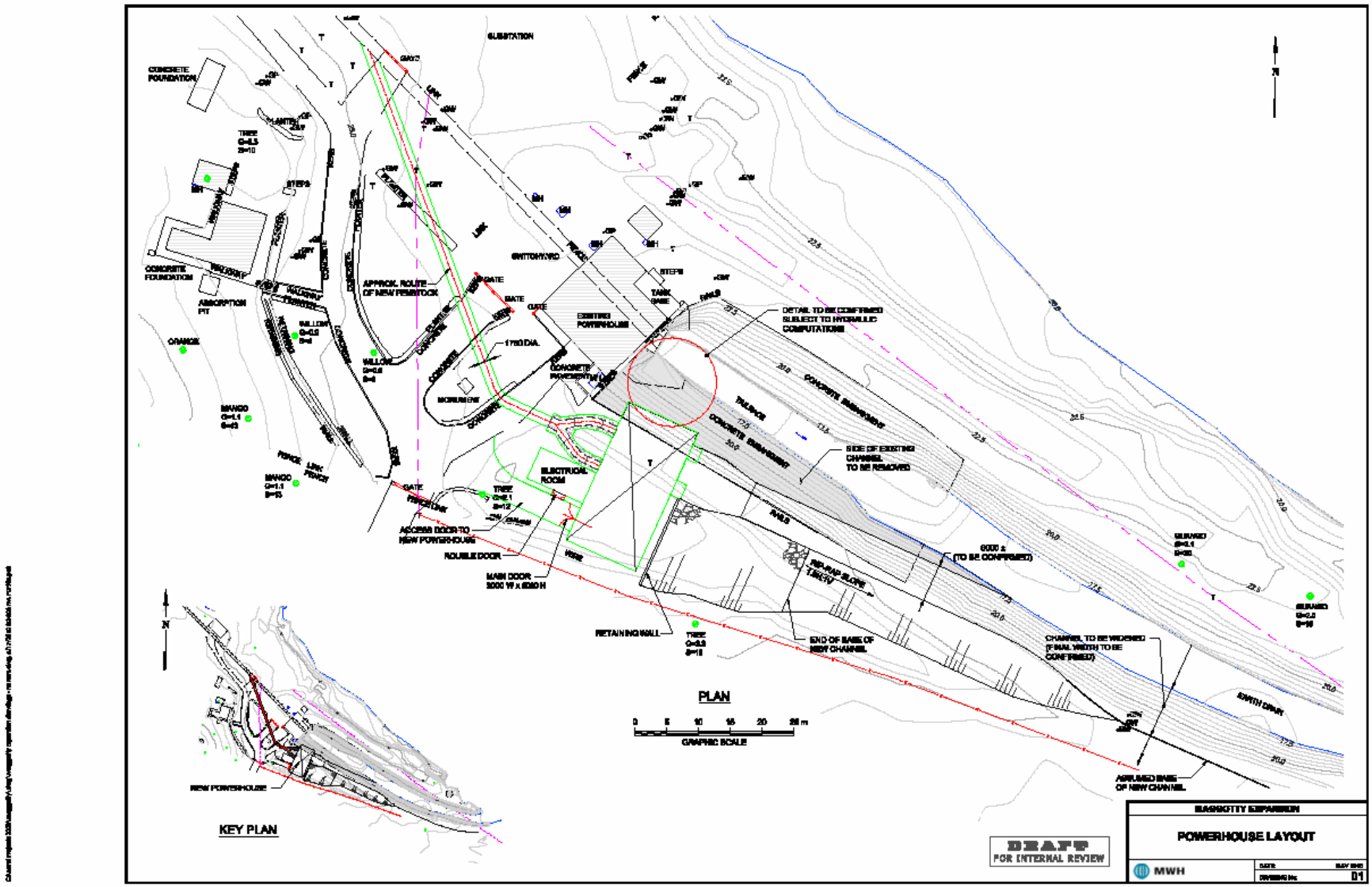
The preference for a GRP (fibre glass pipe) because of the ease of installation along the existing right of way, which in some places is located in narrow cut sections and because of its low maintenance requirements compared with woodstave. This new pipeline will replace the woodstave portion of the existing pipeline and may be installed above or below ground level.

