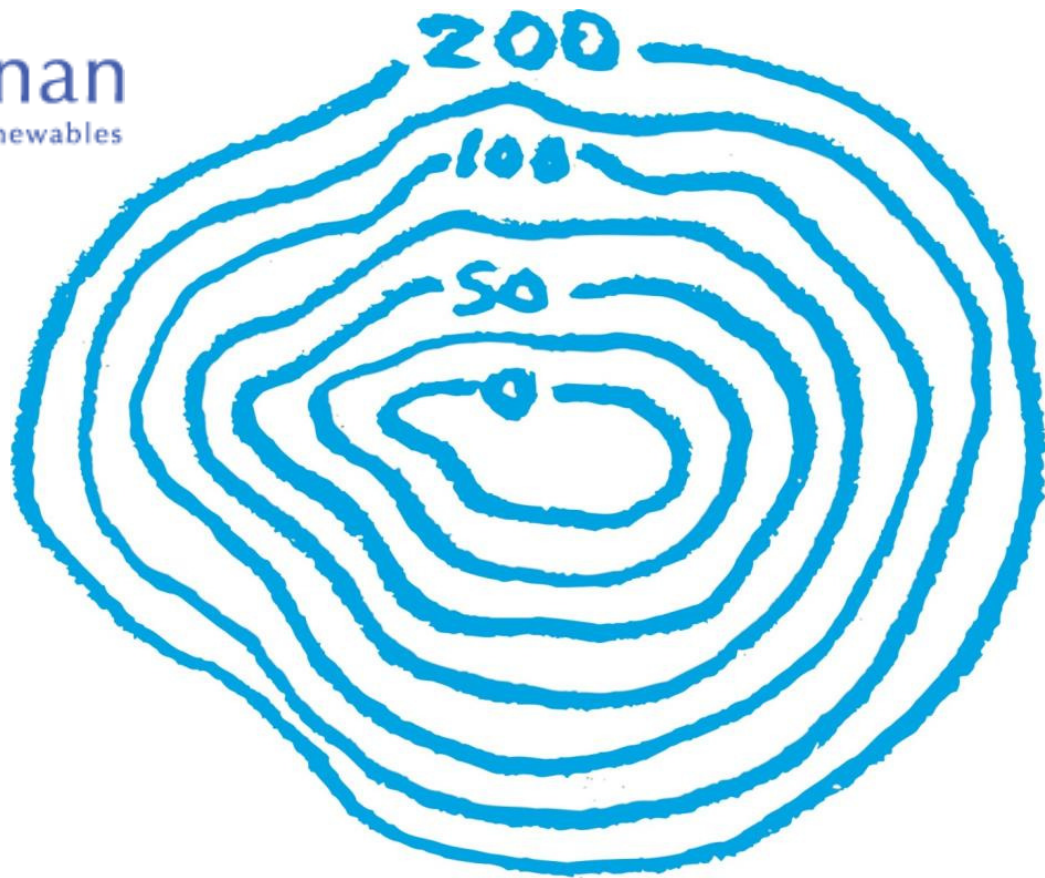


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Environmental Management Plan
Port of Buchanan-Rehabilitation
Final Draft



Prepared By:
EARTHTIME INC.



October 2010

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LIST OF ABBREVIATIONS

ASL	Above Sea Level
AU	African Union
BOD	Biochemical Oxygen Demand
BR	Buchanan Renewables
BRE	Buchanan Renewable Energies
°C	Degrees centigrade
CCME	Canadian Council of Ministries of the Environment
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
COD	Chemical Oxygen Demand
dB	Decibel
DO	Dissolved Oxygen
ECOWAS	Economic Community Of West African States
E. Coli	Escherichia coli
EPA	Environment Protection Agency
EMP	Environmental Management Plan
EPML	Environmental Protection and Management Law
°F	Degrees Fahrenheit
FDA	Forestry Development Authority
GOL	Government Of Liberia
HC	Hydrocarbon
Ha	Hectares
Km	Kilometer
KVA	Kilovolt Ampere
LAMCO	Liberian American Swedish Mining Company
LISGIS	Liberia Institute of Statistics & Geo-Information Services
LWSC	Liberia Water and Sewer Corporation
m	Meter
MHSW	Ministry of Health and Social Welfare
MLME	Ministry of Lands Mines and Energy
MOA	Ministry of Agriculture
MOC	Ministry of Commerce
MOJ	Ministry of Justice
MOF	Ministry of Finance
MPEA	Ministry of Planning and Economic Affairs
mm	Millimeter
MRU	Mano River Union
NAAQS	National Ambient Air Quality Standards
NH ₄ -N	Ammonia Nitrogen

NO _x	Nitrogen Oxides
NPA	National Port Authority
OSHA	Occupation Safety and Health Administration
P	Phosphorous
PCBs	Polychlorinated biphenyls
PM	Particulate Matter
PPE	Personal Protective Equipment
POP	Persistent Organic Pollutants
SO ₂	Sulphur Dioxide
SS	Suspended Solids
STW	Specialized Training Workshops
SW	Solid Waste
TDS	Total Dissolve Solids
TSP	Total Suspended Particles
TN	Total Nitrogen
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WARDA	West Africa Rice Development Association
WHO	World Health Organization

EXECUTIVE SUMMARY

INTRODUCTION

The objective of this EMP is to ensure that the potential impacts from the Wreck removal, Ship breaking and the Buchanan Port Rehabilitation in Liberia and related activities undertaken by Buchanan Renewables are identified, their significance is assessed, and an appropriate environmental management plan (mitigation, monitoring, and institutional strengthening) is developed for the facility and implemented during the project life cycle. The EMP was prepared mainly to assess the impacts associated with the large salvage operation and provide the mitigation measures for the following activities:

- Wreck Removal
- Ship Breaking
- Port Rehabilitation Plan

LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

Section 27 of the Environmental Protection Laws requires Mitigation Plan Audits, and monitoring for existing industries, projects and activities. This Section requires the owner/management of all industries, projects, activities existing or initiated prior to the effectiveness of the Law, which fall into the category of activities subject to an environmental impact assessment, shall submit to the Environmental Protection Agency Plans for improving environmental performance.

EPA is the principal authority in Liberia for the management of the environment as it coordinates, monitors, supervises and consults with relevant stakeholders on all activities in the protection of the environment and sustainable use of natural resources. In addition to the EPA, other organizations have a role in environmental protection and management, particularly the Ministry of Agriculture, the Ministry of Lands, Mines and Energy, Ministry of Planning and Economic Affairs, Ministry of

Justice, Ministry of Public Works, and Ministry of Social Welfare and Public Health. However, the EPA is the main agency for the management of the environment in Liberia.

