ENVIRONMENTAL IMPACT ASSESSMENT

SOAPBERRY WASTEWATER TREATMENT PLANT
ST. CATHERINE
JAMAICA

Submitted to:

ASHTROM BUILDING SYSTEMS
Central Village
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Jamaica

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1. INTRODUCTION

1.1 THE REPORT

This document presents the findings of an Environmental Impact Assessment (EIA) of the proposed Soapberry Wastewater Treatment Plant, St. Catherine, Jamaica.

Wastewater treatment plants are included on the list of prescribed activities under the 1991 Natural Resources Conservation Authority Act (NRCA) that require an application for permission to develop. The National Environmental Planning Agency (NEPA), which administers the NRCAA, has requested that an Environmental Impact Assessment (EIA) be conducted for this project as a requirement for obtaining a permit to implement.

Environmental Solutions Limited (ESL) has been engaged by Ashtrom Building Systems, the Contractor, to prepare the EIA and to provide assistance in other related activities. The Terms of Reference for the EIA are provided at Section 1.3 below.

1.2 BACKGROUND

The National Water Commission (NWC) proposes to construct a 225,000/day wastewater treatment facility at Soapberry located north of Hunts Bay on the southeastern St. Catherine coast (Figure 1.1). The facility will consist of a re-circulated oxidation lagoon system, that is intended to replace the existing smaller treatment plants serving Kingston.

The installation of the wastewater treatment facility is a key component for the long-term expansion of the Kingston sewerage system, and existing and new sewerage lines will connect to the facility.

Discharge of poorly treated effluent to Kingston Harbour has been a major contributor to the ecological deterioration of this major environmental asset. Old dilapidated small plants have long been unable to meet treatment requirements, and the decision to construct Soapberry was made to remove the major source of pollutants to the harbour.

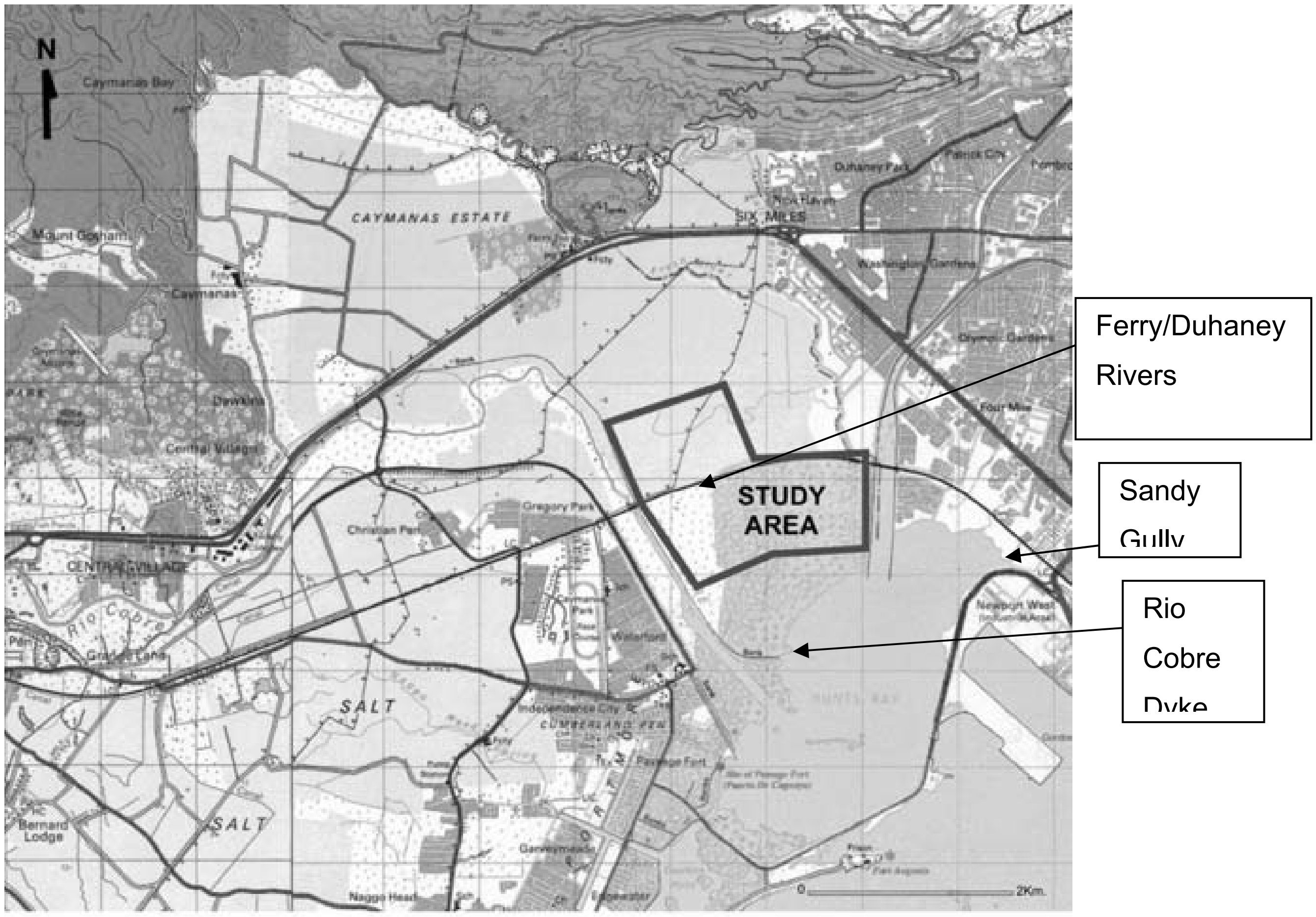

Figure 1.1: Location of project site.

1.3 TERMS OF REFERENCE

The Terms of Reference for the Environmental Impact Assessment are provided below. These have been adapted from World Bank guidelines and take account of NEPA's guidelines for EIA preparation. By letter dated November 22, 2004, NEPA commented on the TOR's, requesting that their comments be addressed in the EIA Report. These comments have been used to modify the terms of reference presented below.

1. Introduction - Identify the development project to be assessed and explain the executing arrangements for the environmental assessment.

2. Background Information - Briefly describe the major components of the proposed project, the implementing agents, and include a brief history of the project and its current status.

Study Area - Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas within the area of influence of the project.

4. EIA Team – Identify the individuals responsible for collecting the data and carrying out the impact assessment and their respective skills.

5. Scope of Work - The following tasks will be undertaken:

Task 1. Description of the Proposed Project - Provide a full description of the overall project (225m^3/d) and its existing setting using plans, maps and graphic aids at appropriate scales. This is to include: location; general layout (size, capacity, etc.); areas slated for development, pre-construction and construction activities; construction methodology (earthworks, bunds, etc.), site management, operation and maintenance activities; project life span; plans for providing electricity and water; and employment. Specific attention will be given to the sewage treatment process, level of treatment and effluent disposal. In addition the management and disposal of grease and sludge will be addressed. The management of trucked septage will be addressed.

Task 2. Description of the Environment - Describe the physical, ecological, demographic, socio-cultural and institutional setting of the project. Review and present information that provides an insight into previously existing conditions of the site and the influences of past development initiatives. Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area, including the following:

a) Physical environment: coastal mainland and riverine features; topography; geology; soils; climate and meteorology; ambient noise (at site and in area of influence); hydrology; drainage and storm water runoff; and Hunts Bay water quality[1]. Any existing sources of pollution and the extent of contamination relevant to the project area will be identified. The natural hazard vulnerability of the site will also be considered, particularly with respect to potential river flooding, hurricanes and storm surge. A stand alone geotechnical report, detailed drainage maps and a hydrological analysis will be carried out.

b) Biological environment: flora and fauna of the terrestrial and wetland ecosystems on and adjacent to the project site as well as the ecology of Hunts Bay. Specify rare or endangered species, species of commercial importance, and species with potential to become vectors or nuisances.

c) Socio-cultural environment: present and projected population size, land use, community structure, issues related to squatting and relocation, current development plans, recreation and public health, public and community perceptions and attitudes on the proposed project, and any historical sites affected by the project. Identify the solid waste management facilities to be used by the project and assess public perception of the proposed development. The population of the catchment area to be served will be included.

Task 3. Legislative and Regulatory Considerations - Describe the pertinent environmental laws, regulations and standards governing land use control, environmental quality, health and safety, sewage effluent discharge, protection of mangroves and other sensitive areas, and protection of endangered species.

[1] Parameters to include: BOD, TSS, NO_3, PO_4, and faecal coliforms.

Task 4. Determination of Potential Impacts – Identify the major issues of environmental concern and indicate their relative importance to the design of the project. Distinguish long-term and short-term impacts, construction and post-construction phase impacts, positive and negative impacts, and direct and indirect impacts. Identify the significant impacts and those that are cumulative, unavoidable or irreversible.

Special attention is to be given to the following matters:

Vegetation clearance, especially wetland habitat disturbance, related to site clearance, pond construction, placement of buildings and services installation. In particular the potential impacts on crocodiles will be addressed.

Modification of existing drainage patterns and surface runoff during construction and post-construction phases.

Potable water supply, demand and resource depletion.

Solid waste management during construction and post-construction phases.

Socioeconomic conditions, effects on existing users of the coastal area, community involvement, and public perceptions of the project.

Potential impacts of the development on adjacent property owners.

Natural hazard vulnerability

Construction impacts including earth materials sourcing, transport and storage; pond construction methods; site management; noise; fugitive dust; traffic obstruction; and employment.

Reference should be made to the extent and quality of the available data and any information deficiencies and uncertainties associated with the prediction of impacts should be clearly identified.

<u>Task 5. Mitigation and Management of Negative Impacts</u> - Recommend feasible and cost-effective measures to prevent or to reduce the significant negative impacts to acceptable levels.

<u>Task 6. Development of an Environmental Management and Monitoring Plan</u> - Prepare the outline of a plan for monitoring the impacts of the project and the implementation of mitigating measures during construction. This plan is to be detailed after the permit for the project is granted and the construction plans for the project have been finalized at which time the plan is to be submitted to NEPA for approval.

<u>Task 7. Determination of Project Alternatives</u> – Examine alternatives to the project including the no-action option and alternatives treatment processes and site location.The examination of alternatives should appropriately defend the proposed alternative examined in the context of the EIA.

<u>Task 8: Assist in Inter-Agency Coordination and Public/NGO Participation</u> - Assist in co-ordinating the environmental assessment with the government agencies and in obtaining the views of local NGO's and affected groups. Manage and coordinate the public hearing on the EIA findings as required by the NEPA permit approval process.

6. <u>Report</u> - The environmental assessment report will be concise and limited to significant environmental issues. The main text will focus on findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to the outline below.

Executive Summary

Policy, Legal and Administrative Framework
Description of Proposed Project
Description of the Environment
Significant Environmental Impacts and Impact Mitigation Measures
Environmental Monitoring Plan
Project Alternatives
Inter-Agency and Public/NGO Involvement
List of References

1.4 STUDY TEAM

This EIA was carried out by Environmental Solutions Ltd. The multidisciplinary team engaged to do the assessment included local expertise in environmental impact assessment, coastal ecology, environmental chemistry, and socio-economics. The team members were:

Environmental Solutions Ltd.:
Mr. Peter Reeson, M.Sc. – Team Leader and EIA Specialist
Mr. George Campbell, M.Sc. – Socio-economist
Mr. Aedan Earle, M.Phil. – Geologist
Dr. Margaret Jones Williams, Ph.D. - Ecologist
Mrs. Sharonmae Shirley, M.Phil. – Environmental Chemist

ESL associates:
Mr. Lloyd Donaldson, M.Sc. – Hydrogeologist

1.5 METHODOLOGY

1.5.1 Physical Parameters

Information was gathered on the existing physical environment, particularly as related to climate, geology, topography, soils, hydrology and drainage and natural hazard vulnerability.

1.5.1.1 Climate, Geology, Topography, and Soils

Information on the climate, geology, topography, soils, was obtained by compiling existing data from reports as well as from source agencies. Aerial photos, satellite imagery and other published maps were also examined.

Field work was carried out to augment and verify existing information relating to geology and soils and to obtain first hand knowledge of the topography.

1.5.1.2 Hydrology, Drainage and Natural Hazard Vulnerability

Surface and ground water characteristics and flows were assessed using field investigation as well as maps, aerial photographs and data from previous reports. A detailed hydrological study was carried out using existing data to assess the flood potential of the site.

Seismic exposure was determined from hazard vulnerability maps prepared for the KMA.

1.5.2 Terrestrial Ecology

In a previous study (Environmental Solutions Ltd., 1993) the flora and fauna of the project area was described and the major habitat types were identified. For the purposes of this report a field visit was conducted on October 5, 2004 to determine the extent to which the earlier assessment still prevailed. Site assessment included a wind shield survey of the project area, as well as ground truthing of the major habitats reported from 1993 (Environmental Solutions Ltd., 1993).

Field assessments were conducted in October 2004, with the following aims:

1) To determine any significant changes to the area that would have resulted in alteration of habitats;
2) To verify the presence of species previously listed from the site; and
3) To identify any species not previously reported.

1.5.3 Water Quality Survey

The primary objective of this baseline water quality assessment is to determine water quality conditions and the nature and extent of present impacts prior to the construction of the Soapberry Wastewater Treatment Plant. The extent of surface water contamination in the project area was assessed based on current data and historical information obtained from the Kingston Harbour Baseline Study [Webber et al, 2003].

Surface Water Quality Stations. Grab samples were collected at the sampling sites at a depth of between 0.5 and 1m from the surface using a "weighted bottle" sampler. All samples collected were stored in pre-cleaned 2 litre polyethylene and 250/500 ml glass bottles (transparent and opaque). Bacterial samples are collected at the water surface in sterilized 100 ml glass bottles.

Dissolved oxygen and conductivity measurements were taken *in situ* at all sampling stations. Measurements were taken at the water surface (0.1m) and just above the bottom at each site.

Laboratory Analyses were performed at the Environmental Solutions Laboratory Division using certified methodology from Standard Methods for Water and Wastewater Analyses (Eaton *et al*, 1995).

The following parameters were analysed:
pH
Conductivity/salinity
Temperature
Dissolved Oxygen
Total Suspended Solids
Nitrate
Phosphate
BOD
Total and Faecal Coliform

Conductivity/salinity, temperature, and dissolved oxygen were measured *in situ* at the sampling stations. The analytical methods used are based on established procedures in Standard Methods for Water and Wastewater Analysis.

1.5.4 Socioeconomic Survey

Rapid appraisal techniques were used in 6 locations that were proximate, to Soapberry. These were the communities of Riverton City, Riverton Meadows, Waterford, New Haven, Callaloo Mews and select enterprises on the Spanish Town Road and in Ferry. In all, 46 persons were interviewed.

2. PROJECT DESCRIPTION

The proposed Soapberry Wastewater Treatment Plant as designed by HGM Consulting Engineers & Planners (1980) Ltd. for Ashtrom Group Ltd on behalf of the Government of Jamaica, has been based on a summary of design data and hydraulic and process calculations derived from two earlier master plans, viz., ***Sentar, 1993,*** and ***KBR, 2003 .***

The ***Sentar Study*** sought to develop a best option for upgrading wastewater collection and treatment to reduce the pollution loading to Kingston Harbour. The proposal included population forecasts, expanded sewering for the Kingston Metropolitan Area (KMA), and a treatment system in the Soapberry area which coincided with earlier recommendations for a “flow west” concept.