Powerhouse

A new surface powerhouse will be located adjacent or near to the existing station. The powerhouse superstructure will be a reinforced concrete frame with concrete block infill

panels, plastered and painted inside and outside. It will be approximately 23.3 m long and 13.1 m wide and will house two turbines coupled to generators. In the original (existing) design a pressure relief valve had to be installed in the pipeline in addition to a surge tank to keep the overpressure in the pipeline within acceptable limits during plant operation. The choice of turbine will depend on the hydraulic transient behaviour with the addition of the new powerhouse. The powerhouse will have two main levels: a generator floor at El m, above the design flood level, and a turbine floor at El m. A runner-removal area will be provided between the units to facilitate maintenance. The erection bay will be located on the left side of the powerhouse. There is space on the turbine floor for a small workshop and a storage room. The control panels and switchgear will be located on the generator floor along the downstream wall.

The generators will be connected to the adjacent switchyard, which will house the 6.9 kV to 69 kV step-up transformer. A site layout and details of the powerhouse are shown in Figure below.


SUBSTATION
CONCRETE FOUNDATION
SWITCHYARD
EXISTING POWERHOUSE
APPROX. ROUTE OF NEW PENSTOCK
1750 DIA.
CONCRETE PAVEMENT
DETAIL TO BE CONFIRMED SUBJECT TO HYDRAULIC COMPUTATIONS
TAILRACE
CONCRETE EMBANKMENT
SIDE OF EXISTING CHANNEL TO BE REMOVED
ELECTRICAL ROOM
ACCESS DOOR TO NEW POWERHOUSE
DOUBLE DOOR
MAIN DOOR
RETAINING WALL
RIPRAP SLOPE PROTECTION
6000 ± (TO BE CONFIRMED)
END OF BASE OF NEW CHANNEL
CHANNEL TO BE WIDENED (FINAL WIDTH TO BE CONFIRMED)
SOUTH DRAIN
ASSUMED BASE OF NEW CHANNEL
PLAN
GRAPHIC SCALE
KEY PLAN
NEW POWERHOUSE
DRAFT
FOR INTERNAL REVIEW
BASKCITY EXPANSION
POWERHOUSE LAYOUT
MWH
01

TERMS OF REFERENCE

The Terms of Reference (TOR) for conducting the EIA are based on the General Guidelines for Conducting EIAs (NEPA revised 2007) for prescribed categories under the NRCA Act.

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

1) Project Objectives
2) Complete description of the existing site proposed for development.
3) Significant environmental issues of concern through the presentation of baseline data, which should include social, cultural and heritage considerations. Assess public perception of the proposed development.
4) Policies, Legislation and Regulations relevant to the project.
5) Likely impacts of the development on the described environment, including direct, indirect and cumulative impacts, and their relative importance to the design of the development's facilities.
6) Mitigation action to be taken to minimise predicted adverse impacts if necessary and quantify associated costs.
7) Monitoring Plan that should ensure that the mitigation plan is adhered to.
8) Alternatives to the project that could be considered at that site or at any other location including no action alternative.
9) Conclusions

To ensure that a thorough environmental impact assessment is carried out, it is expected that the following tasks be undertaken:

Task # 1 - Description of the Project

Provide a comprehensive description of the project and the surrounding environment specifying any information necessary to identify and assess the environmental effects of the project. This should include project objectives and information on, rationale for the project and background, the nature, location/existing setting, timing, duration, frequency, general layout including construction of any additional power lines and their impacts on the surroundings communities, as well as the impact of the turbines on the power supply and carbon footprint of the energy sector are to also be discussed, pre-construction activities, construction methods, works and duration, and post construction plans. A description of raw material inputs, technology and processes to be used as well as products and by-products generated, should be provided. Note areas to be reserved for construction and areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment.

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

Baseline data will be generated in order to give an overall evaluation of the existing environmental conditions, including a historical meteorological evaluation to include but not be limited to wind characteristics and analysis, 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:

1. Physical

i.) A description of the existing soil and geology, landscape, aesthetic values and hydrology. Special emphasis should be placed on storm water run-off, drainage patterns, and aquifer characteristics. Any slope stability issues that could arise should be thoroughly explored.

ii.) Water quality of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of the development.

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

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

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

vi.) Availability of solid waste management facilities

2. Biological

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

3. Socio-economic & cultural

Present and proposed land use; transportation of heavy equipment, road widening and associated traffic considerations particularly in the construction phase of the project, planned development activities; issues relating to squatting and relocation; public health and safety. The historical importance (heritage, archaeological sites and feature) and other material assets of the area should also be examined. While this analysis is being conducted, it is expected that an assessment of public

perception of the proposed development be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings and/or questionnaires/surveys.