BASELINE ENVIRONMENT

The Port of Buchanan where the rehabilitation process will take place is located in Buchanan City of Grand Bassa County. The Port of Buchanan is located 170 miles southeast of Monrovia and covers a surface area of approximately 110,000 square feet. Generally, the Port consists of two breakwaters measuring 1,890m and 590m long) that protect the quay. Whereas, inside the basin a 255m long ore-loading pier is found adjacent to the deeper section of the harbor basin with a water depth of 12.95 m below chart datum. Next to the packing pier, a utility berth for ore carriers is available. The access passage/channel to the port offers large vessels a water depth of 14.95 m below chart datum and a channel width between the breakwaters of 210m. Elevation ranges from 0 to 10 m above sea level.

The average annual rainfall between the years 1959 and 1980 was 4054.7 mm. Rainfall events are particularly concentrated in the season of May until November with a maximum recorded value of 770.9 mm and a minimum value of 27.0 mm. The minimum temperatures in the area range from 69.5 °F to 71.7 °F, while maximum temperatures vary from 80.9 °F to 90.5 °F.

Geologically, the study area is located in the middle on the western edge of the Buchanan Quadrangle in the south eastern part of the Bassa Basin bordered by the Pan-African Province towards the north

The site is well represented by abundant plants and animals. The flora consists of low bush, grasslands, remnants of tropical coastal mangrove species, and phytoplankton (green & blue), while the fauna includes resident birds, turtles, crustaceans, invertebrates, and host of other organisms. The most common turtles

reported in the area are represented by *Dermochelys coriacea* and *Caretta caretta* (MOA, 1999).

The county has six statutory districts, nine administrative districts, three cities, forty-five clans and several. The county also has three cities (Buchanan, Edina, and St. Johnson River). The county's population as estimated by Liberia Institute of Statistics and Geo-Information Services (LISGIS) is 224,839 with a fairly close gender distribution: 111,861 males and 112,978 females.

PROJECT DESCRIPTION

Buchanan Renewables will be engaging in a port improvement operation, focusing on the Port of Buchanan. The operation will include rehabilitation activities in the Port of Buchanan, ship wreck removal from various ports in Liberia (as prioritized by the National Port Authority), and ship breaking activities. A wide range of equipment and techniques will be used and implemented, respectively, during the various activities. Both the timeline and methodology will evolve as the project progresses and as new information about the current state of each wreck is developed. A dedicated team will focus on several tasks simultaneously during the removal of wrecks and general debris that clog the Port of Buchanan. These tasks include:

- Diving equipment (a portable dive center with umbilical lines, cameras, communication devices);
- Hydrolic, submersible, and diesel pumps; and
- A 300 tonne crane, a fully equipped pontoon, a tug, and materials and spare parts for patching ships and maintaining equipment.

BR, will identify any waste products on each ship prior to and during wreck removal and scrapping; all waste will be handled in accordance to EPA's recommendations and standards.

The ship breaking will commence as soon as wreck removal ends and will take place for the entire length of the project, which is approximately one year. Ships processed at the main ship breaking facility will be towed into the V-shaped slipway in Buchanan using the tug and in some cases the pontoon. The ship will be processed into pieces of approximately 5m x 2m using large shears (excavator) and plasma cutters. The scrap will be stockpiled in the scrap storage area using the scrap handler and a magnet. The processed scrap will be transported from the holding area to the commercial quay using dump trucks and scrap trailers. It will be stockpiled and loaded onto a bulk carrier using the equipment on the ship and possibly the scrap handler and magnet. No fuel tanks will be punctured until fully examined, pumped and ventilated. Fuel that is pumped from the ships will be stored in large, clearly marked storage tanks and will be either reused or disposed of by an EPA certified waste management company. Any non-toxic waste will be gathered and removed by an EPA certified waste management company.

BR plans to make minor fixes to the commercial quay in the Port of Buchanan so as to allow larger bulk vessel to safely berth at the quay. These improvements will include:

- Dredging: BR will dredge the entrance of the port, the area along the commercial quay, and other areas, as necessary, to ensure a draft of at least 12m.
- Basic port improvements: BR will make other improvements as necessary to support its operations. Such improvements are likely to include the installation of fenders and bollards along the commercial quay, as well as the installation of navigational aids in and around the port area.
- Other improvements: other improvements may include the rehabilitation of port access roads and the acquisition and operation of 1-2 tug boats, as well as the acquisition and installation of a loading conveyor system. The specific

nature of the improvements, however, will be determined by BR in consultation with the NPA.

IMPACT ASSESSMENT

Maritime development in terms of ship wreck removal and breaking and port rehabilitation may have a wide range of effects on the environment. The proposed project will encompass a multitude of activities, including wreck removal, ship breaking, sea dredging, and access road construction. The main human receptors are the workers at the port, who do not exceed 40 people. The nearest towns to the port are around 4 Km away.

Analysis of impacts that may be incurred by the execution of the project revealed that the greatest negative environmental impacts will be associated with sea water quality, marine ecosystem, and solid waste generation, during both the port improvement and operation phases. Negative impacts on sea water quality and marine ecosystem during operation may be significantly reduced by implementing proper waste management and oil spill plans.

MITIGATION MEASURES

As indicated earlier, impact analysis showed that the greatest potential environmental impacts will occur during both the port improvement and operation phases, particularly with respect to seawater quality, marine ecosystem, solid waste generation, and noise emissions. These impacts, in addition to air quality, traffic, visual intrusion, and health and safety, can be reasonably controlled by adopting proper management and planning procedures. Recommended mitigation measures should be implemented at all stages of the project, including the design, port improvement, and operation phases, with an emphasis on the most significant impacts.

[Table 6-2](#) and [Table 6-3](#) present a summary of the proposed elements of the Mitigation Plan that will be considered in the various phases of the project. Implementation responsibility is also included.

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ENVIRONMENTAL MONITORING

Environmental monitoring will be undertaken during the execution and operation phases of the project, with the aim to:

- Verify the predicted environmental impacts;
- Monitor the performance of the project and the effectiveness of mitigation measures;
- Determine project compliance with national and international requirements and standards; and
- Take remedial action if unexpected problems and unanticipated impacts arise.

Monitoring locations during both the port improvement and operation phases will be limited to the port site boundaries, since there are no sensitive receptors in the immediate vicinity of the project site. [Figure 7-1](#) shows the locations of selected monitoring stations referred to in the text below. Note that locations J, K, L and M are not illustrated in the figure as they depend on the variable locations of the port improvement activities. Environmental parameters to be monitored with their corresponding location, frequency, and duration of monitoring are summarized in

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[Table 7-1](#).

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DATA REPORTING

Periodic environmental monitoring reports will be prepared to analyze the data collected, assess monitoring activities and provide recommendations to ensure the effectiveness of the overall environmental monitoring and management plan during the project life span.

A comprehensive report will be generated to present results of monitoring activities and evaluate the adequacy of environmental control measures. The contents of the report will include the original measurements, sampling locations, time of sampling, influencing factors (weather information, activities on site), environmental quality assessment and data analysis. The reports will be submitted to the EPA.

In case standards are exceeded, notifications will be issued to the contractor and site engineer in order to take immediate corrective actions.