The KBR Study utilized updated specific water consumption data generated by the National Water Commission (NWC), and revised population forecasts for the City of Kingston to produce the “Water, Drainage and Sewage Master Plan” in 2003.

Population forecasts relate to the projected connection to a sewage collection system, and not necessarily to the total population of the defined area. It is significant to note that the Soapberry Treatment system is therefore designed to handle the incremental expansion of sewage connections throughout the service area.

Based on projected flow capacities, the treatment plant will be built sequentially in three identical modules, each having a capacity of 75,000 m^3/day. The design criteria for each module are set out in Table 2.1.

Equivalent population	247,886
Average daily flow (m^3/day)	75,000
BOD loading (kg/day)	18,750
BOD concentration (mg/l)	250
Average hourly flow (m^3/hr)	3,125

Table 2.1: Design criteria for each treatment module.

The three modules will be constructed on low-lying land situated between the Duhaney River and Sandy Gully to the east, the Dyke of the Rio Cobre River flood protection system to the west, and Hunts Bay to the south. Elevation ranges from 0.3 – 1.2 metres above mean sea level (asml) throughout much of the site to 2.5 - 3.3m amsl in the northwest section. The old railway line will separate the first and third modules. The Riverton solid waste disposal site lies immediately adjacent and northeast of the STP site. (Figure 1.1).

The population already connected to the city system will be served by the first module at Stage-1 (the “Western” module), while the implementation of Stage-2 and Stage-3 will depend on the rate of connection of the neighborhoods to the sewage system on the one hand, and the progress of construction of the lagoon system, especially for Stage-2, on the other. The target-year for design is the year 2025 as specified in the “K.B.R.” report.

2.1 CONSTRUCTION OF WTP FACILITY

Each module comprises four primary lagoons in the shape of half-circle segments with radial flow and secondary lagoons encircling them, Figure 2.1. The inlet area of the primary ponds will be deeper and separated from the rest of the pond by a submerged dyke to encourage settling and fermentation. Discharge from the primary ponds will be through eight outlets along the dyke thus ensuring uniform radial flow into the secondary ponds. In this manner uniform radial flow will be achieved thereby avoiding “dead areas” in the system. The last secondary lagoon in each module will be used as a polishing pond.

It was initially planned to use constructed wetland systems to provide the final treatment of the wastewater before discharge into Kingston Harbour, at Hunts Bay. This plan has been changed and it is now proposed to treat the effluent via a sand filter.

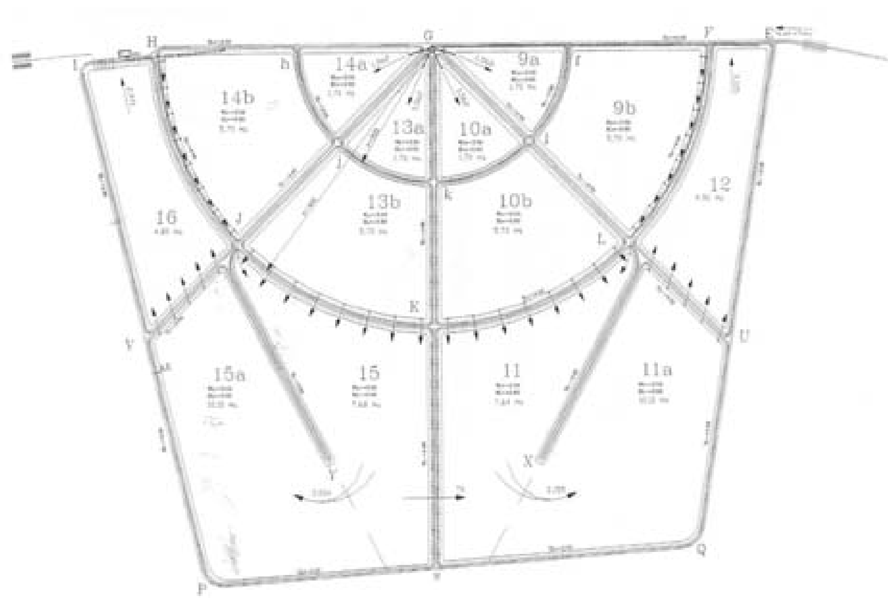

Figure 2.1: Configuration of lagoon showing flow directions

Construction of the lagoons will entail in situ excavation and use of the excavated material to build the dykes and create the lagoons. The additional amounts of earth material, required for construction of the STP are small (less than 20% of the total required fill volume) as the local excavation works will meet most of the needs. Requirements will be brought from an external source. The plan calls for completion of the three modules by 2025.

2.2 OXIDATION LAGOONS SYSTEM DESIGN PRINCIPLES

a. Clearance from the railway and the Rio-Cobre River:

Clearance from the Jamaica Railway to be 60 m from track to embankment centerline.
Clearance from the Rio Cobre Floodway dyke to be 45 m from centreline to embankment centerline.

b. All sewage flowing to Soapberry treatment plant will be pre-treated at its Station of origin:

Pumping stations will include mechanical automatic bar screens.
Greenwich Transfer Station – the Grit Removal system at the station will be rehabilitated and mechanical automatic bar screen system will be added.

c. Lagoon dike design – the following is a description of the dike design and protection and can be observed in Figure-4.

Minimum dike top width- 4.0m' finished with marl surface for protection and access.
Dike top width of 5.0m', with 4.0m' wide marl surfaces, is proposed where necessary to provide for piping or channels.
Maximum side slopes are 3:1 for pond dikes.
Top width of submerged dike at 2.0m' and top elevation of 0.5m' below pond operation level.
Lagoon lining – based on the details and characteristics of the soil described in the ***Jentech*** soil report, mainly that the soil at the western module site is clay and may serve as a sealing layer and therefore sparing the need for additional lining of the lagoons. Also, pond inner dike slopes will be lined with 1.5mm' thick HDPE sheets.

Dike wind and wave protection – the inner dikes are planned to be lined with a "Geo-web" lining as wave and wind protection. Concrete slope protection is provided on the inside slopes of all ponds from elevation- 0.75m' below high liquid levels to the dike tops. The outer dikes will be protected by Heavy "Rip-Rap" as storm protection is provided on exterior slopes adjacent to Hunt's-Bay, from top to bottom of dike slopes.

2.3 STP OPERATIONS

The proposed treatment system will be a re-circulated oxidation lagoon. The "Re-circulated Oxidation Lagoons" (ROL), concept combines the series lagoon system with recycling of treated effluent to the Primary-Lagoon for the main purpose of allowing higher organic loading on the primary lagoon without creating malodors and nuisances. Re-circulation of the effluent provides oxygen and algae rich supplement to the raw wastewater entering the system. This supplement seeds the algae in the wastewater and improves the performance of the system. Furthermore, the algae in the re-circulated stream also have the ability to absorb heavy metals. Common Re-circulation rates range from 2:1 to 1:2 based on the influent flow, the raw sewage quality and the climate conditions.

Mixed liquor, consisting of screened raw sewage and re-circulated secondary effluent, will enter through a distribution chamber at the center of the 'Half-Circle' to the primary facultative lagoons. These are relatively deep (2.4m) and this is where Suspended-Solids removal of up to 90% and BOD removal of up to 70 % take place mainly by means of sedimentation and by oxygen generated through photosynthetic activity of microscopic algae.

The next set of lagoons – secondary facultative lagoons - is shallower (~1.7m) and here oxygen is generated by the photosynthetic activity of microscopic algae. The oxygen is immediately available for bacteria in the wastewater to oxidize a major fraction of the BOD remaining.

Polishing lagoons are the final stage in the treatment process. These are shallower lagoons where further destruction of BOD and pathogenic bacteria takes place through extensive retention time and exposure to solar radiation. Some of the Secondary effluent will be pumped into the inlet channel at a re-circulation rate of 1:1 with the ability to increase the re-circulation rate, if required, to 1:1½. The rest of the secondary effluent is then passed through a sand filter bed before being discharged to the Rio Cobre.

The advantages of oxidation pond systems are:

Relatively high removal of pathogenic bacteria, viruses and protozoa due to long retention times, solar irradiation, biological competition and settling,

Simple flow scheme and simple equipment and installation (minimum piping and pumping, and reduced pretreatment facilities),

Capability to equalize peak hydraulic loads and resist shock organic loads due to large lagoon volumes, long retention times and high buffering capacity,

Low capital investment, especially with regard to construction, and

Simplicity of operation and low maintenance costs not requiring technical sophistication nor highly trained staff.

The advantages of re-circulated oxidation lagoons are:

Capacity to treat large volumes of wastewater,

Low mechanization system (except for re-circulation pumps), and

Low maintenance costs.

The expected quality of the effluent from the Soapberry waste water treatment facility is given in Table 2.2.

		Soapberry Effluent	
Parameter	NEPA Standard	Secondary	Tertiary*

Biological oxygen demand (BOD) (mg/l)	20	24	10
Total suspended solids (TSS) (mg/l)	20	Algae	10
Ammonia (mg/l)		8.5	8.5
Total nitrogen (mg/l)	10	21.5	10
pH	6 – 9	8	8
Faecal coliform	200	38	38

Table 2.2: Designed effluent specifications of proposed waste water treatment facility.

*** Sand filter**

3. ENVIRONMENTAL LEGISLATION AND REGULATORY FRAMEWORK

The environmental laws and regulations of Jamaica that are relevant to the construction and operations of a sewage treatment plant are listed and commented upon below.

3.1 LAWS

Natural Resources Conservation Authority Act (1991)

This is the main environmental legislation that relates to the proposed project. This Act establishes the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development through the protection and management of the country's natural resources and the control of pollution. This is partly achieved through an environmental permit and license system.

The Act gives the Authority power to:

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

The Act also incorporates the earlier Beach Control Act, Wildlife Protection Act and Watersheds Act.

Wild Life Protection Act (1945)

Prohibits removal, sale or possession of protected animals, use of dynamite, poisons or other noxious material to kill or injure fish, prohibits discharge of trade effluent or industrial waste into harbors, lagoons, estuaries and streams. It authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act is the American Crocodile, a species that inhabits the project area.

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

The island of Jamaica and the Territorial Sea of Jamaica has been declared as a Prescribed Area. No person can undertake any enterprise, construction or development of a prescribed description of category except under and in accordance with a permit.

Natural Resources Conservation (Permits and Licenses) Regulations (1996)

These regulations give effect to the provisions of the Prescribed Areas Order. Sewage treatment facilities are included on the list of prescribed activities.

Natural Resources Conservation (Sewage Effluent) Regulations (Draft)

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

Water Quality NRCA Act (1990)

The NRCA has primary responsibility for control of pollution in Jamaica's environment, including pollution of water. National standards exist for industrial and sewage effluent discharges to rivers and streams.

Parish Council Act (1901; amended 1978) and the Local Improvements Act (1914)

The St. Catherine Parish Council is responsible for administering these laws in the parish. General approval under the Parish Council Act is needed for building permits. Section 11 of The Town and Country Planning Act also empowers the council to make decisions for the approval of development projects on its behalf.

Quarries Control Act (1983)

This Act repeals the Quarries Act of 1958 and makes provisions for quarry zones and licenses, quarry tax, enforcement and safety. The proposed project should ensure that any earth materials used for construction purposes at the construction site are obtained only from licensed quarries.

3.2 REGULATIONS

National Sewage Effluent Regulations (Draft, 2002)

These regulations are intended to cover the discharge of sewage effluent, the operations, monitoring and reporting mechanism of sewage treatment facilities. They relate to the National Sewage Effluent Standards, 1997. These standards are given in Table 3.1.

Table 3.1 Sewage effluent standards for plants built after 1997.

Parameter	Effluent Limit
Biological oxygen demand (BOD)	20 mg/l
Total suspended solids (TSS)	20 mg/l
Total nitrogen	10 mg/l
Phosphates	4 mg/l
Chemical oxygen demand (COD)	100 mg/l
pH	6 - 9
Faecal coliform	1000 MPN/100ml
Residual chlorine	1.5 mg/l

4. DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 CLIMATE

The meteorological conditions of the site, like the rest of Jamaica, is subtropical with only slight variations in temperature and rainfall throughout the year. Long term meteorological data has been collected at the Norman Manley International Airport (NMIA) which is 5 km. from the proposed site. Table 4.1 summarises the temperature, rainfall, and humidity values recorded between 1951 and 1989 and this data is indicative of the conditions that have existed at the site.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Mean
Maximum Temp. (°C)	29.8	29.6	29.8	30.3	30.8	31.2	31.7	31.9	31.7	31.3	31.1	30.5	30.8
Minimum Temp. (°C)	22.3	22.3	22.9	22.6	24.7	25.3	25.6	25.3	25.3	24.8	24.1	23.1	24.0
Rainfall (mm)	18	16	14	27	100	83	40	81	107	167	61	31	62.1
No. of raindays	4	4	3	5	5	6	4	6	8	10	6	4	5.4
Rel. Hum.- 7am (%)	80	78	77	77	76	73	76	76	78	80	79	78	77.3
Rel. Hum.-	61	62	64	60	66	65	65	68	68	65	65	64	64.4

1pm (%)													
Sunshine (Hours)	8.3	8.6	8.5	8.7	8.2	7.7	8.2	8	7.2	7.4	7.8	7.8	8.0

Table 4.1: Monthly Mean and Annual Mean Values for Selected Meteorological Parameters: Norman Manley International Airport 1951 – 1980.

The maximum daily temperature ranges from 29.6 °C to 31.9 °C and the minimum from 22.3 °C to 25.6 °C with highest temperatures in July and August. The relatively narrow range in temperature reflects the moderating influence of the sea.

Highest monthly average rainfall occurs between May and October and the annual mean is 62.1 mm. October has the highest average monthly rainfall (167 mm) and days with rain (10).

The wind data for the period 1981 to 1990 show that the most predominant wind directions are from the east and east-south-east, (Table 4.2 and Figure 4.1.). These are the prevailing sea-breeze directions and reflect the effects of the mountains which lie along an east-west axis. The mountains deflect the dominant northeasterly trade winds and provide the easterly component to the winds.

Wind Speed	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N
Knots	020 - 030	040 - 050	060 – 070	080 – 100	110 - 120	130 - 140	150 - 160	170 - 190	200 - 210	220 - 230	240 - 250	260 - 280	290 - 300	310 - 320	330 - 340	350 010
0																
1 – 3	102	47	61	151	66	60	85	143	88	84	64	290	556	644	798	438

4 – 6	373	194	346	796	431	371	545	1035	457	297	281	697	1435	2253	3486	210
7 – 10	536	311	857	2470	1434	1027	1093	1429	578	279	216	545	866	1801	3787	302
11 - 16	169	121	868	5520	3675	1714	751	257	87	59	31	79	96	255	809	930
17 - 21	35	14	265	3734	3322	1475	327	45	10	4	2	6	8	53	108	97
22 - 27	15	0	59	2786	3254	1509	238	12	3	1	1	3	5	54	51	70
28 - 33	7	0	8	594	520	224	19	7	1	0	1	0	5	24	31	52
34 - 40	0	0	0	7	8	10	3	3	0	0	1	0	1	15	0	13
41 - 47	0	0	1	1	0	1	4	0	0	0	0	0	0	0	0	0
48 - 55	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
56 - 63	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0
>63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Average Speed	18.54	19.09	18.29	14.80	13.67	14.32	17.74	19.46	19.16	18.11	18.03	16.99	16.59	17.54	18.54	18.8

Table 4.2: Wind Speed and Direction Data: Norman Manley Airport 1981 – 1990

Sea breeze influences provide a southerly component. Winds from the north-northwest and north are the other dominant direction and reflect land breeze as well as influences of cold fronts and the northeast trades.