Task #3 - Policy, Legislative and Regulatory Considerations

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

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

Examine and identify the major potential environmental and public health issues of concern and indicate their relative importance to the development project. These should include the occupational exposure, health and safety measures and population exposure in the appropriate study area(s) and changes and or enhancement in emergency response plan. Identify potential impacts as they relate to, (but are not restricted by) the following:

- change in drainage patterns
- flooding potential if necessary
- landscape impacts of excavation and construction
- loss of and damage to geological and palaeontological features
- loss of species and natural features
- habitat loss and/or fragmentation
- biodiversity/ecosystem functions including impacts of bird and bat mortality
- pollution of potable, surface or ground water
- air pollution
- socio-economic and cultural impacts
- impact of flooding, loss of natural features, excavation and construction on the historic landscape, architecture and archaeology of the site
- risk assessment
- noise and vibration, EMF
- solid waste disposal
- soil
- change in land use
- visual impacts – aesthetics
- impact on traffic associated with road widening and the transportation of heavy equipment to the site

Distinguish between significant positive and negative impacts, direct and indirect, long term and immediate impacts to include discussion on site restoration and residual impacts and the proposed mitigation measures. Identify avoidable as well as irreversible impacts. Cumulative impacts of this and other proposed and/or existing developments will be explored.

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.

Task #5 - Drainage Assessment

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

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.

Task # 6 Mitigation & Emergency Preparedness and Response

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

Indicate the emergency preparedness and response plans for dealing with risks and hazards identified at Task 4.

Task # 7 - EHS Management and Monitoring Plan

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

An outline of a monitoring programme (if necessary) should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the

commencement of the development. At the minimum the monitoring programme and report should include:

- An introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit and/or licence(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- Project maintenance and decommissioning
- 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

Task # 8 - Project Alternatives

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

Task #9 - Public Participation/Consultation Programme

Conduct public presentation(s) on the findings of the EIA to inform, solicit and discuss comments from the public on the proposed development if necessary.

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

Task #10 – Energy Statement

Examine the Government National Energy Policy and renewable projects. Discuss briefly the Munro Wind Project in relation to the National Energy Policy.