TRAINING

For environmental management to be appropriate, port improvement and operation activities should conform to the current state of the art and knowledge regarding environmental protection. This should be accomplished by hiring competent personnel with appropriate educational and professional background and instituting a periodic training program and site specific plans that are adequate for protecting the general public and the environment as well as contributing to the mitigation of potential environmental impacts.

Thus, it is required that contractors who will be involved in the port improvement and operation of the various components of the proposed project as well as personnel who will be involved in monitoring activities, to attend an environmental training course prior to the initiation of project activities. The objective of this training course is to ensure appropriate environmental awareness, knowledge and skills for the implementation of environmental mitigation measures.

1 INTRODUCTION

Liberia has recently been making significant efforts, through the Environmental Protection Agency (EPA) and other relevant stakeholders, towards sustainable development, and has placed more attention to environmental matters and the need to reduce the burden on the environment. The relatively young EPA has been able in the last few years to considerably improve its capabilities in protecting and managing the environment from the various sources of pollution. Even though at the time of writing this report, it is still considered poorly financed and barely equipped with the appropriate human and technical resources, the EPA is steadily working on setting new environmental standards, building its staff capacity and informational database, and providing the framework to prevent future pollution to spread in Liberia.

In particular, the EPA has developed guidelines for Environmental Impact Assessment (EIA) administrative procedures which are supposed to reflect the objectives of the Environmental Protection and Management Law (EMPL). The Law has been approved by the Government since November 26, 2002. The Law states that any planned project that could cause significant environmental impacts should be subject to the preparation of an EIA that would anticipate these impacts and allow provision of mitigation measures to minimize the significance of these impacts, or even eliminate their likelihood.

The EPA has taken a further step by requesting an Environmental Management Plan (EMP) from most existing projects in order to secure environmentally sustainable operations to the best extent possible. However, the EPA still needs to set standards and guidelines for (1) Monitoring systems; 2) Measurement of water quality (including drinking water and water for industrial and agricultural purposes); 3)

Monitoring ambient and occupational indoor air quality; 4) Better Management of Soil and 5) Reducing Noise Pollution.

Additionally, Liberia is endowed with ample natural resources, including mineral and agricultural wealth. However after the civil war, the export of such resources and import of large shipments from and to Liberia have been practically hindered by inadequate infrastructure including ship wrecks and general debris that clog the Liberian ports. In order to remove the excess of 50 wrecks, most of which are close to shore or in shallow water in and around the ports of Monrovia, Buchanan, Greenville, and Harper, the National Port Authority in November 2008 signed an agreement with Buchanan Renewable Energies (Liberia) to undertake shipwreck removal and port improvement activities in Liberia. The purpose of the agreement is to improve the viability of the ports, which are fundamental to the development of Liberia's local and export economy. This initiative will enable Buchanan Renewables to make a significant contribution to creating a more attractive investment climate in Liberia both by improving the functionality of Liberia's ports as well as facilitating its own biomass export business, which will demonstrate the viability of doing business in Liberia to potential investors and clients. Buchanan Renewable aims to invest in profit generating activities that also have significant environmental and development benefits.

1.1 PORTS OF LIBERIA

The National Port Authority (NPA) was created in 1967 by an Act of Legislature (amended in 1970) as a state-owned enterprise to "manage, plan, and develop all ports within the Republic of Liberia". The NPA is also responsible for the administration of all ports and provides services such as vessels handling, warehousing, and an oil jetty exclusively, for petroleum products in Liberia. These

ports include: the Freeport of Monrovia, the port of Buchanan, port of Greenville, and port of Harper.

The four ports handled about 200,000 tons of general cargo and around 400,000 tons of imported petroleum products per year prior to the conflict. The Freeport of Monrovia and the port of Buchanan handled all the bulk iron ore exports, while the ports of Buchanan and Greenville were responsible for most of the timber exports. The conflict resulted in the damage and looting to warehouse and loading facilities, shipwrecks in ports, channel siltation and spillage in petroleum storage tanks (UNEP, 2004).

The Freeport of Monrovia

The Freeport of Monrovia is located to the south situated in the southern direction towards the Atlantic Ocean on Bushrod Island and ranks as the largest port in the Authority's network. It handles most of the Authority's imported cargoes. The harbor encircles a basin of 300 hectares of secure water and is protected by two breakwaters, measuring 2,350m and 2,200m long. The general cargo berth, (the main pier), consists of an opened piled, 610m long by 11m wide marginal wharf with a reinforced concrete deck. The main wharf serves 2nd and 3rd generation coastal and mainline vessel (<http://nationalportauthorityliberia.org/History.html>).

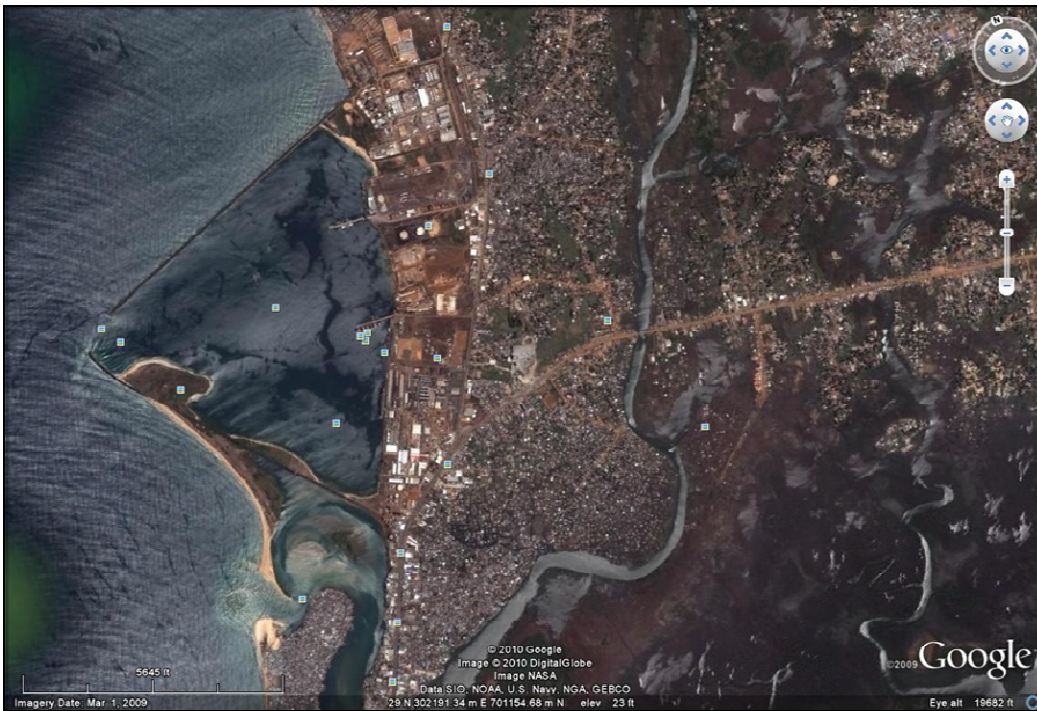


Figure 1-1: Freeport of Monrovia (Source: Google Earth, 2010).