The mean wind speed over the period was 10.3 knots (19.1 km/h). Winds from the south had the highest wind speeds (19.5 knots (kt)) followed by the south south-west. Winds from the ESE had the lowest average wind speeds. Calm winds were reported 14.7% of the time and wind speeds of 1 to 3 kt 4.2% of the time.

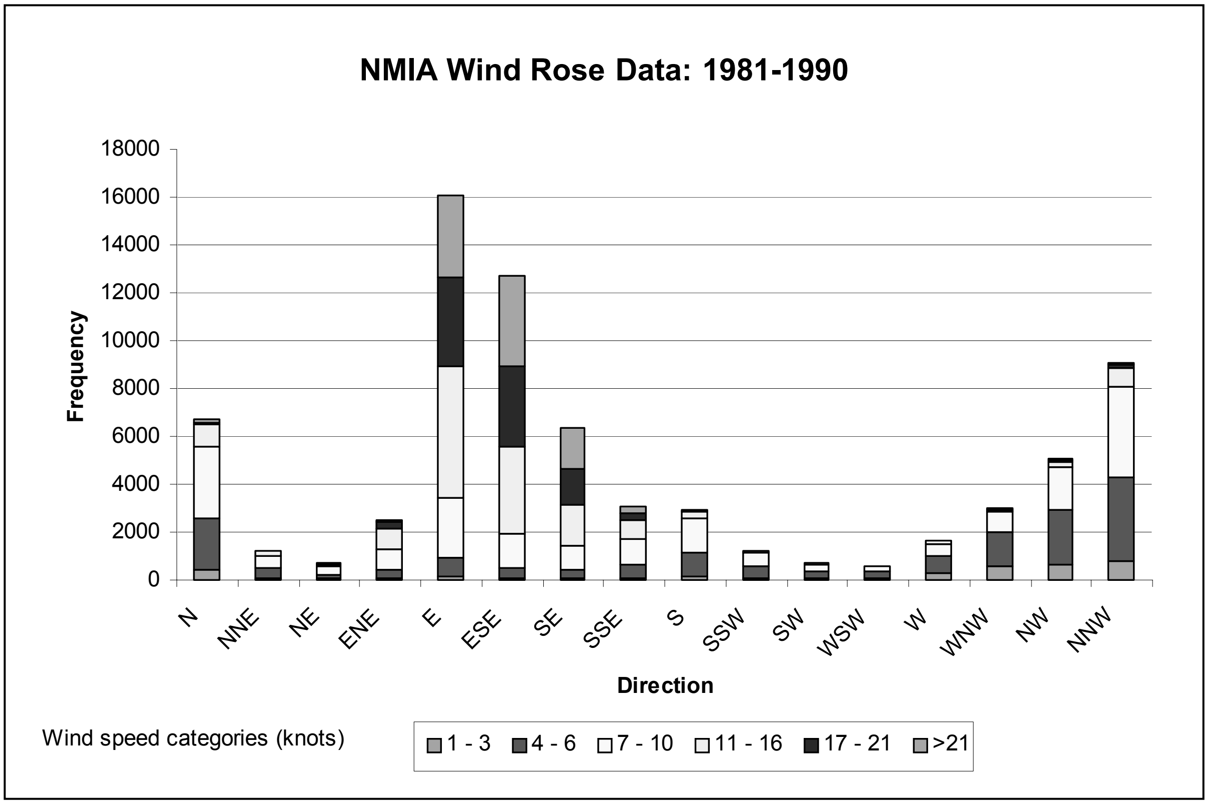

Figure 4.1 :Wind Speed and Wind Direction Frequencies: Norman Manley International Airport, 1981 - 1990

4.2 TOPOGRAPHY

The Soapberry site lies on a strip of coastal flatland at the southern end of an expansive alluvial plain that extends from the limestone foothills in the north to the coast at Hunts Bay in the south, (Figure 4.2). The site lies between the Rio Cobre in the west and the Duhaney River in the east, and is bounded on the northern, western and eastern sides by berms that are about 2.5 meters high. The area is flat with maximum elevation of 4 meters but generally the site is close to sea level with depressions up to 1 meter below sea level. The land slopes very gently towards the south.

The site can be divided into three distinct areas that correspond to the location of the three phases of the project, (Figure 4.2). The Phase 1 area is to the west of the site adjacent to the Rio Cobre. The berm on which the railway line runs forms the northern boundary while the western boundary is marked by the construction a dyke running along the bank of the Rio Cobre. This area is generally flat with the highest elevations towards the west and gently to the east and south. Elevations here are in the order of 3.5 meters.

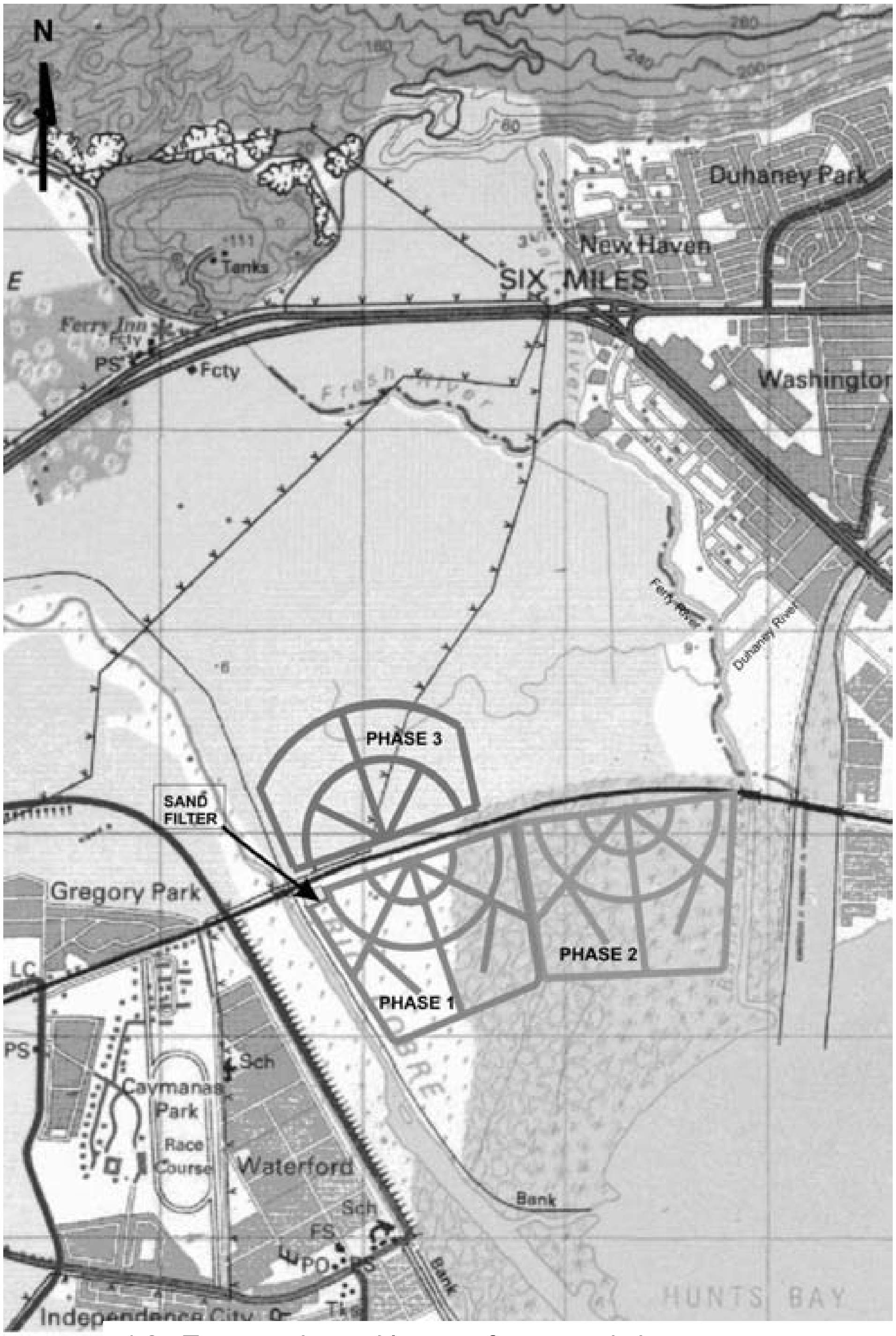

Figure 3 4.2: Topography and layout of proposed site

Phase two is located to the east and is bounded on all sides by a berm. This area has been completely filled in with dredge spoil and is entirely flat with the surface about 2 meters above sea level. The Phase 3 area is located to the north of the railway line that forms the southern boundary. The land is generally flat but has been made uneven by numerous pits dug for sand mining. A coastal marsh occupies the land between the proposed site and the Hunts Bay coastline to the south.

4.3 GEOLOGY AND SOILS

The site is underlain by a thick sequence of alluvium that is part of an extensive alluvial plain extending from Kingston in the east to southern Clarendon in the west. The alluvial plain is bounded in the north by the foothills of the central white limestone plateau. No significant geologic structures such as faults traverse the site.

Boreholes drilled on the site indicate that the soils are generally very soft clay, peaty clay or peat, (Appendix 2). The soils found on the western side of the site consist of soft to firm clays while soils on the eastern side are mainly soft clay or peat. Results of tests carried out on these soils is given in Appendix. The soils were classified as medium sand mixed with clay or silt. The soils were shown to be normally consolidated with optimum compaction water content of 27.5 percent and maximum dry density of 1425kg/m^3. The measured permeability at optimum compaction was 8.87 * 10^{-8} cm/sec.

4.4 SURFACE DRAINAGE

The surface drainage of the proposed site is determined by the regional topography and modifications that have altered the local surface flow conditions. The proposed site lies on the divide separating the Rio Cobre drainage basin and the smaller sub-basin of the Ferry-Duhaney Rivers, Figure 4.3. The Rio Cobre drains a watershed area of 580 Km2 located in north east St. Catherine.

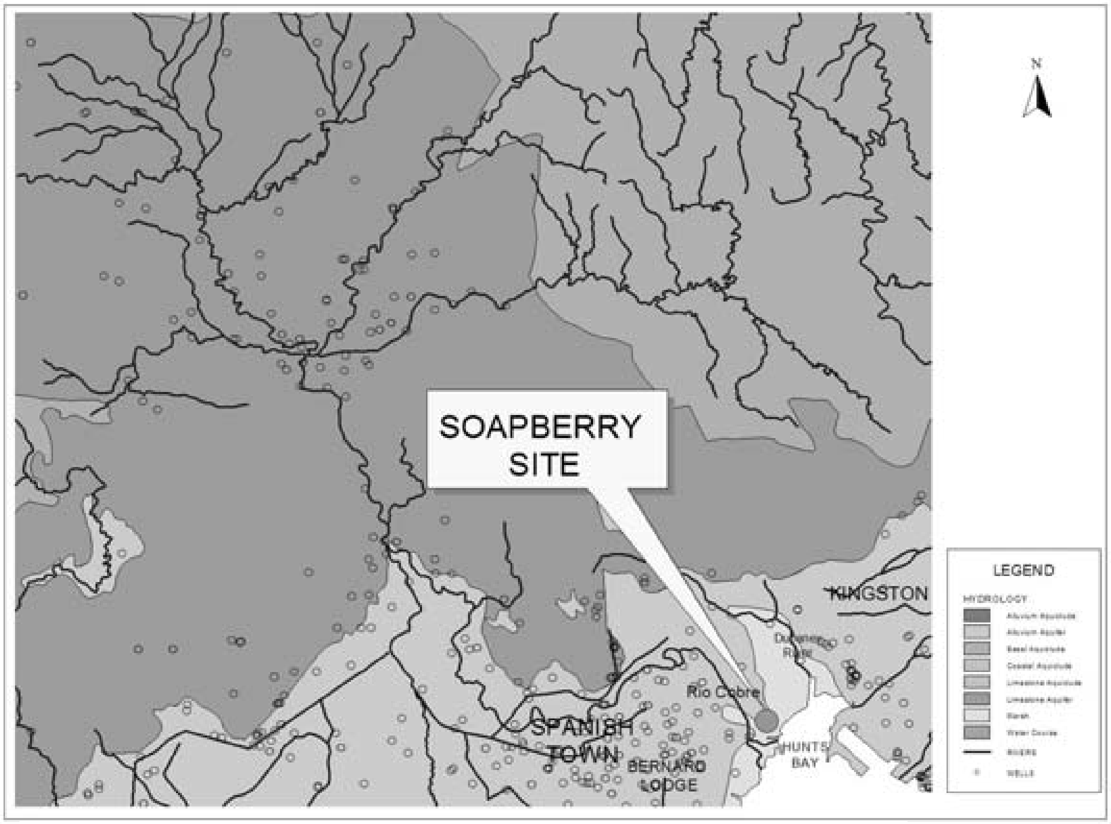

Figure 4.3: Drainage and Hydrology

The Rio Cobre flows in a southerly direction along the western boundary of the proposed site. In the vicinity of the site a 3 meter high dyke has been built on the western and eastern banks to contain flood flows within the channel. The mean discharge of the Rio Cobre is approximately 6.2 $m^3 s^{-1}$ but during flash floods peak flow may rise to 283 $m^3 s^{-1}$.

The Ferry River joins with the Duhaney River close to the eastern boundary of the site and flows southerly into Hunts Bay. These streams are fed by upwelling of ground-water along the limestone-alluvial contact at the base of the foothills in the north. The estimated mean discharge of the Ferry River below the confluence with the Duhaney River is 2.8 m^3/sec.

The generally low-lying flat alluvial plain between the limestone hills to the north and the sea has no other distinct drainage features. After long duration intense rainfall, significant sheet flow occurs overland and flows slowly to the south. Significant ponding occurs over large areas. The proposed site receives this overland flow which slowly accumulates in the Rio Cobre and the Ferry and Duhaney Rivers, and dissipates into the sea as slow moving overland flow or evaporates over time from the ponded areas. A detailed drainage map of the proposed project is provided in Appendix 2.

The construction of the proposed project will modify the existing drainage conditions by forming an obstacle to the movement of overland flow. However the designed drainage system around the constructed lagoons will divert overland sheet-flow around the facility allowing it to flow southward to the sea. In addition the present low lying areas in which extensive ponding occurs will be surrounded or raised by the construction of the lagoons and therefore less ponding of this overland flow is expected.