THE EIA REPORT

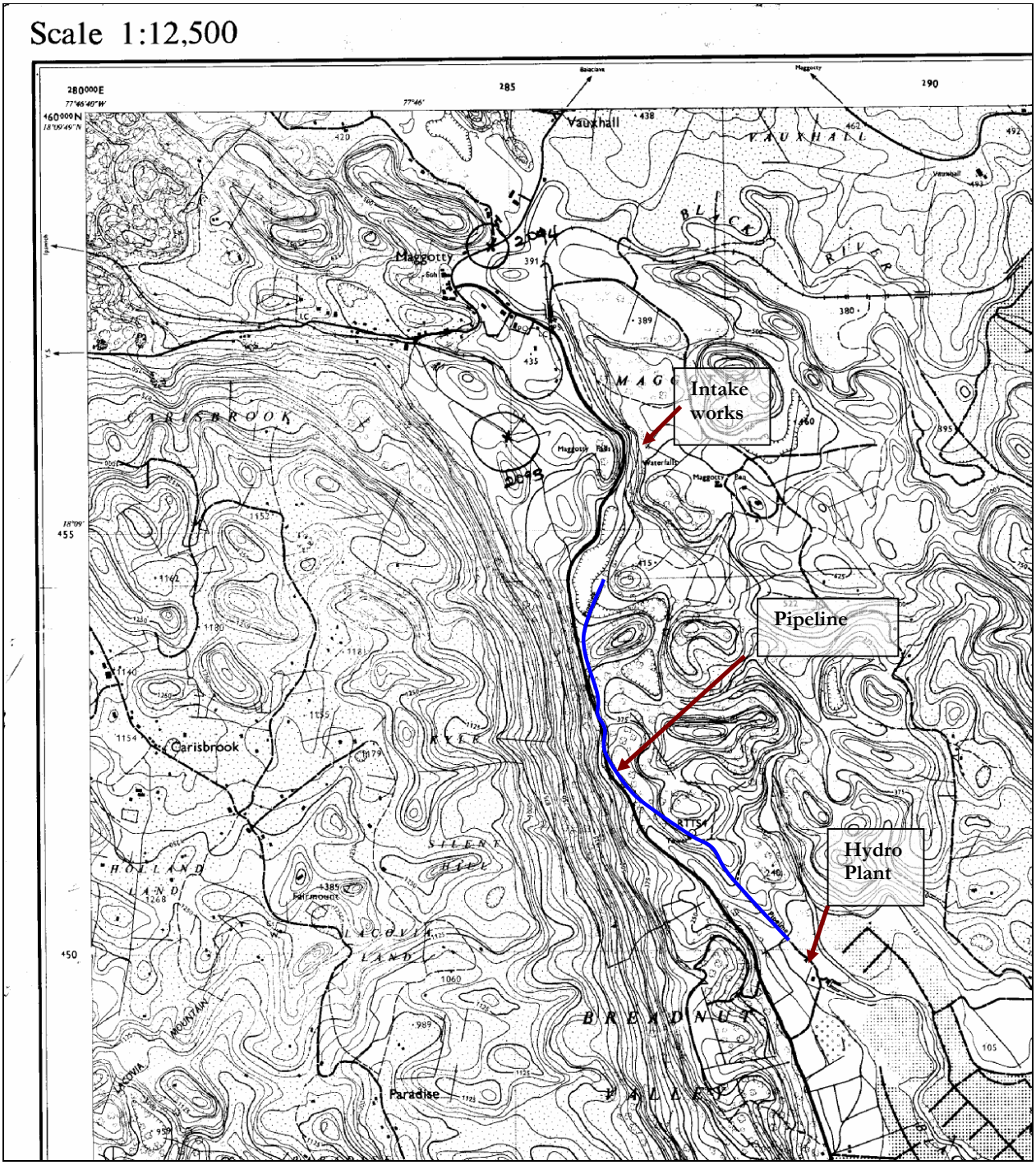
All Findings will be presented in the EIA report. The report will contain an introduction explaining the need for, and context of the project. The report should, at a minimum, cover the following basic aspects:

- Executive Summary
- Policy, Legal and Administrative Framework
- The EIA Methodology
- Description of the Existing Environment

- Description of the Proposed Project in detail
- Identification and Assessment of Potential Direct, Indirect, Cumulative, Positive and Negative Environmental Impacts
- Physical
- Natural Hazard Risk
- Biological
- Heritage - Cultural and Historic Heritage Sites
- Human/Social
- Public Involvement
- Recommended Mitigation Measures
- Identification and Analysis of Alternatives
- Management of the Environmental and Heritage aspects of the Project
- Environmental Management of the Project
- Environmental Quality Objectives
- Training
- Draft Outline Monitoring Programme
- List of References
- Appendices including:
    - Reference documents
    - Photographs/ maps/ site plans
    - Data Tables
    - The study team including Technical Team – name, qualifications and roles
    - TOR
    - Notes from Public Consultation
- Glossary of Technical Terms used

Fourteen hard copies and an electronic copy of the report will be required for submission to the National Environment and Planning Agency (NEPA).