The Port of Buchanan

The port of Buchanan is located approximately 170 miles southeast of Monrovia and was constructed in 1960 by the Buchanan Liberia-American Swedish Mining Corporation (LAMCO) to export the iron ore deposits of the Nimba Range. The harbor is protected by two breakwaters, measuring 1,890m and 590m long. Inside the basin, a 225m long ore-loading quay is located to the deeper section of the harbour basin with a water depth of 12.95m below chart datum. On the inner side of the secondary breakwater, a commercial quay 334m long is located with an available water depth of 10.15m below chart datum. The access channel to the port provides ships with a water depth of 14.95m below chart datum and a channel width between the breakwaters of 210m (<http://nationalportauthorityliberia.org/History.html>).

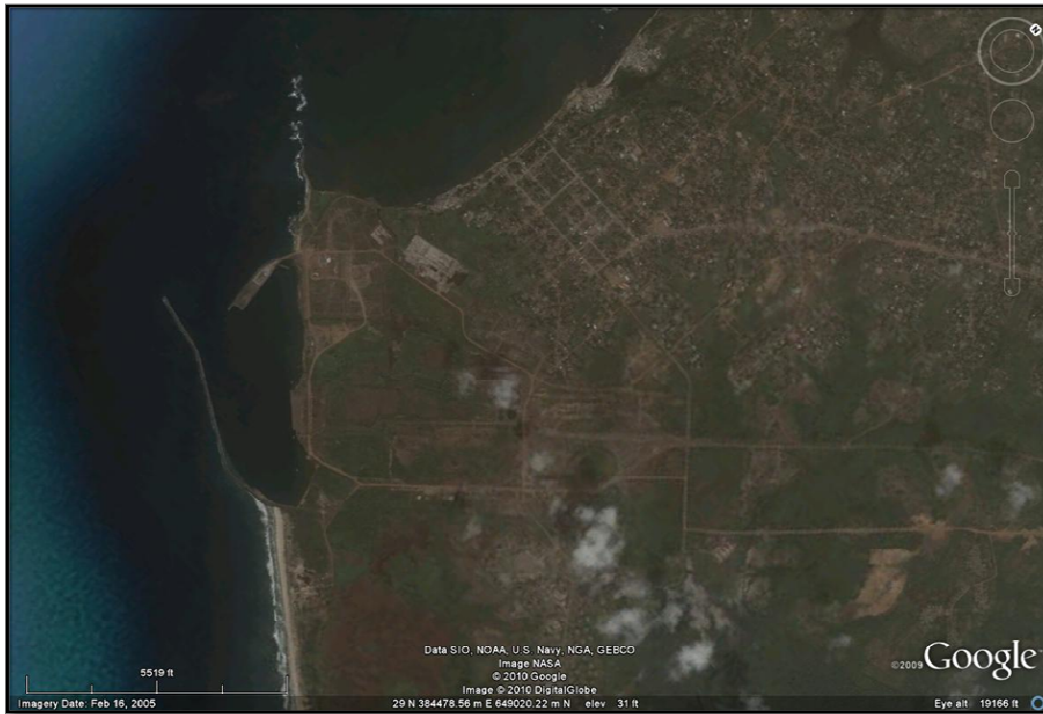


Figure 1-2: Port of Buchanan (Source: Google Earth, 2010).

The Port of Greenville

The Port of Greenville is located in the southeastern region of Liberia in Sinoe County, approximately 421 miles from the Freeport of Monrovia. The Port's harbor is protected by a 400m long breakwater. There are two quays (70m and 180m long respectively) on the inner side of the breakwater for berthing facilities, with an existing water depth of 6m below chart datum. The Port was rehabilitated in the early eighties with loan from the German Development Fund. The port functions mainly as an outlet for the timber industry (<http://nationalportauthorityliberia.org/History.html>).

The Port of Harper

The Port of Harper is located about 476 miles from Freeport of Monrovia, in Maryland County in the southeastern region of Liberia, near the border with the

Ivory Coast. The port was constructed in 1959, on the rocky Russwurn Island, by connecting the island to the main land with a causeway and by constructing a 150m long breakwater off Russwurn Island. A 100m long reinforced concrete pier provides docking facilities (<http://nationalportauthorityliberia.org/History.html>).

Table 1-1: The Four Ports of Liberia and applicable details (County, Area, and Year of Establishment)

<i>Port</i>	<i>County</i>	<i>Break water length</i>	<i>Year of Establishment</i>	<i>Water Depth Below Chart Datum</i>
The Freeport of Monrovia	Montserrado	2,350m and 2,200m	1967	NA
The port of Buchanan	Grand Bassa	1,890m and 590m	1960	12.95 m
The port of Greenville	Sinoe	400 m	Early 1980s	6m
The port of Harper	Maryland	150 m	1959	NA

1.2 THE ENVIRONMENTAL MANAGEMENT PLAN

The objective of this EMP is to ensure that the potential impacts from the Wreck removal, Ship breaking and the Buchanan Port Rehabilitation in Liberia and related activities undertaken by Buchanan Renewable are identified, their significance is assessed, and an appropriate environmental management plan (mitigation, monitoring, and institutional strengthening) is developed for the facility and implemented during the project life cycle. The EMP is an “interactive document” and should be updated as needed to reflect the changing operations, working geographical areas and lessons learned. It was prepared mainly to assess the impacts associated with the large salvage operation and provide the mitigation measures for the following activities:

- Wreck Removal
- Ship Breaking
- Port Rehabilitation Plan

1.3 SCOPE OF WORK

Besides, the introductory section, the scope of work implemented in the preparation of the current report includes the following:

- Definition of the legislative and institution framework
- Description of the Environment
- Description of the Project Activities
- Identification and analysis of potential environmental impacts
- Development of environmental management and monitoring plan

The present EMP report shall be updated and detailed by potential contractors with emphasis on implementation mechanisms of environmental management plans to reflect the elements of the complete design and specific characteristics.

2 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

2.1 LEGISLATIVE FRAMEWORK

Article 7 of the 1986 Constitution of the Republic of Liberia sets the fundamental basis for the constitutional, legislative, and institutional frameworks for the protection and management of the environment. It also encourages public participation in the protection and management of the environment and the natural resources in Liberia.

The EPA of Liberia was created by the Legislative Act of November 26, 2002 and published on April 30, 2003. The establishment of the EPA marks a significant step forward in the protection and management of the environment in Liberia.

Part II, Section 5 of the Act designated the EPA as the principal Liberian authority for environmental management which shall co-ordinate, monitor, supervise, and consult with relevant stakeholders on all activities for environmental protection and the sustainable use of natural resources. Section 6 (b) of the Act stipulates that the EPA should propose environmental policies and strategies to the Policy Council and ensure the integration of environmental concerns in the overall national planning.