The Rio Cobre flowing along the western boundary of the project site has the potential to generate significant discharge during peak flows. In order to prevent overbank flow from the Rio Cobre, dykes have been constructed along both the western and eastern banks of the Rio Cobre in the vicinity of the project site. The potential for flooding by the Rio Cobre is discussed further in the hazard vulnerability section below.

4.5 GROUND WATER

The silty-clay and sand sequence underlying the site represents the eastern extension of the Rio Cobre Alluvium Aquifer. The water table elevation at the site is less than 0.3 m above mean sea level and the groundwater gradient is very flat. Groundwater flow in this area, is influenced by the Ferry and Rio Cobre Rivers, the wetlands, recharge over the existing disposal site and tidal activity.

The groundwater flow direction will vary depending on the factor exerting the greatest influence at the time of groundwater level measuring. The regional groundwater flow direction is however south towards the coast at Hunts Bay. Groundwater level fluctuation in this area is typically less than 0.2m.

4.6 TERRESTRIAL ECOLOGY

4.6.1 Flora

Previous investigations (Environmental Solutions Ltd., 1993) revealed that the site has a relatively calm seacoast where the black mangrove (*Avicennia germinans*) and the white mangrove (*Laguncularia racemosa*) trees dominate. The presence of Seaside Purslane and other halophytes indicate high salt levels in the substrate.

A list of plants previously identified from the area is given in Table 4.3 and the main ecological habitats are shown in Figure 4.4. Many of the plants exhibited morphological adaptations to high light intensity and dryness. Some of these features are thorns, succulents, small leaves and hairy stems. Most of the plants present on the site are typical of coastal areas.

Family	Botanical Name	Common Name	Habit
Monocotyledones:			
Arecaceae	Cocos nucifera	Coconut	Tree
Cyperaceae	Cladium jamaicense	Saw Grass	Herb
Liliaceae	Sanseviera metallica	Mother-in-law's Tongue	Herb
Poaceae	Andropogon sp.		Herb
Poaceae	Chloris barbata		Herb
Poaceae	Gynerium sagittatum	Wild Cane	Herb
Poaceae	Panicum maximum	Guinea Grass	Herb
Poaceae	Rhynchelytrum repens		Herb
Poaceae	Sporobolus pyramidatus		Herb

Family	Botanical Name	Common Name	Habit
Dicotyledones			
Aizoaceae	Sesuvium portulacastrum	Seaside Purselane	Herb
Amaranthaceae	Alternanthera halimifolia		Herb
Apocynaceae	Urechites lutea	Nightshade	Shrubby Vine
Asteraceae	Tridax procumbens		Herb
Asteraceae	Vernonia cineria		Herb
Avicenniaceae	Avicennia germinans	Black Mangrove	Shrub/ Tree
Bignoniaceae	Tecoma stans	Yellow Elder	Shrub
Boraginaceae	Cordia alba	Duppy Cherry	Shrub/ Tree
Boraginaceae	Cordia sp.		Shrub/ Tree
Boraginaceae	Heliotropium angiospermum	Dog's Tail	Herb
Caesalpiniaceae	Cassia alata	King-of-the-Forest	Shrub
Caesalpiniaceae	Cassia emarginata	Yellow Canlewood	Shrub/ Tree
Capparaceae	Capparis flexuosa	Bottle-cod Root	Shrub
Combretaceae	Laguncularia racemosa	White Mangrove	Shrub/ Tree
Combretaceae	Terminalia catappa	West Indian Almond	Tree
Euphorbiaceae	Euphorbia blodgetti		Herb
Euphorbiaceae	Jatropa gossypifolia		Shrub
Fabaceae	Abrus precatorius	Crab's eye	Climber
Malavaceae	Sida aggregata		Undershrub
Malvaceae	Thespesia populnea	Seaside Mahoe	Tree
Mimosaceae	Acacia farnesiana		Tree
Mimosaceae	Leucaena leucocephala	Lead Tree	Shrub
Mimosaceae	Pithecellobium unguis- cati	Bread-and-Cheese	Tree
Portulaccaceae	Talinum triangulare		Herb
Zygophyllaceae	Tribulus cistoides	Kingston Buttercup	Herb

Table 4.3: Flora on the project site in 1993.

Figure 4.4: Ecological habitats

Three ecological habitats were distinguished in 1993 on the basis of vegetation type, prior and current land use, and physical features. These were mangrove scrub, tidal mudflats, and scrubland.

The field visit carried out in October 5, 2004 confirmed the continued presence of those zones. However, there have been modifications to the estuarine mudflats and the scrublands. Firstly, 113 hectares (280 acres) of mudflats at the north eastern area of the site have now been filled with dredge spoil from ongoing maintenance dredging at the mouths of the Rio Cobre and the Sandy Gully, (see Plates in Appendix 3). Secondly, contractors in preparation for site development have since cleared a small area of closed canopy woodland in the scrubland at the northwestern section of the site.

Ponds reported from the site in 1993, largely created by sand mining, still exist except for that in the northwestern section which has since been filled by dredge material. The present extent of the habitats described above are shown in Figure 4.4.

4.6.2 Habitats

The three main ecological zones or habitats (Figure 4.4) categorised in 1993 are still the main zones occurring in the project area. These are as follows:

- **Mangroves**

  Mangroves were identified lining the banks of the Rio Cobre (west), the Duhaney River (east), Hunts Bay (south) and the train track (north). The shoreline of the Duhaney River is less disturbed than that of the Rio Cobre having low sloping grassy banks. The banks of the Rio Cobre are very steep reaching up to 20ft. in some areas.

- **Tidal mudflats**

  A large mudflat exists in the eastern half of the property. This zone can be divided into three sections:

  a. The northern section with muddy flats, scattered mangroves, ponds, many mangrove stumps, and 280 acres of dredge spoil, (see plates in Appendix 2).
  b. Higher ground in the central region where landfill activities appeared to have been concentrated. This area has a grassy belt, scattered *Acacia* sp. (Cassia) trees, scrub and coastal herbs (*Sesuvium* sp.). There are many ridges, depressions, sand patches and mounds giving further evidence of land-fill.
  c. The southern portion of the project area is muddy with mangrove stumps. This area was reported as having the remains of several coal kilns in 1993, as coal

burning was a major activity on the site resulting in the loss of the dense coverage of mangroves that had existed prior to that time.

- **Scrubland**

The western side of the property was reported in 1993 (ESL, op. cit.) as being densely vegetated with grass, shrubs and trees. This area remains so today with large trees (15-20 ft in height). The closed canopy woodland (trees 30-40 ft in height) reported in 1993 exists no longer as these trees have been cleared from the property.

The area to the north of the railway line, slated for Phase 3 of the STP development, which was not assessed in 1993, is also covered with disturbed scrub vegetation. This area is dominated by the thorny scrub *Acacia sp*. with ruinate vegetation and mined out sand pits.

4.6.3 Fauna

- **Birds**

  The list of birds identified in 1993 is given in Table 3.4. The same species were also observed in 2004. The 1993 study was conducted toward the end of the summer and several migratory and over-wintering species were reported. On October 5, 2004, migratory species were also observed. The common winter visitor, the American Redstart (*Setophaga ruticilla*), was observed in the wooded areas and scrubland, identified for the establishment of Phase III of the project. This species was not reported in the 1993 study.

  Because of the variety and availability of habitats the birds at Soapberry show a high degree of diversity and abundance. The majority were species that utilise the shoreline, river banks, mangroves and ponds such as terns, herons, egrets, plovers and sandpipers. The other dominant species of birds were those usually reported from open areas and scrubland.

Scientific Name	Common Name	Status
Cathartes aura	Turkey Vulture	Common resident
Fregata magificens	Magnificent Frigate Bird	Common resident
Pelecanus occidentalis	Brown Pelican	Common resident
Arenaria interpres	Ruddy Turnstone	Common winter visitor
Himantopus mexicanus	Common Stilt	Common resident
Ardea herodias	Great White (Blue) Heron	Common winter visitor
Butorides virescens	Green Backed Heron/Gaulin	Common resident
Nycticorax nycticorax	Black Crowned Night Heron	Fairly common resident
Nycticorax violaceus	Yellow Crowned Night Heron	Common resident
Egretta caerulea	Little Blue Heron	Common resident
Egretta tricolor	Tricoloured Heron	Fairly common resident
Egretta thula	Snowy Egret	Common resident
Larus atricella	Laughing Gull	Common resident
Gallinula chloropus	Common Moorhen	Very common resident
Sterna antillarum.	Least Tern	Common summer resident
Calidris sp.	Sandpiper	Six species of Sandpipers occurring in Jamaica: 2 fairly common winter visitors; 1 common winter visitor; and 3 uncommon winter visitors
Charadrius sp.	Plover	Common winter visitor and fairly common winter visitor
Charadrius vodiferus	Killdeer	Common resident
Eudocimus albus	White Ibis	Uncommon resident in mangroves
Ralllus longirostris	Clapper Rail	Uncommon resident
Zenaida aurita	Zenaida Dove	Locally common resident
Columbina passerina	Ground Dove	Very common and widespread resident
Tyrannus caudifasciatus	Loggerhead Kingbird	Common and widespread
Dendroica discolor	Praire Warbler	Common winter visitor
Dendroica petechia	Yellow Warbler	Common resident
Helmitheros vermivorus	Worm Eating Warbler	Uncommon transient and winter visitor
Crotophaga ani	Smooth Billed Ani	Common resident
Saurothera vetula	Jamaican Lizard Cuckoo	Resident, less common than the Chestnut-bellied Cuckoo
Chordeiles gundlachii	Antillean Nighthawk	Common summer resident
Falco sparverius	American Kestrel	Very common resident
Loxigilla violacea	Greater Antillean Bullfinch	Common resident
Tachornis phoenicobia	Antillean Palm Swift	Very common resident
Setophaga ruticilla	American Redstart	Common winter visitor

Table 4.4 List of birds identified at Soapberry

* Identification and status based on Downer and Sutton, 1990; Bull and Farrand, Jr, 1977; Bond, 1985

- **Butterflies**

In 1993, nine species of butterflies were observed only within the scrubland and mangrove areas (Table 3.3) and none recorded from the landfill or grassy areas.

Common Name	Scientific Name	Distribution
Julia	*Dryas iulia delila*	Islandwide
Antillean Great White	*Ascia monuste eubotea*	Islandwide
Buckeye	*Precis evarete zonalis*	Islandwide
Maerula	*Anteos maerula maerula*	Islandwide
Cloudless orange	*Phoebis agarithe cubana*	Islandwide
Statira	*Aphrisa statira cubana*	Islandwide
Sulphur	*Eurema sp.*	Islandwide
Antillean malachite	*Siproeta stelens stelens*	Islandwide

Table 4.5: List of butterflies reported from the project area in 1993.
Identification and status based on Brown and Heineman (1972)

In the site assessment of 2004, several of these species were observed within the same habitat areas.

- **Mammals**

The only mammals that were recorded on the property in 1993 were dogs (as evidenced by tracks) and mongooses. No dogs or mongooses were observed in October 2004, but it is likely that these species are still present.

- **Fish**

Representative fish specimens were not collected in 1993, but reports from fishermen in the area indicated that snook, mullet, tarpon, and perch were present in the rivers.

Mangroves provide a major ecological function for Hunts Bay as they provide a source of detritus, act as shoreline protection and provide nursery habitat for fish. The ecology of Hunts Bay has been severely compromised by development in recent times.

- **Reptiles**

Reptiles observed in 1993) and noted again in 2004 included several species of lizards (Table 3.4) and the American Crocodile, C*rocodylus acutus,* which inhabits the Rio Cobre, Duhaney River, and the Hunts Bay.

Scientific Name	Status	Distribution
Anolis lineatopus	Endemic	Islandwide
Anolis grahami	Endemic*	Islandwide
Anolis valencienni	Endemic	Islandwide

Table 4.6: Reptiles recorded at Soapberry

Identification and status based on Schwartz and Henderson, 1991

* Introduced on Bermuda

- **Other invertebrates**

Many invertebrates were observed on the site in 1993 and were still present in 2004, including dragonflies, mosquitoes, lady bugs, flies, bees, wasps, termites, land crabs, fiddler crabs, and shrimp (rivers and Hunts Bay).

- **Endangered species**

The American crocodile (*Crocodylus acutus*) is indigenous to Jamaica occurring naturally in wetland areas where there is brackish water and adequate food. Populations in Jamaica are primarily found along the south coast from St. Thomas to Westmoreland,

and on the north coast in Hanover and Trelawny. The population of Jamaican crocodiles is threatened by destruction of wetlands particularly for coastal developments, aquatic pollution, hunting and wanton killing. The mangrove fringed Hunts Bay, the rivers leading into the Bay and the Kingston Harbour environs are known habitats for this species. *Crocodylus acutus* is protected by both national and international legislation. It is illegal to kill or to have in ones' possession any part of the animal. A crocodile management plan is included as Appendix 5.

4.7 HUNTS BAY ECOLOGY

Hunt's Bay has traditionally been a major source of shrimp fishery. The fisherfolk located on the Causeway, fish in Hunts Bay, as well as further out to sea. Based on data received from the Fisheries Division (Environmental Solutions Ltd, 2002). Hunts Bay has a licensed fishing beach with seventeen (17) boats in use. The Portmore Causeway fishing beach is not registered but has one hundred and three (103) boats in use. The Causeway Fishing Beach, though unlicensed, is the largest fishing beach in the Harbour rim.

The main resources for the fisherfolk on the Causeway Beach and in Hunts Bay are snapper and shrimp. Kingston Harbour and Hunts Bay have both been recognized as dying ecological systems resulting from continued pollution loading over the years, and the fisheries have been further compromised by overfishing. Anecdotal information over the years has indicated that the shrimp fishery in the Bay has steadily declined and the fisherfolk indicated that fish and shrimp have almost disappeared from the Harbour.

Webber *et al* (2003a) noted that organic pollution of Kingston Harbour has continued unabated since the initial ecological assessments conducted in the early 1970's)indicated that the area was under stress. Species of polychaetes previously described as being indicators of organic pollution in Hunt's Bay and the Inner Harbour/Upper Basin no longer occur. There has been a complete loss of benthic macrofauna in the central areas of Hunts Bay and the Upper Basin. The only animal groups found in these areas are meiofauna with a dominance of nematodes (90 - 100%) in this assemblage. The sediment macrofauna have totally disappeared from the deeper basins within the Harbour as well as in Hunts Bay.

A study by Webber, *et al* (2003) showed that there are three major types of currents in Kingston Harbour. These are density or salinity driven currents, wind driven currents and tidal currents. All sources act in concert with each current type to determine the circulation pattern in the different zones of the harbour. The outer harbour behaves as a true estuary with density currents dominating surface circulation patterns while deep currents are tidally driven. The inner harbour however, appears to be more tidally driven due to existing bathymetry, which accentuates the tidal currents.

High rainfall levels and winds influence the inner harbour surface layers with wind and density generated currents frequently opposing each other. The upper basin appears to be least active and is dominated by wind driven currents that are strong but short-lived. These currents produce gyres of circulation enhancing mixing within the upper basin but there is little net current motion between inner harbour and upper basin.