APPENDIX 2: MAP OF MAGGOTTY



APPENDIX 3
Presumptive Soil Profiles

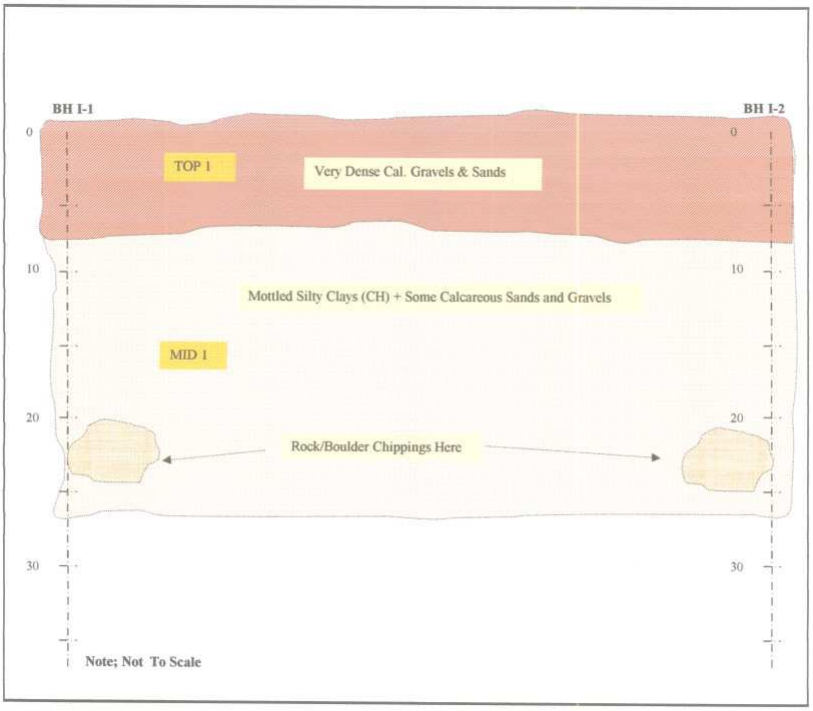
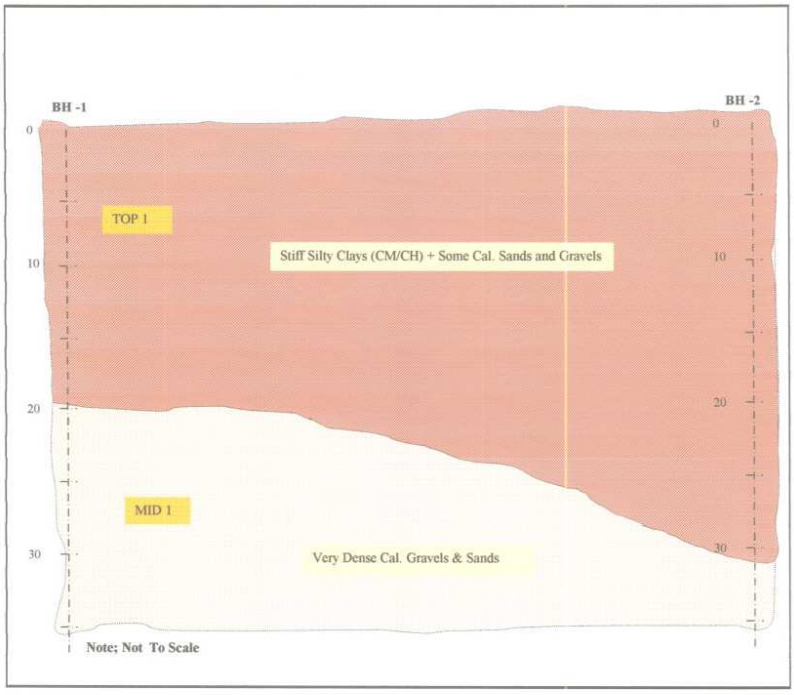