Meanwhile, Section 1 of The EPML gives the responsibilities of sustainable development, protection and environmental management to the EPA in partnership with regulated Ministries and organizations and in a close relationship with the people of Liberia. The EPA should also provide high quality information and advice on the state of the environment and for matters connected therewith. This article indicates that environmental protection by the EPA should be accomplished taking into consideration public health and welfare of the Liberian societies. In addition, Section 15 of the EPML states that business investors should present an

environmental mitigation plan to the EPA, which should include the following sections:

- Objectives.
- Description of activities to be carried out by the project to mitigate any adverse effects on the environment.
- Period within which the mitigation measures shall be implemented.
- Proven efficacy of the mitigation measures of indicating their experimental nature.

Moreover, Section 12 of the same law requires environmental review for project or activities that may have significant impact on the environment. The project proponent shall submit to the EPA their plans for improving environmental performance including:

- Identification of the major environmental effects; and
- A comprehensive mitigation plan in accordance with section 15 of this Law

In addition, Section 6 of The Environmental Protection and Management Law which requires an Environmental Impact Assessment license or permit for the commencement of such projects, and Section 13 requires the preparation of an environmental impact study for such a project. Moreover, the Agency (EPA) is empowered to carry out among others, the following aspects of environmental protection and management in Liberia:

- Establish environmental criteria, guidelines, specifications, and standards for production processes and the sustainable use of natural resources for the health and welfare of the present generation, and in order to prevent environmental degradation for the welfare of the future generations;
- Identify projects, activities, and programs for which environmental impact assessment must be conducted under this Act.

- Review and approve environmental impact statements and environmental impact assessment submitted in accordance with this Act;
- Monitor and assess projects, programs, and policies including activities being carried out by relevant ministries and bodies to ensure that the environment is not degraded by such activities and that environmental management objectives are adhered to and adequate early warning and monitoring on impending environmental emergencies is given;
- Review sectoral environmental laws and regulations and recommend for amendments and to initiate proposals for the enactment of environmental legislations in accordance with this Act or any other Act;
- Encourage the use of appropriate environmentally sound technologies and renewable sources of energy and natural resources;
- Function as the national clearinghouse for all activities relating to regional and international environment-related conventions, treaties and agreements, and as national liaison with the secretariat for all such regional and international instruments.

[Table 2-1](#) describes the main categories of legislation in Liberia. [Table 2-2](#) shows international conventions that are signed and ratified by the Liberian Government. In terms of environmental legislation, [Table 2-3](#) represents a list of all issued legislation.

Borttaget: Table 2-1

Borttaget: Table 2-2

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Borttaget: Table 2-3

Table 2-1: Categories of Legislations in Liberia.

Law	Laws are passed by the National Legislature of Liberia comprising of the Senate and the House of Representatives. Any citizen or group of citizens, Cabinet Ministers, Managing Directors of public corporations or agencies can propose a bill to the National Legislature for enactment. The draft bill is first passed over to the appropriate Steering Committee of the Legislature. In case of environmental bill, this committee is generally the Committee on Natural Resources and the Environment. The Committee reviews, assesses and presents the bill to the Legislative Plenary with appropriate amendments for debate, public hearing and subsequent enactment by the Legislature.
Executive Order	The Executive Branch of government headed by the President can issue Executive Order without the approval of the National Legislature. The Executive orders have the power of a law provided that they do not contravene the existing law. The power of such orders has a limited time of existence.
Regulations	The national Legislature has empowered Cabinet Ministers and Managing Directors of public corporations and agencies to issue regulations for their respective functionaries without legislative approval or supervision, provided that such regulations are not inconsistent with the statutory Laws and the Constitution of Liberia.

Table 2-2: International Environmental Conventions Signed/Ratified by the Government of Liberia.

CONVENTION	STATUS	YEAR
African Convention on Conservation of Nature and Natural Resources	Ratified	NA
Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Ratified	1981
Convention Concerning the Protection of the World Cultural and Natural Heritage	Signed	2002
Framework Convention on Climate Change and the Kyoto Protocol	Signed	2002
Stockholm Convention on Persistent Organic Pollutants (POP)	Signed	2002
Ramsar Convention on Wetlands of International Importance	Signed	2003
Convention on Biodiversity	Ratified	2000
Bio-Safety Protocol	Ratified	2003
Convention on Desertification	Signed	1998
Vienna Convention for the Protection of the Ozone Layer	Signed	1996

Montréal Protocol on Substances that Deplete the Ozone Layer	Signed	1996
International Convention for the Safety of Life at Sea (SOLAS)		1980
Protocol to the International Convention on the Establishment of an International Fund of Compensation for Oil Pollution Damage		1994
Protocol to the International Convention on Civil Liability for Oil Pollution Damage		1981
Convention on Limitation of Liability for Maritime Claims		1986
International Convention for the Prevention of Pollution from Ships as modified by the Protocol of 1978		1983
Protocol relating to the International Convention for the Safety of Life at Sea (SOLAS Prot.) 1981		
International Convention for the Prevention of Pollution from Ships, (MARPOL) - Annex III (Optional): Hazardous substances carried in packaged form		1973
International Convention for the Prevention of Pollution from Ships (MARPOL) - Annex V (Optional) =Garbage		1995
Protocol relating to Intervention on the High Seas in Cases of Pollution by Substances other than Oil		1983
Annex VI to MARPOL 73/78 on the prevention of air pollution from ships		2003

Table 2-3: Relevant Environmental Legislations.

LEGISLATION (ACT)	DATE	TITLE/ DESCRIPTION
Law	1953	Conservation of the Forests of the Republic of Liberia. This Law provided the framework for the use of forest and wildlife resources and allowed for the creation of government reserves, native authority reserves, commercial forests, national parks and wildlife refuges.

LEGISLATION (ACT)	DATE	TITLE/ DESCRIPTION
Law	1957	Supplementary Act for the Conservation of Forests. This Supplementary Law also provided the framework for the use of forest and wildlife resources and allowed for the creation of government reserves, native authority reserves, commercial forests, national parks and wildlife refuges.
Law	1976	The Act that created the Forestry Development Authority (FDA). The Act established and defined the responsibilities of the FDA, outlined forest offences and penalties; made provision for an Advisory Conservation Committee and specified powers of forest officers with regard to trees in reserve areas.
Law	1976	Public Health Act. It contains provision for the protection of drinking water resources and the inspection of potential sources of pollution.
Law	1979	The Natural Resources Law of Liberia. This Law includes chapters on forests, fish, and wildlife, soil, water, and minerals.
Law	1988	Wildlife and National Parks Act. The Act identifies a number of protected areas; specifies policies and objectives regarding wildlife and conservation in the country.
Law	03/04/ 2000	The New Minerals and Mining Law. The Law and its resulting policy call for restoration of land to its previous state as much as possible after mining activities. All medium to large-scale mining activities are to submit Environmental Impact statements. Environmental audits and periodic assessments will be undertaken to ensure compliance.
Law	26/11/ 2002	The Environment Protection Agency (EPA) Act. The Act provides the Agency with the authority of government for the protection and management of the environment in Liberia. It provides for an Environmental Administrative Court to hear from aggrieved parties. It requires that an Environmental Impact Assessment (EIA) be carried out for all activities and projects likely to have an adverse impact on the environment.