4.8 WATER QUALITY

Hunts Bay is a shallow basin of an area of 10.10 km^2 with depth ranges from 0.31 m - 4.57 m (Goodbody, 1970; Wade, 1976; Ranston, 1998 in Webber 2003). The Bay is subjected to considerable salinity fluctuations due to fresh water run off from the Rio-Cobre, Ferry and Duhaney Rivers and from the Sandy Gully (Fig. 3.5) and is now only connected to the Harbour by a 213.36 m opening since the construction of the Causeway Bridge in 1969 (Webber 2003).

Fresh water enters the harbour at Hunts Bay from two main rivers, the Rio-Cobre and the Duhaney Rivers, and by a drainage scheme, the Sandy Gully as well as via several intermittent streams (Webber, 2003). The most important source of fresh water is the Rio-Cobre, which has a mean discharge of approximately 6.2 $m^3 s^{-1}$ but during flash flood peak flow may rise to 283 $m^3 s^{-1}$ (Government of Jamaica, 1968; Wade, 1976 in Webber 2003).

The discharge rate of the Duhaney River is fairly uniform (2.83 $m^3 s^{-1}$) but is less than half that of the Rio Cobre while Sandy Gully discharge over a one-year period was approximately 61,317 million litres or 1.9 $m^3 s^{-1}$ (Government of Jamaica, 1968; Wade, 1976 cited in Webber 2003). When there is significant land runoff, water also enters the harbour along its northern shore via several gullies. The flow rate of these gullies on the north shore was 1.7 $m^3 s^{-1}$ or 54,504 million litres per year (Webber, 2003).

Webber et al (2003) clearly show that the concentration of pollutants in Hunts Bay have increased considerably over the last twenty years. Webber (2003) further show that the eutrophication of Kingston Harbour can only be reversed by control of the domestic and industrial waste presently released into it. Even with such waste being diverted, the slow flushing time of the Harbour make that a difficult task (Webber 2003). It is important therefore that adverse impact(s) on these surface water systems be minimized to prevent further degradation of the water quality.

Treatment of sewage by the proposed Soapberry WWTP will considerably improve the water quality of the Rio Cobre and Hunts Bay. The water quality in these water bodies is presently quite stressed with high bacterial, nutrient and organic loading. In the long term this should contribute to the reduction of the effects of eutrophication and a restoring of some of the ecological attributes of the Bay.

Three surface water sampling stations were investigated indicated on Figure 4.5 as stations SB1, SB2 and SB3, and described in Table 4.7. The results obtained from the analysis of these samples are presented in Table 4.8. The current and historical water quality data gives an indication of the water quality of the surface water systems under investigation.

STATION	LOCATION
SB3	Rio Cobre at its mouth
SB2	Hunts Bay – South
SB1	Duhaney River at the mouth

Table 4.7: Surface Water Quality Stations

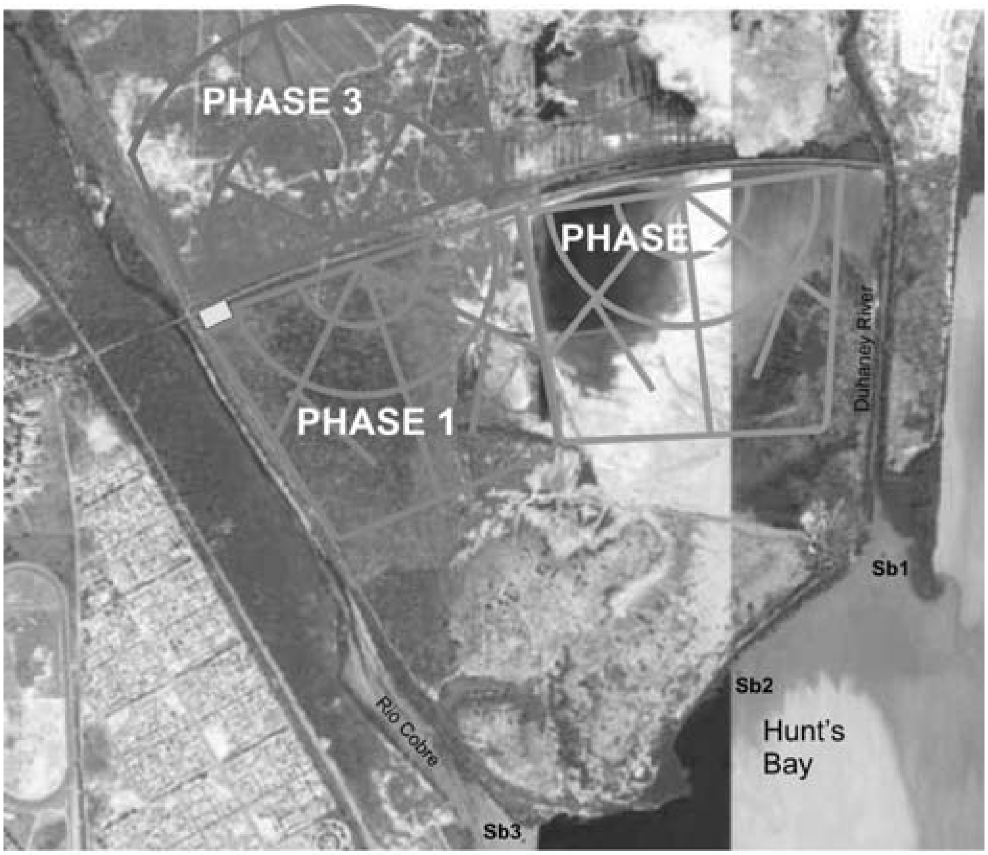

Figure 4.5: Water quality sample stations

PARAMETERS	SAMPLES			NEPA Marine Standards
	SB 1	SB 2	SB3	
pH	7.8	8.7	8.3	8.0-8.44
Salinity (ppt)	4.0	9.1	2.2	-
Dissolved Oxygen (mg/L)	2.8	7.8	5.9	4.5-6.8
BOD (mg/L)	3.0	12.0	10.0	0.57-1.16
Nitrate (mg/L)	1.2	0.1	3.8	0.001-0.081
TSS (mg/L)	5.0	16.0	31.3	-
Phosphate (mg/L)	0.2	0.2	0.3	0.001-0.055

Oil & Grease (mg/L)	2.0	0.5	0.7	-
Total Coliform (MPN/100ml)	>2400.0	93.0	>2400.0	48-256
Faecal Coliform (MPN/100ml)	1100.0	23.0	1100.0	<2-13

Table 4.8: Water Quality Data for the Soapberry EIA

Key:* : Draft NEPA Ambient Water Quality Standard for Marine Water

The data generated for the surface water systems show considerable organic contamination and high bacterial loading.

Dissolved Oxygen

Dissolved oxygen levels were good at Stations S1 and S3 ranging from 5.9 to 7.8. The dissolved oxygen levels at the mouth of the Duhaney River were however quite low.

pH

The waters at all three stations sampled were slightly alkaline.

Biochemical Oxygen Demand (BOD_5)

BOD for surface waters in excess of 2.0 mg/l indicates elevated organic loading, which is a cause for concern. BOD levels were elevated at all three stations ranging between 3 and 12 mg/l. High BOD levels are a direct consequence of the high concentration of oxygen demanding species in the surface waters.

Total and Faecal Coliform Bacteria

Faecal Coliform is used as indicators of the possible presence of pathogenic organisms. The generally accepted limit for faecal coliform in surface waters is 200 MPN/100 ml. A guideline of 450 MPN/100 ml is used for one off samples. This limit has been significantly exceeded at two stations, where levels were in excess of 1,100 MPN/100ml. Sewage effluent (raw and partially treated) from several sewage treatment facilities, as well as raw sewage from residences without sanitary facilities is discharged into these surface water systems. It is well known that many of these treatment plants are not operating efficiently and are discharging untreated sewage effluent into the surface water systems. These activities are the probable cause of the high faecal coliforms present in the surface water systems.

Total Suspended Solids (TSS)

Total Suspended Solids loading at the water quality stations ranged between 5 and 32 mg/l. The mouth of the Duhaney River was most impacted with considerable quantities of detritus.

Oil and Grease

The oil and grease concentration recorded at each station was below the recommended national guideline.

4.9 NATURAL HAZARD VULNERABILITY

The project site is exposed to the main natural hazards that affect Jamaica, hurricanes, earthquakes and flooding. The location, topography and geology of the proposed project site makes it susceptible to coastal and riverine flooding associated with high intensity rainfall from hurricanes and other extreme weather systems. In addition the site is susceptible to earthquake induced ground shaking located as it is in the zone of highest earthquake frequency and intensity.

4.9.1 Flood Hazard

The site is located close to the eastern bank of the lower reach of the Rio Cobre as well as the coastline in the south from which it is separated by a coastal marsh. The flatness of the land surface and low elevation of the site makes it susceptible to flooding. The potential sorces of flooding are from over bank flow from the Rio Cobre, inundation from storm surge run-up as well as from overland sheet flow.

A dyke has been constructed on both banks of the Rio Cobre to contain overtopping the banks from flood flows. While 50 and 100 year peak flows have been estimated for the Rio Cobre at close to 2000 and 2500 m3/sec respectively, no significant flooding has been recorded in this area as a result of high flows in the Rio Cobre. In 2002 flood flows in the Rio Cobre resulting from intense rainfall were determined to represent 100 year discharge levels. However no overtopping of the dykes in the vicinity of the project site occurred.

The passage of Hurricane Ivan in 2004 along the southern shoreline of Jamaica generated significant storm surge that inundated susceptible parts of the south coast. However, no significant storm surge was recorded within Hunts Bay or along its northwestern coastline that is adjacent to the project site. The control of overland sheet flow by an appropriate storm water drainage system will effectively divert overland storm water flow around the facility and into Hunts Bay. This will have the effect of channelizing and controlling storm water flow and thus preventing ponding.

The presence of the dykes along the river bank separating the site from the Rio Cobre together with the height of the berms for the WTP lagoons suggests that riverine flooding will not adversely affect the structures of the WTP facility. However the low lying, flat nature of the site will require an extensive stormwater drainage system to prevent ponding. Storm surge inundation effects are also expected to be limited as these will be minimized by the expected relatively low storm surge heights and the distance of the WTP facility from the coastline.

4.9.2 Seismic Activity

Earthquake hazard zonation for Jamaica determined over the period 1692 to the present time, shows that the Kingston area is susceptible to seismic activity (Figure 4.6). Data from the Earthquake Unit at the University of the West Indies indicate that for Modified Mercalli Intensities (MMI) the Kingston area has an average exposure rate of 7 occurrences per century. MMI is the threshold for damage to ordinary but well-built structures.

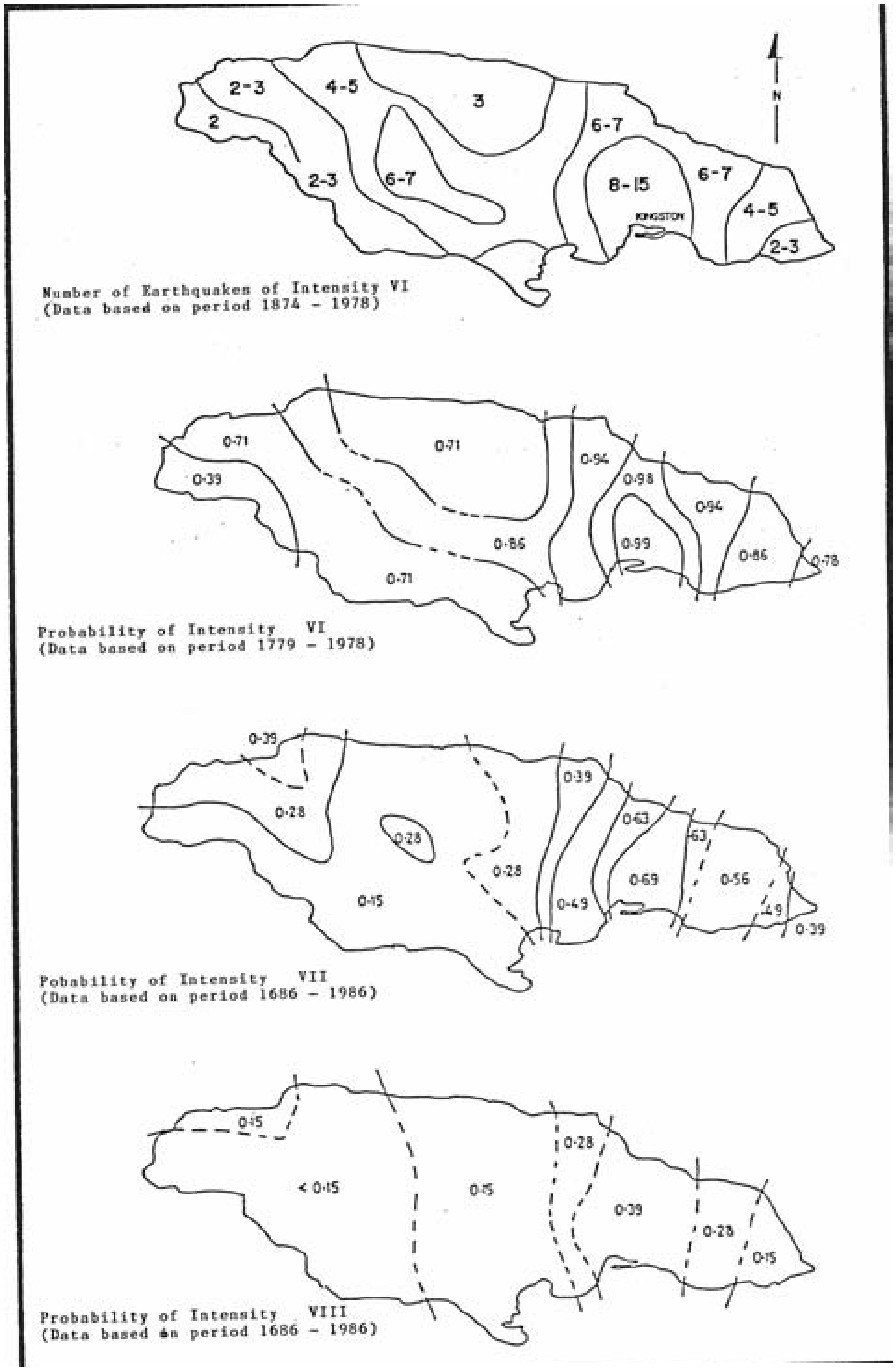

Figure 4.6: Earthquake hazard Zonation of Jamaica.

Strong motion studies of earthquakes and the response of underlying materials by the CDMP 1999, produced a strong motion earthquake hazard map for Kingston Metropolitan Area. This map presented as Figure 3.7 shows the horizontal ground motion expected as a percentage of gravitational acceleration in areas of differing underlying substrate. The acceleration rates represent the site-corrected earthquake ground motion that have a 10% chance of being exceeded in 50 years. The map indicates that the proposed project site lies in an area that requires a site specific ground motions study to determine the likely behavior of the existing soils to ground motion induced by earthquakes.