FIG. 4.1 PRESUMPTIVE PROFILE ; **Maggotty INTAKE Area – BH I-1 & BH I-2**



4.2 PRESUMPTIVE PROFILE ; **Maggotty BRIDGE Area – BH -1 & BH -2**

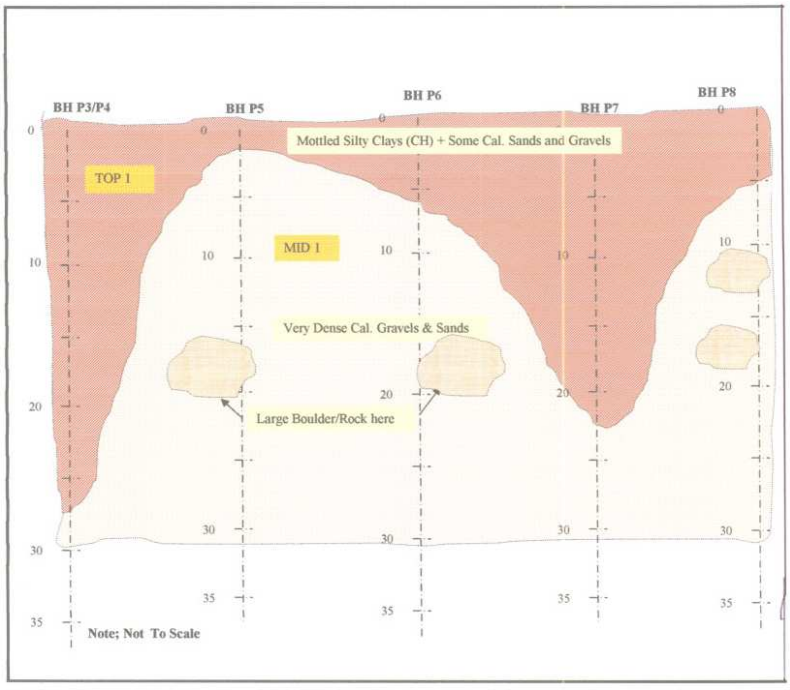


FIG. 4 .3 PRESUMPTIVE PROFILE ; **Maggotty Pipeline Area -- BH –P3 to BH –P8**

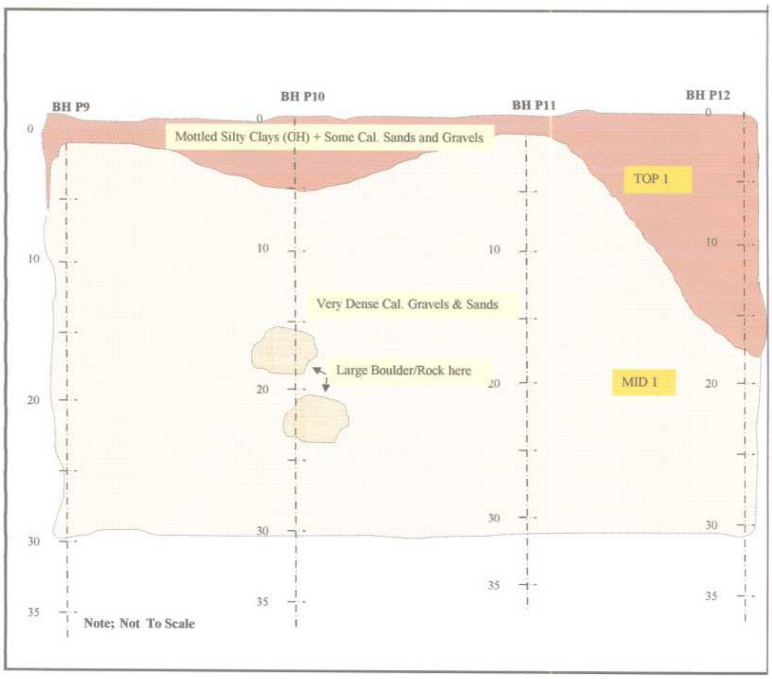


FIG. 4 .4 PRESUMPTIVE PROFILE ; **Maggotty Pipeline Area – BH –P8 to BH –P12**

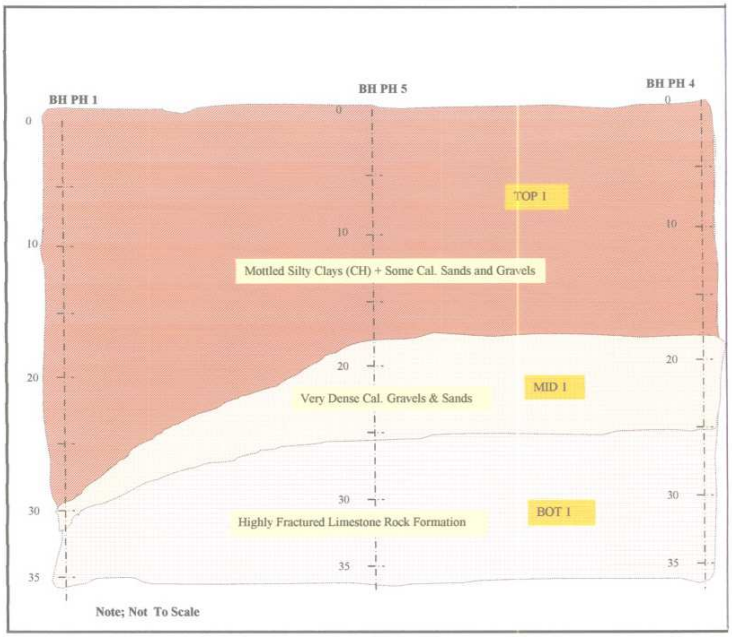


FIG. 4 .5 PRESUMPTIVE PROFILE ; **Maggotty Power House Area – BH –PH 1, PH 5 & BH –PH 4**