LEGISLATION (ACT)	DATE	TITLE/ DESCRIPTION
Law	26/11/2002	The Environment Protection and Management Law. The Act enables the Environment Protection Agency to protect the environment through the implementation of the Law. It arranges the rules, regulations, and procedures for the conduct of EIA. It establishes regulations for environmental quality standards, pollution control and licensing, among others.
Law	26/11/2002	The National Environmental Policy Act. It defines policies, goals, objectives, and principles of sustainable development and improvement of the physical environment, quality of life of the people and ensures coordination between economic development and growth with sustainable management of natural resources.
Law	2006	National New Forestry Reform Law. The administration of this Act provides for the Forestry Development Authority to exercise the power under the Law to assure sustainable management of the Republic's forestland, conservation of the forest resources, protection of the environment, sustainable economic development with the participation of and for the benefit of all Liberians and to contribute to poverty alleviation in the country.

2.2 ENVIRONMENTAL QUALITY STANDARDS

Several environmental quality standards are under preparation by EPA. Some of these environmental quality standards shall include: 1) Air Quality Standards; 2) Noise Level Standards; 3) Combustion Conditions and Emission Standards for Municipal and Hospital Wastes Incineration; and 4) Selected Standards for Discharge into surface waters.

2.3 INSTITUTIONAL FRAMEWORK

At a regional cooperation level, Liberia is a member of a number of organizations that play an important role in the protection and management of the environment. These organizations include the Economic community of West Africa (ECOWAS),

The Mano River Union (MRU), The West African Rice Development Association (WARDA), and the African Union (AU).

In addition to the EPA, other organizations play a vital role in environmental protection and management, particularly the Forestry Development Authority (FDA), Ministries of Lands, Mines and Energy (MLM&E), Ministry of Planning and Economic Affairs (MPEA), Ministry of Justice (MOJ), Ministry of Public Works (MPW), and Ministry of Health and Social Welfare (MHSW), Ministry of Agriculture (MOA), Ministry of Commerce (MOC), and the Liberia Water and Sewer Corporation (LWSC).

However, EPA is the main agency and principal authority in Liberia for environmental management and shall co-ordinate, monitor, supervise and consult with relevant stakeholders when needed.

The main functions of the EPA are:

1. Co-ordinate, integrate, harmonize and monitor the implementation of environmental policy and decisions of the Policy Council by the Line Ministries,
2. Propose environmental policies and strategies to the Policy Council and ensure the integration of environmental concerns in overall national planning;
3. Collect, analyze and prepare basic scientific data and other information pertaining to pollution, degradation and on environmental quality, resource use and other environmental protection and conservation matters and undertake research and prepare and disseminate every two years a report on the state of the environment in Liberia;
4. Encourage the use of appropriate environmentally sound technologies and renewable sources of energy and natural resources;

5. Establish environmental criteria, guidelines, specifications and standards for production processes and the sustainable use of natural resources for the health and welfare of the present generation, and in order to prevent environmental degradation for the welfare of the future generations.

3 DESCRIPTION OF THE ENVIRONMENT

3.1 GENERAL SETTING

The quadrangle of Liberia is located on the western side of the African Continent. It is positioned on the Atlantic coastline of Africa, and has a surface area of 111,370 km². It is bordered by Guinea from the north, Sierra Leone from the west and Côte d'Ivoire from the east (Figure 3-1). The border with Guinea is approximately 563km, with Sierra Leone approximately 306km, and with Cote d'Ivoire approximately 716 km. Liberia has a studded coastline approximately 560 km long. It is characterized by unbroken sand strips, and is dominated by lagoons and marshes. Generally, Liberia has low relief topography. However, the hinterland is made up of ill-defined and dissected plateaus and low relief mountains few rising abruptly above the surface to an elevation of 400m asl. The highest mountain (Mount Wutivi) is located in the northeast (Yekepa) and rises to an elevation of approximately 1,380m asl.

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Borttaget: Figure 3-1

Liberia has virgin rain forests that are primarily located inland and in mountainous areas. The rest of the land is occupied by small farms. Liberia has four types of vegetation cover (Figure 3-7). Those are distributed according to the following: brush, grassland, cultivated and tree crops dominate the central and coastline areas; swamps are present as patches along the coastline mainly near river mouths; broadleaf evergreen forests are present in the southeastern part of the country; and broadleaf deciduous and evergreen forests dominate the northern parts and are present in the central parts.

Borttaget: Figure 3-7

Liberia has six major rivers that subdivide the country into several quadrants. The rivers are Cavalla, Cestos, St. Paul, St. John, Lofa, and Mano. The longest and largest is the Cavalla River (Table 3-1).

Borttaget: Table 3-1

Table 3-1: Major rivers in Liberia and there approximate annual discharge at their discharge points. (Liberia Hydrological Services, 1988).

Basin	Area(Km ²)	Annual Flow (m ³ /sec)
Mano	6,604	251
St. Paul	12,820	512.3
St. John	14,726	N/A
Cavalla	13,726	380
Cestos	10,000	60.3
Lofa	9,194	N/A

3.2 LOCATION

3.2.1 General Setting

The Port of Buchanan where the rehabilitation process will take place is located in Buchanan City of Grand Bassa County. The County is located in the area from latitude 6° 30' to latitude 5° 30' North, and from longitude 10° 30' to longitude 9° 00' West. The county is bordered by Margibi County on the Northwest, Bong County on the North, Nimba County on the East, and River Cess County on the Southeast. The Atlantic Ocean, with a coast extending in Northwest-Southeast direction borders the county on the Southwest. Buchanan is the third largest city in Liberia lying on Waterhouse Bay, part of the Atlantic Ocean. The coastline is impacted by great tidal waves emanating from the ocean and extends inland from the seashore, where it slightly falls to the limitation of the City.

3.2.2 Site Setting

The Port of Buchanan is located 170 miles southeast of Monrovia and covers a surface area of approximately 110,000 square feet. The Liberia-American Swedish Mining Corporation (LAMCO) constructed the port in 1960 to facilitate the export of iron ore deposits mined from the Nimba Range. Generally, the Port consists of two breakwaters measuring 1,890m and 590m long) that protect the quay. Whereas, inside the basin a 255m long ore-loading pier is found adjacent to the deeper section of the harbor basin with a water depth of 12.95 m below chart datum. Next to the packing pier, a utility berth for ore carriers is available. The access passage/channel to the port offers large vessels a water depth of 14.95 m below chart datum and a channel width between the breakwaters of 210m. Elevation ranges from 0 to 10 m above sea level. The port is accessed through one major road leading to the

Monrovia-Buchanan Highway. Another road, which used to lead to Upper Buchanan, was washed away by the sea. The nearest towns to the port include:

- Giabli: 4 Km Southeast
- Bakonbli: 4.3 Km Southeast
- Gwebi: 4 Km Northeast
- Pegabli: 4.1 Km Northeast
- Jacob Town: 4.6 Km North-Northeast
- Joko Town: 3.8 Km North
- Tumipasum: 4.8 Km North

An airfield known as James Cheeseman Airfield with a soft surface is located between Joko Town and Tumipasum Town and is 4 Km north of the port. Another airfield, located in Sayou town is 2.5 Km east of the port.