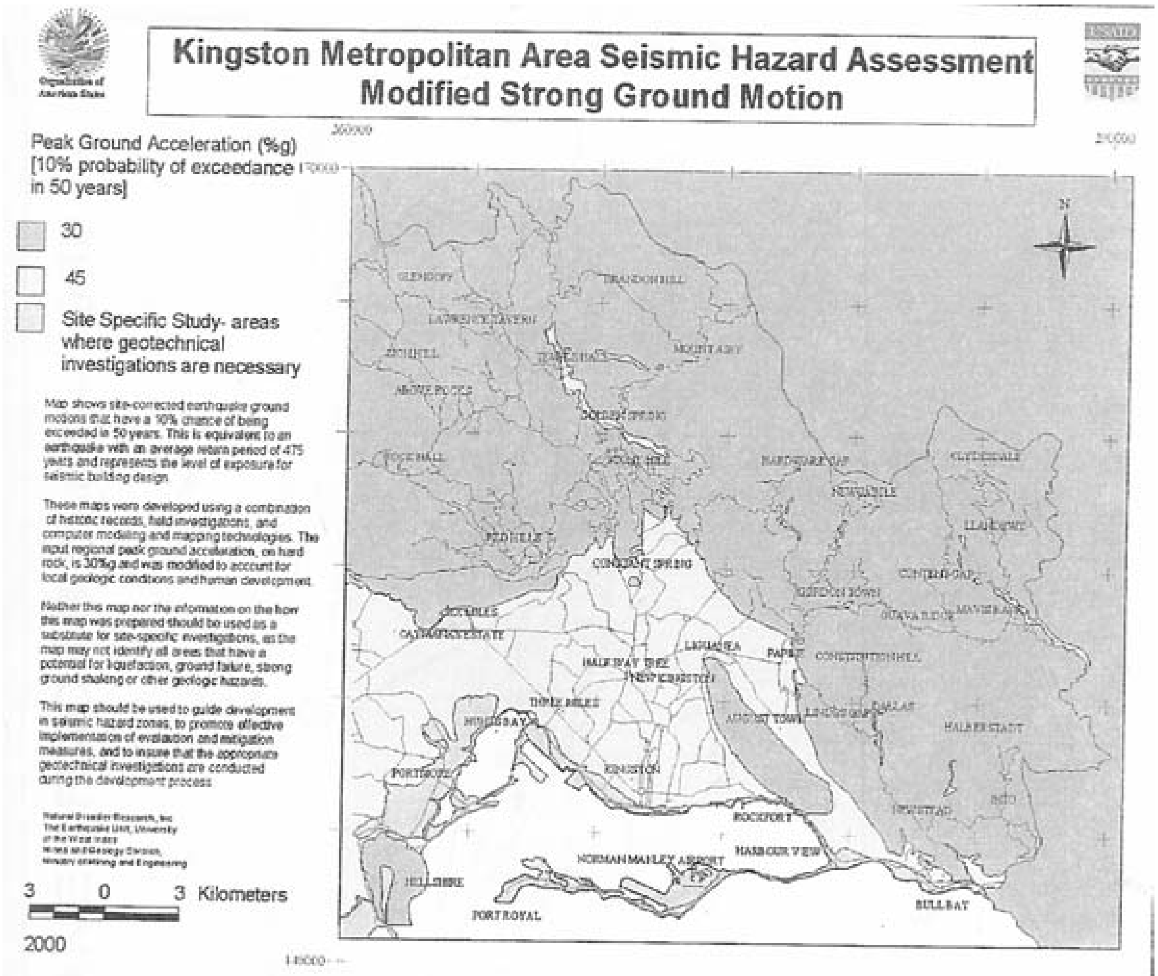

Figure 4.7: Strong motion seismic hazard for the Kingston Metropolitan Area

4.10 SOCIO-ECONOMIC ENVIRONMENT

The socio economic assessment involved conducting interviews in communities and select enterprises thought to represent or lie on the periphery of any negative human settlement impacts that might arise from the Project. The communities included Riverton City, Riverton Meadows, Waterford and New Haven.

4.10.1 The Communities

Waterford

Waterford is one of the earlier housing developments undertaken in Portmore. It lies roughly east of Caymanas Park and north of Independence City, and is bordered by the Dyke Road. As such, it is the nearest of the Portmore communities to Soapberry.

The community can be characterized as a mainly lower middle income residential community, with employment being outside of the community and in the KMA and Greater Spanish Town areas in particular. Most occupations are represented within the community. Civic pride is evident and the community is well-maintained.

Riverton City

Riverton City spreads west of the Spanish Town main road from a point a mile south east of the Six Mile intersection, to the north of the Old Passport Office. The community is a squatter community with substandard housing in all instances observed, and one which has been well documented as one of the most depressed urban communities in terms of living conditions. Fronting, or close to the main road through the community to the landfill were about 121 shanty units, although observation suggests that the total number of dwellings could be twice this number.

It is a community whose existence is integrated with the main landfill serving several Eastern parishes.

Riverton Meadows

Riverton Meadows is a part of the larger Riverton community, but lies to the south of Riverton City. It takes its name from a low income housing scheme constructed several years ago, to rescue the community from the image of squalor associated with it. It lies just east of Riverton City, but like Riverton City, its existence is highly integrated with the landfill. The housing scheme comprises 100 completed units with 20 more units remaining to be finished. However, at least a similar number of shanty dwellings also border the scheme.

New Haven

New Haven is located at Six Miles on the Mandela Highway. Geographically it lies farthest from Soapberry. It comprises a core planned residential community, increasingly encroached upon by unplanned residential development. It is mainly a lower middle class community, but likely to number most occupations within the community. Seven (7) persons were interviewed.

4.10.2 Land Use and Livelihoods

Recycling waste is a very important form of livelihood in the Riverton City and Riverton Meadows communities. This is a hustling occupation where the main incomes come from collecting and selling glass bottles, copper scraps, aluminum scraps, brass scraps and rebuilding broken items of furniture etc. A recycling enterprise, Caribbean Paper Recycling, located close to the entrance of Riverton is one focal point of this activity.

Of those engaged in sorting occupations, 70% reside within the community and 30% are visiting sorters. For all sorters, 77% do this as their sole source of income. (Hamilton, 1998). Periodically, uneasy relationships develop between public management of the dump and the community members, and this has in the past led to setting fire to the dump.

Community members complained of the lack of reliable employment and stated that most community members did not hold jobs outside of the community. From the large number of apparently idle persons observed, underemployment is likely to be high. In keeping with other communities visited, a frequent question directed at interviewers is the possibility of employment within the project being planned.

4.10.3 Public Health and Safety

New Haven is fully served by public utilities and shares a health clinic with its neighbouring Duhaney Park. Similarly its fire services and policing rely on those facilities located at Halfway Tree and Duhaney Park, respectively. There is a New Haven Citizens Association, which meets periodically.

Riverton receives its water through illegal connections to the main NWC supply serving neighbouring areas or from entities that allow their supply to be tapped. A spring is said to exist in the community, and several persons were seen carrying containers to and from its reported location. Toilets are mainly pit latrines with very few dwellings appearing to have inside flush toilets.

Several random and unmanaged dump sites were observed, especially for old car and truck bodies. Smoke and dust from the landfill is repeatedly complained about. Dust is also generated by the vehicles bringing garbage to the landfill, both from their contents and also from the unpaved roads serving the landfill site.

Riverton Meadows, being an approved development, receives its water through NWC and its electricity through metered JPS connections. Outside of the housing scheme, water supply seemed to be derived from the same type of sources as for Riverton City.

All of the scheme houses are sewered but those in the surrounding shanty community use mainly pit latrines.

Riverton Meadows is evidencing clear signs of urban deterioration. The housing scheme itself, presents the appearance of becoming overcrowded and poorly maintained. Green spaces are virtually non existent, except in the form of a poorly maintained football field. Mini dump sites are crowding the schemes borders. A church affiliated small visiting clinic exists, but seems to cater mainly to the children of the basic school which it operates.

Waterford also enjoys full access to the utilities, including a reliable supply of water from NWC. The entire scheme is sewered and garbage is routinely collected by the municipality. Although not served by its own health clinic, it has access to one in Independence City, and the nearest hospital is in Spanish Town. Similarly its fire services and policing rely on those located in nearby communities and serving the Portmore area. There is a Waterford Citizens Association that meets periodically.

4.10.4 Social and Physical Infrastructure

Several churches and basic schools exist in New Haven and Waterford. A small computer lab has been sponsored by the Roman Catholic Church, which is active in the area, and is used to teach computing skills to interested adults. There is also a secondary school in Waterford.

Drainage is a problem in the communities which are generally flood prone. Riverton City and Waterford and New Haven flood regularly due to either low-lying/flat topography and/or poorly designed and maintained drainage ways. Waterford residents complained that flooding is mainly attributable to poor drainage that pushes water from surrounding areas into Waterford.

4.10.5 Attitude to Project

Knowledge of the proposed project was minimal, but residents generally regarded the planned project with apprehension and cynicism. Their view of sewage treatment plants was invariably negative, the main concern being the persistent odour associated with them. They pointed to the ever-malfunctioning plant at Independence City, the ponds at Hillview and the relatively small plant at Portmore Villas. Members of the community were willing to accept that the technology of treatment ponds is reliable, but they had no faith in the private or public sector, whether central or local government, to operate and maintain the technology over time. Several members within groups spoken to were very vocal against the project. In addition to odour the main concerns were mosquitoes and general health.

It is evident that the community, based on its experiences, can easily be mobilized to strongly resist the project. Among those interviewed was a total consensus that the project would not benefit the community in income or employment terms, sufficiently to offset its perceived disadvantages. Community dialogue and awareness building may help to reassure residents that their concerns can be addressed, and may help avoid any public conflict over the project.

4.11 Design Flow Comparisons

Two population forecasts for Kingston and Portmore provide an indication of the number of persons who will benefit from the project when it is completed. The Sentar study (SENTAR, 1993) estimated the combined populations in 2015 to be 966,035. The K.B.R. Master Plan projects the populations in 2025 to be 966,990. Both figures include an 'equivalency' factor which adjusts for industrial and commercial use.

The proportion of the populations to be served can be approximated from the ratio of projected flows to the plant over the phasing of the Project. The daily flows to Soapberry in 2025 are projected at 220,213 m^3/day. The proportion of this total achieved at the end of each phase is given in Table 3.9.

	STAGE 1	STAGE 2	STAGE 3
TOTAL	56%	66%	100%

Table 4.9: Proportion of Population Served at the End of Each Phase

A comparison of design between the SENTAR study (SENTAR, 1993) and the K.B.R. study (2003) are summarized in Table 4.10 below.

	Stage 1 (start)	Stage 1 (end)	Stage 2 (end)	Stage 3 (end)
Soapberry	63,188	104,573	126,794	201,082
Portmore	8,800	19,131	19,131	19,131
Total	71,988	123,704	145,925	220,213

Table 4.10: Summary of Design Flows to Soapberry Treatment Plant [m^3/ day] [1]

5. ENVIRONMENTAL IMPACTS AND MITIGATION

5.1 Engineering Assessment

The construction of the Soapberry Sewage Treatment facility is a positive and necessary intervention. However there are both positive and negative impacts of this proposed new sewage treatment facility for Kingston and Portmore. The main issues include:

1. Level of treatment provided to sewage produced in the KMA and Portmore

At present a large volume of the sewage produced in the KMA is untreated or treated at a very basic level and well below the established NEPA effluent standards. The Sentar report (1993) and the K.B.R. report show that raw sewage, poorly treated sewage and non-point source sewage enter Kingston Harbour. The non-point source sewage comes from several lots where sewage is discharged into the ground through various types of soil absorption systems including absorption pits with direct discharge of sewage to the pits; and elsewhere, the direct discharge of sewage to the storm drain systems from communities that have developed along the banks of these storm-drains.

The Western Sewage Treatment plant, as well as Greenwich STP, receive septage removed from the absorption pits and septic tanks throughout the KMA, and some from areas far outside the KMA. With no treatment occurring at these plants this septage is effectively being discharged untreated into Kingston Harbour.

Once the lagoon system sewage plant is constructed in Soapberry, it will be able to receive and treat all the sewage described above before disposal to the harbour, with secondary treatment removing more than 90% of organic loadings and tertiary treatment bringing the BOD concentrations to around 10 mg/l.

The proposed Oxidation Lagoon System STP will be able to reduce loadings as shown in the following table:

Element	Removal Rate (%)
Biochemical Oxygen Demand (BOD)	90-97%
Chemical Oxygen Demand (COD)	90-95%
Total Nitrogen	80-90%
Total Phosphorus	55-60%
E Coliform bacteria	99.99%

2. Method of treatment employed

The large sewage treatment facilities in Jamaica that have relied on mechanical means for treatment have not over the long term been effective because of the maintenance and repair costs. These facilities have not been maintained at the standard that they should, and consequentially the effluent quality declines.

The knowledge of these facts brought both Sentar (in the 1993 report) and KBR (in the 2003 report) to the conclusion that the most suitable solution recommended for the treatment of the KMA and Portmore sewage are stabilization ponds.

In addition, the climatic conditions in Jamaica in general and in Soapberry in particular, are optimal for stabilization ponds: winds for mixing, warm weather, and sun all year round for photosynthesis and disinfection.

The application proposed for Soapberry is a natural system utilizing ponds. The operation and maintenance costs of these systems are much reduced and therefore the ability to effect better quality control is enhanced. In addition, these plants are far better suited for shock loads and for fluctuating loads.

3. Effluent quality and maintenance of effluent quality

The use of natural means to treat the sewage is strongly recommended in keeping with earlier comments. The combination of the sewage lagoons and the sand filter will provide effluent of a high quality. Through the monitoring of this development a further design strategy can be implemented in the second phase of the plant to ensure that the phosphorous level is further reduced.

As effluent quality is good it should also be considered for use as irrigation, especially if used in the normal flood method within the cane producing areas.

4. Disposal of effluent

The effluent is to be discharged into the Rio Cobre just downstream of the lower railway bridge.

5. Sludge management

Scum develops on the top of lagoons and requires management to reduce accumulation. Scum accumulation can create three main problems:

It accumulates in specific areas induced by the wind and direction of flow through the plant and eventually affects the design flow regime.

It produces odours because it accumulates and becomes anoxic.

It breeds flies because it is floating and the upper surface remains above the liquid level.

The radial design of the system will reduce the effects of accumulated scum. The shape is intended to have the ponds aligned with the wind so that the scum will not accumulate because the flow is in opposition to the wind and the accumulation areas are in the acute angular corners out of which the sewage is discharged. The sewage flow will therefore push the scum out of these areas and reduce accumulation.

Sludge accumulation in sewage ponds is minimal when properly designed. Therefore it is absolutely important that the design flow for the ponds is not exceeded, as this is a significant factor in sludge accumulation in ponds. When flows increase, or other areas are brought on to the sewage collection system, they must not be connected to the Soapberry system without the due expansion of the treatment facilities.

The STP is designed in 3 modules and each module has its maximum loading ability. When loadings increase as a result of connection of more neighborhoods or increase in septage or both, the modules will be added according to need for treatment. Also, re-circulation at the design rates will be adjusted to the incoming flows. The regulatory agencies are to monitor this, and expansion of collection must have a preceding expansion in treatment capacity.

The sedimentation zone of the primary ponds is deeper than the other ponds allowing anaerobic activity at the bottom, and also acting as storage for stabilized sludge accumulating over the years. The amounts of stabilized sludge accumulating will be negligible.