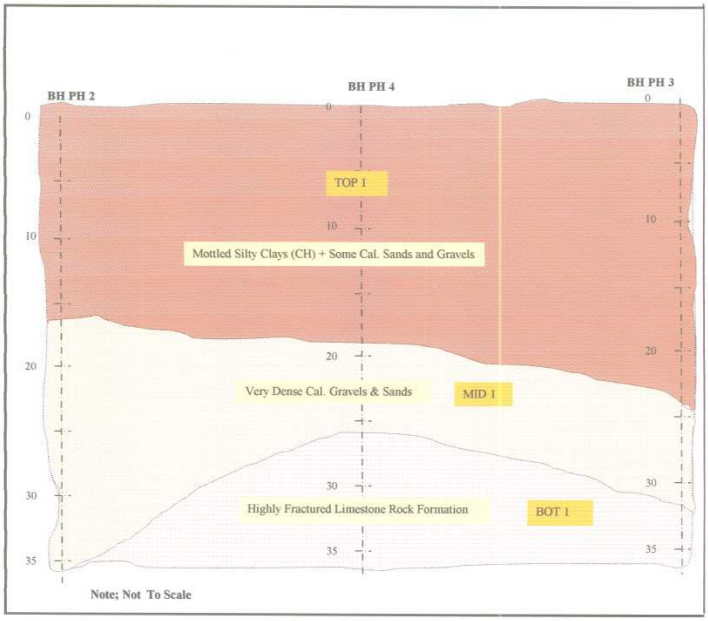


FIG. 4 .6 PRESUMPTIVE PROFILE ; **Maggotty Power House Area – BH – PH 2, PH 4 & PH 3**

APPENDIX 4

SOCIO-ECONOMIC SURVEY (September 2010)
Proposed Hydropower Energy Project, Maggotty, St. Elizabeth, Jamaica

PERSONAL/CONFIDENTIAL

Personal Interview Schedule (Target: Household Head)

Interviewer: _____ **Respondent ID:** _____
Date: _____ **Location:** _____

In order to determine the social and economic characteristics of the area, and garner your views, perspectives and acceptance of the proposed development I would like to ask you some questions.

Please indicate response by placing a tick in the appropriate box ☑

Demographic Profile

1. Sex: Male ☐ Female ☐

2. To what age group do you belong?
   <18 ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 and over ☐

3. How long have you lived there (here)? _____

4. Where are you originally from (Town and Parish)? _____

Quality of Life Indicators

Education

5. What is the highest level of education you have attained? (last school you attended)
   None ☐ Primary/All Age ☐ Training/Skills Institution ☐

   High School ☐ College ☐ University ☐ Other, specify _____

6. Are you presently attending school? Yes ☐ No ☐

Employment and Income

7. Are you employed? Yes ☐ No ☐

Please tick the box which best describes your type of employment

Full-time ☐ Part-time ☐ Self-employed ☐ Other, specify _____

8. What is your present means of livelihood (occupation)? _____

9. What is your main means of travel? (work, shopping etc.)?
Private vehicle ☐ Bus ☐ Taxi ☐ Other, specify _____

10. What is your weekly/monthly income in Jamaican Dollars (JMD)? (optional)

Less than $10,000 ☐ $10,001-$30,000 ☐ $30,001-$60,000 ☐

$60,001-$90,000 ☐ $90,001-$120,000 ☐ $120,001 – $150,000 ☐

Above $150,000 ☐

Housing (including Tenure), Health and Social Services

11. Do you _____ your house?
Own ☐ Lease ☐ Rent ☐ Other, specify _____

12. Do you _____ the land on which your house is located?
Own ☐ Lease ☐ Rent ☐ Other, specify _____

13. Including yourself, how many people live in your household? _____
(a) Number of adults _____
(b) Number of children less than 18 years _____
(c) Which School(s) do they attend_____ (include community location)

14 What type of sanitary conveniences (toilet facility) does your household use?
Water Closet/Flush toilet ☐ None ☐ Pit Latrine ☐ Other, specify _____

15a. What is the main source of lighting for your home?
Electricity ☐ Kerosene ☐ Candles ☐ Other, specify _____

15b. What is the average monthly cost of your electricity bill? _____

15c. How reliable is your electricity supply? _____

16. What type of fuel is used mostly by the household for cooking?
Gas☐ Electricity☐ Wood☐ Kerosene ☐ Other, specify _____