The Port's entry channel is 60 meters long and has three sections: the commercial pier, the iron ore key, and oil jetty. The commercial pier has a length of 320 meters and a depth of 10 meters, and can take ships with 38-40 summer dead weights (SDW). The iron ore quay is 257 meters long and has a depth of 13.58 meters with capacity to service ships with 43-53 summer dead weights (SDW). The oil jetty is 126 meters long and 9.12 meters deep. The SDW capacity of the oil jetty is 20-25.

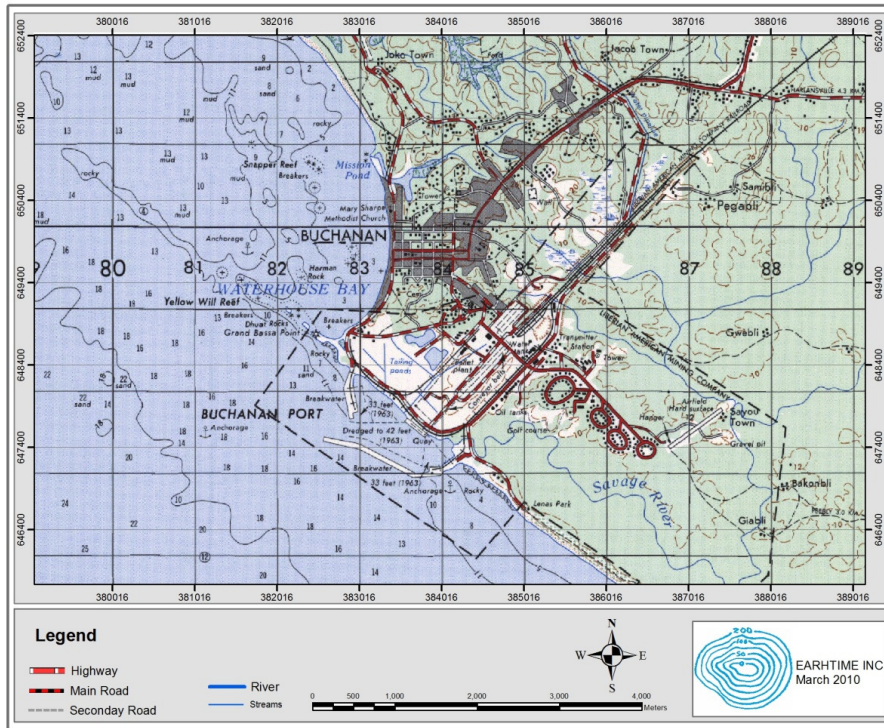


Figure 3-2: Location map of the study area showing the location of the Port of Buchanan.

3.3 METEOROLOGICAL SETTING

Liberia has a typical tropical climate, with heavy rainfall that ranges between 2,000 mm/year and 4,000 mm/year (UNEP, 2004) most of the rainfall occurring between April and November. Precipitation varies between 2,240 mm/year along the coast and 5,210 mm/year inland. Measurements indicate that the rainfall ranges between 4000 and 5000 mm/year. The average temperature in Liberia is approximately 28°C with a maximum that rarely exceeds 38°C. Generally, the temperature is warm throughout the year with very high humidity (UNDP, 2006).

Meteorological data including primarily precipitation, ambient temperature, as well as wind direction and speed, are necessary for developing and understanding an important part of the environmental conditions in the region and consequently for adequately assessing environmental impacts in a comprehensive approach.

3.3.1 Precipitation

Data on precipitation was obtained from records of a station that was operated by LAMCO J.V. Operating Company at location Latitude 5° 52' North and Longitude 10° 03' West where monthly rainfall records were obtained for the company for the period of 1959-1980. [Figure 3-3](#), shows the average yearly precipitation from year 1959 till 1980. The average annual rainfall between the years 1959 and 1980 was 4054.7 mm. [Figure 3-4](#) shows the average monthly precipitation with a major increase of precipitation in the months of June, July, August, September and October. Rainfall events are particularly concentrated in the season of May until November with a maximum recorded value of 770.9 mm and a minimum value of 27.0 mm.

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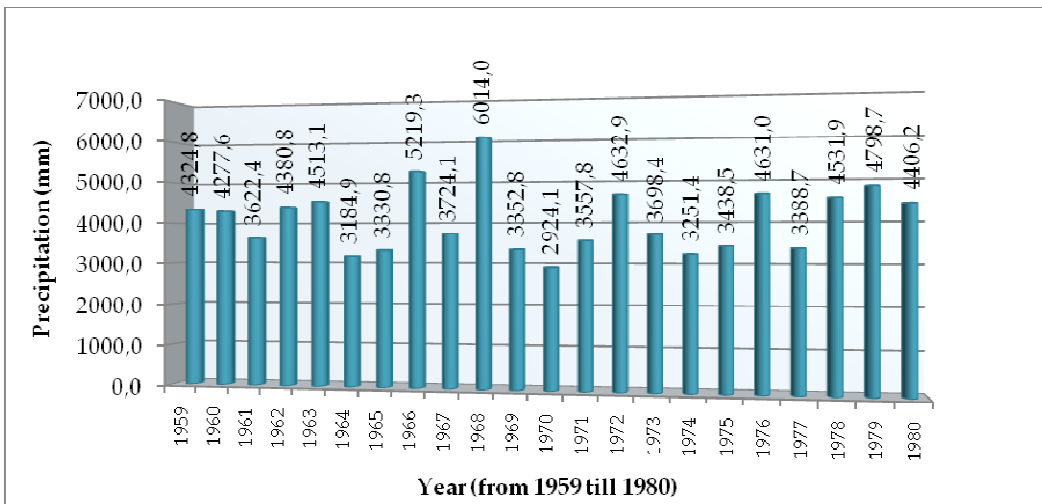


Figure 3-3: Average annual precipitation between 1959 and 1980 (Liberian Hydrological Service, 1981).