If it is found necessary, desludging could be carried out approximately every 7 years. The distribution chamber at the inlet to each module will be equipped with penstocks in order to isolate a train to empty, clean and maintain if needed.

Once the ponds are emptied, sludge at the bottom of the ponds should be allowed to drain and dry. As the dry sludge at the bottom will be stabilized, it could be gathered by mechanical means and removed to the nearby Riverton City Solid Waste Disposal site.

6. Odour

In order to avoid odour problems that may occur in these systems re-circulation of plant effluent to system inlet is added at a minimum rate of 1:1, thereby reducing the load on the plant inlet and primary pond.

Another potential source of odour is scum which has already been discussed above. If the ponds are overloaded it will result in odour problems because the treatment capacity will be exceeded.

If for process reasons or others, scum does accumulate at a particular time, scum removal systems will be in place including:
High-pressure water spray to break up the scum so that it will settle.
Boats and rakes to allow staff to break up the scum or remove it from the pond.

Finally, preliminary treatment (screening) was added at Greenwich (also existing grit channels will remain) and Nanse Pen pumping station, thereby reducing one of the sources of odours.

5.2 SITE CLEARANCE AND PREPARATION IMPACTS

5.2.1 Loss of natural habitat and biodiversity

The clearing of existing vegetation during pond construction and the development of the facility will result in the complete loss of associated ecological habitats and their fauna, within the footprint of the development. Noise, vibrations, and intrusive activities related to construction works will tend to scare away any animals remaining on the site after vegetation clearance. These are the environmental trade-offs for the anticipated improvement in the water quality and biology of Kingston Harbour. The existing salina and scrub habitats will be replaced by an artificial but productive aquatic system maintained by natural climatic factors.

Mitigation:

- *The purpose of the wastewater treatment project is to reduce the current amounts of untreated sewage that enters Kingston Harbour, thereby allowing for recovery of the inherent natural productivity of the harbour and restoration of the economic benefits to be derived from a healthy ecosystem.*
- *Clearing and construction activity should be restricted to within the footprint of the development.*
- *There should be no side-tipping of excavated material or cleared vegetation unto areas outside the footprint.*
- *The fringing mangrove on the Hunt's Bay and the Rio Cobre should not be altered during construction activities. The habitat for the endangered crocodile Crocodylus acutus is therefore not at threat of loss.*

5.2.2 Soil erosion

Vegetation clearance, road construction, excavation works, and pond construction works will expose soils in the affected project areas leaving them vulnerable to erosion by surface run-off and ultimately threatening adjacent coastal waters with high turbidity and sediment deposition, a negative consequence. Such conditions are only likely to occur during periods of intense rainfall. The flat topography of the site would tend to reduce erosive surface flows and the overall threat of turbidity should exist only for the duration of construction works before embankments and drainage works are put in place that would reduce the susceptibility to soil erosion. The Duhaney River and Hunts Bay near to the site could be affected by soil erosion and turbidity.

Mitigation:

To the greatest extent possible, phase site clearance so as to minimize the area of exposed soil at any given time.

- *Temporarily bund exposed soil and redirect flows from heavy runoff areas that threaten to erode or result in substantial surface runoff to adjacent marine waters*
- *Monitor areas of exposed soil during periods of heavy rainfall throughout the construction phase of the project so as to implement sediment dispersal measures as appropriate.*

5.2.3 Nuisance dusting

It can be anticipated that a certain amount of air borne particulate matter (dust) will be generated by earth moving activities during pond construction and during off loading of marl. This situation will be worse during the dry season and during the afternoons when the winds are most prevalent. Air borne particulates may pose a hazard to residents in the vicinity or downwind of the construction site that suffer from upper respiratory tract problems. Otherwise it may only be a nuisance. The impact of dusting is short-term, lasting for the duration of the construction activity, but it may be severe if it causes significant health problems.

Mitigation:
Access roads and exposed ground should be regularly wetted in a manner that effectively keeps down the dust.
Stockpiles of fine materials (e.g. marl) should be wetted or covered with tarp during windy conditions.
Workers on the site should be issued with dust masks during dry and windy conditions.

5.2.4 Noise

The use of heavy equipment during site clearance and road construction works will inevitably generate noise but this should not be of any consequence to adjacent communities that are located sufficiently far away as to not be affected. The remoteness of the site should help to ameliorate noises.

Mitigation:

If necessary, local residents should be given notice of intended noisy activities so as to reduce degree of annoyances.

Workers operating equipment that generates noise should be equipped with noise protection gear. Workers operating equipment generating noise levels greater than 80 dBA continuously for 8 hours or more should use earmuffs. Workers experiencing prolonged noise levels of 70 – 80 dBA should wear earplugs.

5.3 CONSTRUCTION IMPACTS

5.3.1 Loss of land use options

The construction of a wastewater treatment plant will involve building large embankment structures on what is a green field site. This will result in a loss of the options for alternative land use and thus represents an irreversible commitment of land resources. Although the loss of optional uses for the land in the future is considered to be a negative impact, in this case the land is marginal in terms of alternative agricultural or residential use and the impact is not considered significant.

Mitigation:

N/A

5.3.2 Earth material sourcing

Earth materials needed for construction (e.g. marl, sand) are normally obtained from quarry and mining operations. Conscious or unwitting purchase of these materials from unlicensed operations indirectly supports, encourages and promotes environmental degradation at the illegal quarry sites and causes medium to long-term negative impacts at source.

Mitigation:
Earth materials must be obtained from officially licensed and approved quarries and copies of the relevant licenses made available for inspection at the site by the Contractor.

5.3.3 Materials transportation

The various materials required for pond and building construction (e.g. steel, blocks, lumber, marl, etc.) will be obtained from sources elsewhere and transported to the site. Transportation of these materials, typically in over-laden and sometimes uncovered trucks, usually results in undue road wear-and-tear. Special note is made here of the unpaved road surfaces in the Caymanas/Soapberry area.

In the case of fine earth materials, dusting and spillages occur on major roadways between source and site. Dusting degrades local air quality and material spillages worsen driving conditions and increase the risk of road accidents. These occurrences represent indirect, short-term, reversible, negative impacts on public health and safety.

Mitigation:
All fine earth materials must be enclosed during transportation to the site to prevent spillage and dusting. Trucks used for that purpose should be fitted with tailgates that

close properly and with tarpaulins to cover the materials. The cleanup of spilled earth and construction material on the main roads should be the responsibility of the Contractor and should be done in a timely manner (say within 2 hours) so as not to inconvenience or endanger other road users. These requirements should be included as clauses within the contracts made with relevant sub-contractors.

The transportation of lubricants and fuel to the construction site should only be done in the appropriate vehicles and containers, i.e. fuel tankers and sealed drums.

As far as possible, transport of construction materials should be scheduled for off-peak traffic hours. This will reduce the risk of traffic congestion and of road accidents on the access roads to the site.

Appropriate traffic warning signs, informing road users of a construction site entrance ahead and instructing them to reduce speed, should be placed along the main road in the vicinity of the entrance to the Soapberry lands.

Flagmen should be employed to control traffic and assist construction vehicles as they attempt to enter and exit the project site.

5.3.4 Materials storage

The improper siting of stockpiles and storage of sand, gravel, cement, etc., at the construction site could lead to fine materials being washed away, during heavy rainfall events, into Hunts Bay and Kingston Harbour. This would not only represent a waste of materials but would also contribute to turbidity and sedimentation with consequent negative impacts on inshore marine water quality of the bays.

Refueling and maintenance of large vehicles and earth moving equipment will take place at the construction site and therefore fuel and lubricants will have to be stored on the site. This will create the opportunity for accidental spills of hydrocarbons and contaminants could be washed into the sea at Hunts Bay.

Mitigation:

The stockpiling of construction materials should be properly managed and controlled. Fine-grained materials (sand, marl, etc.) should be stockpiled away from surface drainage channels and features.

Low berms should be placed around the piles and/or tarpaulin used to cover open piles of stored materials to prevent them from being washed away during rainfall.

Safe storage areas should be identified and retaining structures put in place prior to the arrival and placement of material.

Hazardous chemicals (e.g. fuels) should be properly stored in appropriate containers and these should be safely locked away. Conspicuous warning signs (e.g. 'No Smoking') should also be posted around hazardous waste storage and handling facilities.

5.3.5 Modification of surface drainage

Mitigation:

- *The appropriate design of storm water drainage system*

5.3.6 Construction waste disposal

Solid waste generated during site preparation and construction work would include cut vegetation and typical construction waste (e.g. wasted concrete, steel, wooden scaffolding and forms, bags, waste earth materials, etc.). This waste would negatively impact the site and surrounding environment if not properly managed and disposed of at an approved dumpsite. Cleared vegetation burnt onsite would generate smoke, possibly impacting negatively on ambient air quality and human health. Vegetation and solid waste, if allowed to accumulate in drainage ways, could cause localised pooling and flooding. Pooling of water, in turn, would create conditions conducive to the breeding of nuisance and health-threatening pests such as mosquitoes. Poor construction waste management constitutes a short-term negative impact.

Mitigation:

A site waste management plan should be prepared by the contractor prior to commencement of construction works. This should include designation of appropriate waste storage areas, collection and removal schedule, identification of approved disposal site*, and a system for supervision and monitoring. Preparation and implementation of the plan must be made the responsibility of the building contractor with the system being monitored independently.

Vegetation and combustible waste must not be burned on the site.

Reusable inorganic waste (e.g. excavated sand) should be stockpiled away from drainage features and used for in filling where necessary.

Unusable construction waste, such as damaged pipes, formwork and other construction material, must be disposed of at an approved dumpsite.

The official dump for eastern Jamaica is at Riverton Landfill.

5.3.7 Sewage and litter management

Inadequate provision of toilets for use by workers can lead to ad hoc defecation in secluded areas on the site, thus creating unsanitary conditions and sources of fly infestation. Improper disposal of food cartons and other domestic forms of construction camp garbage could lead to littering of the site and pollution of adjacent coastal waters.

Mitigation:

Proper solid waste receptacles and storage containers should be provided, particularly for the disposal of lunch and drink boxes so as to prevent littering of the site.

Arrangements should be made for the regular collection of litter and for its disposal only at the Riverton site.

5.3.8 Replanting and landscaping

Landscaping and replanting of trees will be needed to recreate some semblance of the original appearance and condition of the site and to provide some aesthetic quality. No details of landscaping plans or planting material are available at this stage but the plant species selected for replanting will in large part determine which types of birds, butterflies, and other fauna, if any, inhabit the area surrounding the ponds after their construction. In addition to enhancing the aesthetic appeal of the project site, landscaping provides the means for partially restoring the site's natural elements and ecological habitats. It is therefore a significant mitigation activity with a positive impact.

The landscaping plan should seek to avoid the use of non-native and potentially invasive species. It should include low-maintenance local species and the types of trees and shrubs used for feeding by local bird species. The landscape design should seek to encourage bird life, especially for the endemics, and maximize shade.

Mitigation:
N/A

5.3.9 Employment/Income generation

Several categories will be required during the construction phase. This will include skilled and unskilled labourers, engineers, and a small number of other professionals. These levels of short-term employment would have a positive impact on the local economy and on regional unemployment.

Mitigation:

N/A

5.4 OPERATION IMPACTS

5.4.1 Employment/Income generation

The STP facility will provide employment for several persons. This would represent a positive long-term impact.

Mitigation:

N/A

5.4.2 Water supply

Workers at the facility will demand water for drinking, washing, and flushing toilets. This demand will be insignificant in terms of resource depletion and impact on the local water supply network.

Mitigation:
N/A

5.4.3 Facility sewage disposal

Sewage generated by workers at the STP facility will be collected and treated on site.

Mitigation:

5.4.5 Use of electricity

The Jamaica Public Service Company Ltd. (JPSCo.) will supply power for the development site from the existing mains. The incremental demand will be within the capacity of the system and this will be confirmed in writing by the utility. The expansion should therefore not cause any supply shortages to the rest of the system. However, this increased demand will commensurately increase the utility's use of fossil fuel to generate that electricity, and thus the project will indirectly incur negative impacts associated with greenhouse emissions.

Mitigation:

- *Mitigation measures relate to improving energy management and conservation practices.*
- *Sub-meters and real-time energy monitoring equipment, timers, photoelectric cells, thermostats, etc. should be installed in the villas.*
- *Install translucent shades and fluorescent lighting.*
- *Pipe insulation, tank lagging (not asbestos!) and heat recovery systems should be installed wherever it is practical to do so.*

5.4.6 Odour

Whereas one of the main sources causing odour is scum, overloading of the ponds will also result in odour problems because the treatment capacity will have been exceeded. Wind action on the ponds can also cause odours. Odour is best controlled by proper design and the nuisance risk is reduced by proper alignment of the ponds. The size of the ponds will result in some degree of wave action. The wind is the effective source of aeration through surface mixing, but too much wind action can disturb bottom sediments and also create an odour problem.

The odour caused by scum has already been discussed. However, the scum that is removed must be properly treated. The scum could be treated as a solid waste and could be taken to the Riverton Sanitary Landfill, after appropriate arrangements are made with the National Solid Waste management Authority (NSWMA). Alternatively, the scum should be solar dried, stabilized and then disposed of orr utilized as with the sludge.

Mitigation: Ensure proper sizing and alignment of the lagoons Ensure scum is appropriately disposed of or properly stabilized. The issues of scum and overloading have been addressed above. However it is also important that the effect of wave action be carefully considered in the design. If aggressive wave a action occurs bottom sediments will be disturbed. The proposed radial configuration must be evaluated also against this possible situation. There are lessons are to be learnt from the existing pond sewage treatment plants in Greater Portmore, Negril and Montego Bay.

5.4.7 Habitat Modification

The creation of ponds and associated effluent transportation systems will constitute an enhancement of habitat for certain species including the endangered crocodile and waterfowl. The establishment of the sewage treatment facility is already within the crocodiles' habitat and enhancement of the habitat by the creation of features attractive to the animal, will encourage the animal in the area. In terms of the habitat, this will not result in any displacement of the animal through habitat modification. However, the encouragement of the animal into the operative area (ponds and waterways) of the sewage treatment facility could pose a threat to workers in the area. This is so during the construction phase while activities such as clearing and trenching are ongoing, and during the operation phase while ponds are in use.

Waterfowl, shoe birds and waders already within the habitat of the proposed development site, will be somewhat displaced as their food source will be altered. However, the creation of the ponds adjacent to the wetlands and the Hunt's Bay will mean that species should find alternative feeding grounds in close proximity.

Mitigation A Management Plan which speaks to the possible interactions of humans and crocodiles, and ways to minimize the potential threat to human welfare, is given in Appendix 5.

5.4.8 Water Quality

Impacts on water quality are anticipated as being only positive impacts, as treated sewage effluent will significantly reduce pollutant loading to the harbour.

Mitigation: No mitigation measures required.

5.4.9 Flood Hazard

The low lying flat nature of the site and proximity to the Rio Cobre, the coastline and the region's drainage characteristics make the site susceptible to flooding. While the effects of riverine and coastline flooding are assessed to be minimal the obstruction of overland or storm water runoff by the facility can have potential negative impacts.