17. What is the main source of domestic water supply for the household?

Public piped water into dwelling☐ Private Tank☐ Public piped water into yard☐
Community Tank ☐ Government Water Trucks (free) ☐ Public Standpipe☐
Private Water Trucks (paid)☐ Spring or River☐ Other, specify _____

18a. What is the main method of garbage disposal for your household?
Public Garbage Truck☐ Private Collection☐ Burn☐ Other, specify _____

18b. If public garbage truck, how often do trucks pick up garbage? _____

19. Do you have access to a residential telephone? Do you have access to a cellular phone?
Yes☐ No☐

20. Do you have access to the following services?

Type of Service	**Location**	**Distance Travelled (km)/miles**
Health Care		
Police Station		
Fire Station		
Post Office/Agency		

Natural Resource Usage and Management

21. Do you or your family members utilise the resources of the Black River?

21b. If yes, what resource(s) and for what purpose(s)

22. How long have you been using these natural resources?

23. Is your livelihood primarily dependent on the resources of the Black River?

24. Has there been an increase or decrease in the amount/quantities of resources that are available for use?_____

25. What has caused this increase and/or decrease?

_____
_____
_____

26a. Are the resources used by other persons within and outside of the community?

26b. If yes, for what purpose(s)

27a. Is the Black River threatened by any form of pollution? _____

27b. What are the sources of the pollution affecting the river? _____

Community Development

28. (a) What does the average person do for fun within the community?

Parties ☐ Youth Clubs ☐
Sports Clubs ☐ Charity ☐
Church groups/activities ☐ Other, specify ☐

(b) Do you belong to any social groups? _____

29. What do you value most about your community?

_____
_____
_____

30. What types of improvement are needed in the community?

_____
_____
_____

31a. Is the community usually affected by Hurricanes/natural disasters (flooding, fire, earthquake etc.,)
How did you fare in the last Hurricane/tropical storm/natural disaster?

_____
_____
_____

31b. Has the Black River ever caused in the flooding of your community?

32. How long after a major disaster were water, power and telephone restored in your community?

_____

Perception of the Proposed Development

33. Do you know what a hydropower plant is? Yes☐ No ☐ (If yes, please explain its use)

_____
_____
_____
_____

34. Are you aware of the proposed upgrading/expansion of the hydropower plant development in Maggotty?

Yes☐ No ☐ If yes, through what medium? _____

35. What kind of impact do you think this development will have on the community?

_____
_____
_____
_____
_____

36. What do you think of the JPS Co. upgrading/expanding the Maggotty hydropower plants to increase electricity supply to satisfy electrical demand by the country?

_____
_____
_____
_____
_____
_____
_____

37. What do you think will be the benefits of the upgraded/expanded hydropower plant (a renewable energy project) to your community and Jamaica?

_____
_____
_____
_____
_____
_____

Thank you for your cooperation and participation in this survey☺

Interviewer Comments and Observations

_____

_____

_____

_____

APPENDIX 5
Calibration Certificate for Quest 2100 Sound Level Meter

QUEST TECHNOLOGIES
a 3M company

3M

Certificate of Calibration

Certificate Number: 248817DAJ080015

Model: 2100 Sound Level Meter **Date Issued:** 24-August-2010

S/N: DAJ080015

Quest Technologies, Inc. certifies that the above listed product meets or exceeds the requirements of the following standard(s):

ANSI S1.4 - 1983 (R1997)

IEC 651-1979: Class/Type 2

EN60651

IEC 61672-1-2002 Class 2 Sound Level Meter Type 2

Test Conditions: Temp: 18-25°C Humidity: 20-80% R.H. Barometer: 950-1050 mBar

Test Procedure: S053-903

Subassemblies:

QE7052 S/N: 35361 - QE7052

Reference Standard(s):

Device	Cal Due Date	Uncertainty - Estimated at 95% Confidence Level (k=2)
B&K Ensemble	8-October-2010	+/- 2.2% Acoustic (0.19dB)
Fluke 45	3-March-2011	+/- 1.4% AC Voltage, +/-0.1% DC Voltage

Calibrated By: Mary E. Roth

Mary E. Roth Assembler

In order to maintain best instrument performance over time and in the event of inspection, audit or litigation, we recommend the instrument be recalibrated annually. Any number of factors may cause the calibration item to drift out of calibration before the recommended interval has expired.

All equipment used in this test is traceable to NIST, and applies only to the unit identified above.
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058-387 Rev H

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