Mitigation:

Design of a comprehensive storm water drainage system involving the construction of cut-off drains around the facility to intercept excessive overland flow. Adequately sized and configured conduits would control and divert excessive overland flow and discharge it into Hunts Bay.

6. CONSIDERATION OF ALTERNATIVES

The alternatives to the proposed waste water treatment plant is presented below . These include alternate treatment process options, alternate project sites and the no action alternative.

6.1 Alternative treatment options

A comparison of the features of the two main waste water treatment options available is presented below as Table 6.1.

	Oxidation Lagoon Systems	**Waste Activated Systems**
Capital investments	Low	High
Investment in equipment and spares importing costs	Low	High
Energy consumption and operation costs.	Low	High
Ability to function with little control and minimal or no use of electromechanical equipment	High	Low
Area and land requirements	High	Low
Process control	Low	High
Operation and maintenance requirements and requirements of technical sophistication and personnel training	Mediocre – With effluent re-circulation.	High
Ability of equalization of large volumes ability of peak hydraulic loads and	High – Due to large lagoon volumes, long	Low

	Oxidation Lagoon Systems	**Waste Activated Systems**
resistance to shock organic loads.	retention times and high buffer capacity.	
Effluent quality	Mediocre	High
Ability to control the process for removal of substances other than organic, such as nitrogen, phosphorus - to an exact desired concentration.	Low	High
Flow schemes, equipment and installation	Simple - Piping, pumping and reduced pretreatment facilities.	Complex
Removal of pathogenic bacteria, viruses and protozoa	Relatively high due to long detention periods, solar irradiance, especially in Jamaica.	Low
Year round climate in Jamaica	Advantage – utilization of high stable temperatures, humidity and winds for the process.	Disadvantage – accelerated deterioration of equipment, motors due to the humidity and rainfall.

Table 6.1: Comparison of the advantages of Oxidation Lagoon or systems to Waste-Activated sewage systems.

6.2 Alternative site

The Soapberry Lands is the only available site with the size, topography and proximity to Kingston, that is adequate for the installation of the lagoon sewage treatment plant system.

6.3 No action alternative

The No Action Alternative would see the continued release of untreated sewage into the Kingston Harbour system, exacerbating the deterioration of the Harbour ecosystems. The Soapberry Wastewater Treatment Plant is seen as a long awaited option for the treatment of sewage for the Kingston Metropolitan Area.

7. DEVELOPMENT OF AN ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

If a permit is granted for the proposed project, and before site preparation and construction activities begin, the project developers, should submit an Environmental Management and Monitoring Plan to NEPA, **if this is requested by the Agency**. The aim of the Environmental Management and Monitoring Plan is to ensure compliance with relevant legislation, implementation of the mitigation measures, and long-term minimization of negative environmental impacts.

The Monitoring Plan should include a Construction Plan and Schedule with a description of any proposed phasing of activities, recommended mitigation measures, and proposed methods of compliance. The Environmental Management and Monitoring Plan should also include an Inspection Protocol; planned Supervision of Site Preparation and Construction Activities, and implementation of Post Construction Monitoring.

During construction, reports should be submitted to NEPA at intervals, as and if specified by NEPA in the permit.

8. SUMMARY AND CONCLUSIONS

The proposed sewage treatment plant (STP) to be built on the Soapberry Lands in St. Catherine Jamaica is a large scale facility that will ultimately treat all the sewage from the sewered areas of the Kingston Metropolitan Area. The proposed STP will be a recirculated lagoon facility consisting of three arc shaped modules to be constructed in three stages. This system is a low maintenance biological system that will produce high quality effluent after it is filtered through a sand filter before discharge into the nearby Rio Cobre River.

The proposed Soapberry Lands site is located on the north western coastline of Hunts Bay between the Rio Cobre and the Duhaney Rivers on its western and eastern boundaries respectively. The site lies south of the railway and north of the coastal marshland. The site is the southern extension of the St. Catherine alluvial plain that extends southward into a coastal marsh. The site is highly disturbed with both the underlying soils and ecosystems being highly disturbed. Crocodiles are the only species that will require special attention in terms of their potential interaction with humans.

The site lies in the flood plain of both the Rio Cobre and Duhaney Rivers, and is located in an area susceptible to earthquakes, overland stormwater run off and storm surge effects of hurricanes. The flat terrain comprising the project site as well as the protective berm along the Banks of the Rio Cobre will prevent flooding by overbank peak flow of the Rio Cobre. Storm surge effects will be minimized by the sheltered nature of Hunts Bay and the distance of the facility from the coastline. Special attention will have to be given to the design of the facility to ensure diversion of overland flow and adequate safety factors for construction on soils susceptible to ground shaking from earthquakes.

The proposed STP will ultimately receive the sewage produced from sewered areas of Kingston and will have the highly beneficial effect of stopping the pollution of Kingston harbour with untreated sewage. The nature of the proposed system will prevent the production of odours and sludge thus making the facility of little nuisance to the surrounding communities. Effluent quality will be of a high standard and will be discharged into the Rio Cobre which then flows into Hunts Bay. The specified quality of the effluent from the facility will be of a higher quality than the water in the Rio Cobre as well as the water in Hunts Bay.

It is expected that the proposed facility as specified will provide a long term solution to the sewage disposal needs of Kingston and its environs. With proper maintenance and environmental monitoring the facility is not expected to have any adverse effects on the terrestrial or marine environments or on the surrounding communities.

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APPENDICES

APPENDIX 1: JENTECH - SOIL INVESTIGATION REPORT, 2001

(Attached as separate document)

APPENDIX 2: DETAILED DIAGRAMS OF PROPOSED DRAINAGE SYSTEM.

APPENDIX 3: ECOLOGY PLATES

Plate 1: Scrubland

Plate 2: Ponded Area

Plate 3: Existing road through the property

Plate 4: Large pond on site

Plate 5: Ruinate vegetation

Plate 6: Shrubland

Plate 7: Ruinate vegetation – grassland and shrubs

Plate 8: Old building on the property

Plate 9: Mudflats

Plate 10: Ponded area

Plate 11: Area filled in with dredge spoil

Plate 12: Dredge fill areas

Plate 13: Ponded area with vegetation stumps

APPENDIX 4: COMMENTS ON TERMS OF REFERENCE FROM NEPA

Letter from NEPA

November 22, 2004

Mr. Peter Reeson

Director, Environmental Solutions Limited
20 West Kings House Road

Kingston 10

Dear Mr. Reeson:

Re: Comments on Terms of Reference (TORs) for an Environmental Impact

Assessment (EIA) for the proposed Sewage treatment Plant at Soapberry, St. Andrew

The National Environment and Planning Agency (NEPA) has reviewed the captioned TORs and the comments are attached for your attention.

Please address these comments as part of the EIA Report to be submitted to NEPA. You are reminded that at least ten (10) copies of the EIA Report will be required, along with an electronic copy to facilitate an expeditious circulation and review.

Do not hesitate to contact us for clarification on any matter.

Yours sincerely

Joseph McCarthy

for Chief Executive Officer

cc: Frances Blair - Manager, Applications Secretariat

Comments on Terms of Reference (TORs) for the Proposed Sewage Treatment Facility at Soapberry, St. Andrew

General Comments

Based on the proposed location for the site, a Geo-technical and Hydrological Study should be conducted.

A Drainage Plan should be developed for approval by the National Works Agency (NWA).

Specific Comments

Task 1 – Description of the Proposed Project

The population or catchment area to be served should be included.

Sludge, as well as oil and grease management and disposal should be addressed.

The facility should be designed to receive and treat septage. Activities surrounding the receival of septage should be covered in the study.

A Risk Assessment of the project should also be conducted.

Task 4 – Determination of Potential Impacts

Wetland habitat disturbance should also be addressed with respect to any potential for impact on crocodiles.

Task 6 – Development of a Monitoring Plan

This caption should read "Development of an Environmental Management and Monitoring Plan".

The Plan should include both Environmental Management and Monitoring.

The Environmental Management and Monitoring Plan should cover both construction and operation phases of the project.

Task 7 – Determination of Project Alternatives

An estimate of the costs associated with each alternative should also be provided.

Section 6 - Report

The significant issues reported on should be related to Tasks 1-8. Data reported should be the most current available.

"Environmental Monitoring Plan" should be revised to "Environmental Management and Monitoring Plan".

The EIA Report shall be presented to the National Environment and Planning Agency (NEPA) for review. At least ten (10) hard copies and an electronic copy of the Report shall be presented.

Applications Processing Branch (APB)

November 19, 2004

APPENDIX 5: DRAFT MANAGEMENT PLAN FOR POTENTIAL INTERACTION BETWEEN HUMANS AND CROCODILES.

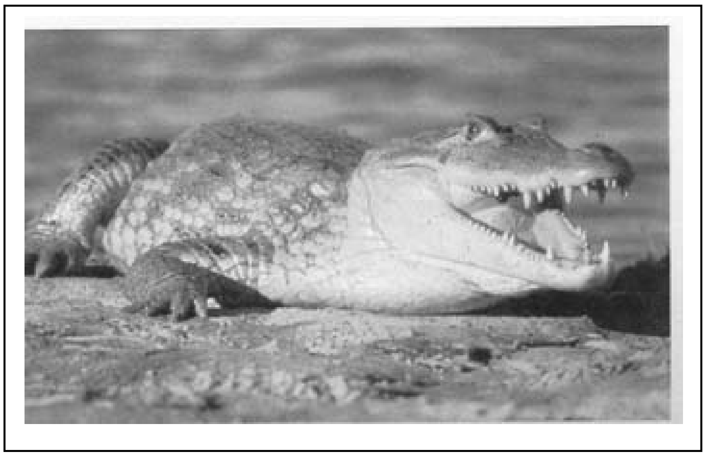

Table of Contents

1.0 Context

This document has been prepared as part of the environmental management services being offered to the Ashtrom Limited regarding the establishment of the Soapberry Wastewater Treatment Plant in St. Catherine. The location of the project area adjacent to the Rio Cobre and Duhaney Rivers and in close proximity to Hunts Bay, is within a known habitat for the endangered American Crocodile *Crocodylus acutus*. This document seeks to identify issues related to the potential interactions between humans and crocodiles, as contact is likely.

There are twenty-one species of crocodiles throughout the world occurring in wetlands, rivers and lakes in the tropics and sub-tropics. Crocodiles are the largest predators in their habitat and can pose a significant threat to humans and their livestock. Worldwide, many species are exploited for their valuable skin. The loss of any crocodilian would be a significant loss to biodiversity as well as global economic potential and ecosystem stability.

The American crocodile (*Crocodylus acutus*) is indigenous to Jamaica occurring naturally in wetland areas where there is brackish water and adequate food. Populations in Jamaica are primarily found along the south coast from St. Thomas to Westmoreland, and on the north coast in Hanover and Trelawny. The population of Jamaican crocodiles is threatened by destruction of wetlands particularly for coastal developments, aquatic pollution, hunting and wanton killing. The mangrove fringed Hunts Bay, the rivers leading into the Bay and the Kingston Harbour environs are known habitats for this species.

2.0 Relevant Legislation

Crocodylus acutus is protected by both national and international legislation. It is illegal to kill or to have in ones' possession any part of the animal. The following legal instruments apply:

2.1 The Endangered Species (Protection, Conservation and Regulation of Trade) Act (1999)

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

2.2 Wildlife Protection Act (1945)

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

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

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

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

The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (The Oil Spills Protocol), which was adopted and entered into force at the same time as the Cartagena Convention;

The Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region (The SPAW Protocol), which was adopted in two stages, the text in January, 1990 and its Annexes in June, 1991. The Protocol entered into force in 2000;

The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region (LBS Protocol), which was adopted in October, 1999.

2.4 Biodiversity Convention

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

Develop plans for protecting habitat and species.

Provide funds and technology to help developing countries provide protection.

Ensure commercial access to biological resources for development.

Share revenues fairly among source countries and developers.

Establish safe regulations and liability for risks associated with biotechnology development.

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

2.5 Convention for International Trade in Endangered Species of Flora and Fauna (CITES) (1975)

The CITES Convention aims to regulate international trade in animas and plants that are, or may be threatened, to ensure that the trade is sustainable and not threatening to the survival of the species. CITES is one of the largest and most important treaties on species conservation, and has more than 150 countries signatory to the convention. *Crocodylus acutus* is listed on Appendix I of CITES where no commercial trade is allowed.

3.0 Reasons for Potential Interactions

3.1 Project Location in Habitat

Crocodiles are known to inhabit the mangrove areas adjacent to the Rio Cobre, the Duhaney River and Hunts Bay.

3.2 Site Preparation and Construction Activities

During the site preparation and construction phases for the treatment ponds and associated transmission lines, particular works such as trenching and pipe laying will provide new niches for individuals and also opportunities for direct contact with humans. Experience with other projects that have similar activities has shown that crocodiles do take advantage of trenches and pipes laid, and water bodies created.

4.0 Plan of Action

4.1 Sensitization of Project Staff and Contractors

Sensitization Sessions should be scheduled and held with project staff that are likely to be in contact with the crocodiles, through working in their habitat. These sessions should be conducted by NEPA and assisted by other organizations that constitute the Crocodile Rescue, Research and Operations Committee, as necessary.

Topics to be covered in the Sensitization Session should include, but not necessarily be limited to, the following:

Description and Basic Biology of the Species

Preferred Habitats
Behavioral Patterns
Breeding Season
Preferred Nesting Areas
Basic Do's and Don'ts if an interaction occurs
Emergency numbers to call

Copies of the NEPA brochure entitled *Crocodiles - The last of the dinosaurs* should be made available to the project team.

4.2 Increased Diligence During the Breeding Season

During the breeding season (March to August) there should be increased diligence and awareness of the project staff. This is because females can become more aggressive in the protection of nesting areas and their young. A Sensitization Session should be conducted at the beginning of the breeding season in March, and half-way through the breeding season in June, during each year of construction.

4.3 Solid Waste Management

All waste material should be disposed of in an appropriate manner using designated bins and/or skips and collected by a certified waste removal company. This is essential as adult crocodiles will scavenge through garbage dumped along rivers, in wetlands and along beaches, particularly if their regular food supply of birds, frogs, crabs, snakes and fish, is low. All work sites should be adequately equipped with skips which are emptied regularly by an approved contractor. Kitchens and lunch areas should be kept clean and food waste removed daily.

4.4 Reporting Procedure

If a crocodile is observed in the project area, in a trench, pipe, river or canal the project management team must be immediately informed by the site staff or contractors, and they will contact NEPA. NEPA would be responsible for the dispatch of a qualified individual to visit the site and assist in the restraint and removal of the animal, if it is posing a threat to workers, or its presence has resulted in the cessation of construction activities. Project staff or contractors should make no attempts to tie, secure or capture any crocodile.

4.5 Security

Security is an issue to be considered for the project. Security in the form of fencing may also be required to restrict access to the ponds by crocodiles, and to minimize the potential for human/crocodile interactions.

4.6 Monitoring

Monitoring should be carried out, if required by NEPA and any conditions specified in the environmental permit. Monitoring Reports should be submitted to NEPA for review and approval as required. NEPA should also routinely conduct their own site inspection and monitoring of the project works.

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