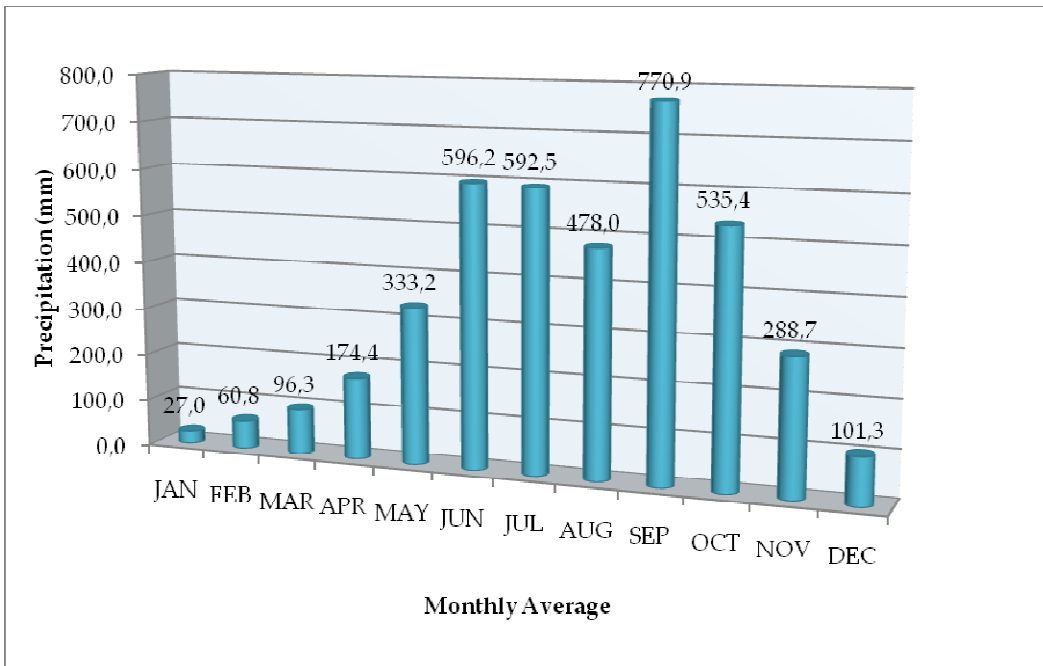


Figure 3-4: Average monthly precipitation from year 1959 till 1980 (Liberia Hydrological Service, 1981)

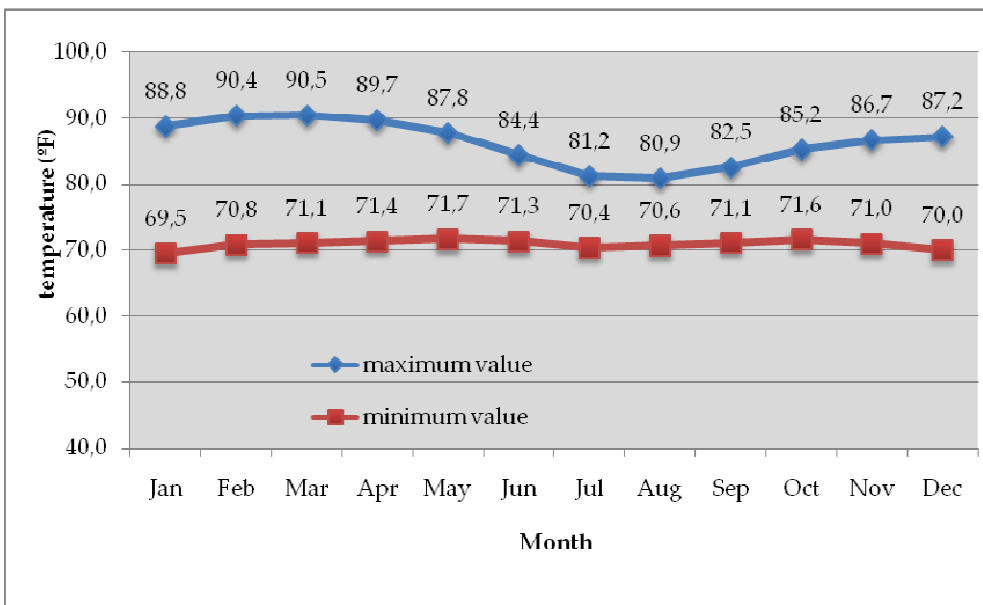


Figure 3-5: Average Monthly Temperature Variation fom Year 1936 till 1981(Liberian Hydrological Service, 1981)

3.3.2 Temperature

Temperature data are available from one station located in Firestone-Harbel for the year 1936 till 1981. Records from temperature-reading station in that area, indicate that minimum temperatures fall within the months of November, December and January while hot weather condition prevail in the months of February, March, and April (Figure 3-5) (Liberian Hydrological Service, 1982, 1981). Moreover, the minimum temperatures in the area range from 69.5 °F to 71.7 °F, while maximum temperatures vary from 80.9 °F to 90.5 °F.

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3.3.3 Winds

The seasons in Liberia are mainly the results of the movement of two air masses. The Inter-Tropical Convergence Zone (ITCZ) from the northern hemisphere. At the same time cool air masses over the South Atlantic Ocean in the southern hemisphere overhead south. Due to this pressure shifts the air masses, dry continental air mass and moist south-equatorial maritime air mass replace each other every six months (UNDP, 2006).

However, the dominant wind directions are the NE and SW Monsoons as well as the Harmattan, which is a dust laden wind from the Sahara Desert. The south-westerly winds rain bearing winds hits the coastline of Liberia at a right angle. As the air reaches the coast it rises and cools resulting in heavy rainfall. On the other hand in the immediate vicinity of the coast another air circulation takes place. It is a daily change in land and sea breezes (UNDP, 2006).

The total wind speed is lowest in the dry season and greatest in the rainy season. The greatest wind speed is between July and September and the lowest is in December and July. The coastal area has much more wind than the interior of the country. High vegetation cover in the interior serves as windbreak in the interior (UNDP, 2006). According to UNDP, 2006 average wind speeds of 6.8 mph have been recorded at Harbel (Firestone). The highest wind speed is 45 miles/hour was

recorded in Buchanan in April and May 1988. The average annual wind speed was 19.5 mph (UNDP, 2006).

Table 3-2: Average Annual Rainfall (1961-1980) (Liberian Hydrological Service, 1981).

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1959	59.4	167.4	217.9	115.4	414.4	817.2	949.3	332.2	472.4	551.9	201.8	25.5	4324.8
1960	40	52.7	170	149.7	190	925.5	279	663.4	1050	459.4	173.8	124.1	4277.6
1961	14.6	44	38.8	173.3	214.7	841.8	646.4	95.9	911	434.2	194.6	13.1	3622.4
1962	78.6	51.3	108.8	182.4	310.1	803.5	778	314.2	1027.6	391.5	294	40.8	4380.8
1963	19.4	105.2	178.5	166	77.2	344.7	732.8	820.3	830.4	624.2	154.4	460	4513.1
1964	49.8	2.3	12.2	43.1	254.7	896	417.6	187.2	348.5	385.6	323.6	264.3	3184.9
1965	31.7	12.5	33.9	208.6	317	382.4	563.8	438	412.4	723.6	177.1	29.8	3330.8
1966	1.8	149.2	82.01	196.6	436.7	722.1	893.8	529.5	1115.9	745.8	171.2	174.7	5219.3
1967	20.8	13.8	15.3	333.5	231.9	581.3	281.1	61	949.7	824.4	209.5	201.8	3724.1
1968	4.2	65.1	136.8	135.7	356.3	599.5	939.7	639.7	536.4	317.2	2226.9	56.5	6014.0
1969	0.5	2.2	20	150	364.7	456.8	594.9	400	622.5	529.5	118.8	92.9	3352.8
1970	52	68.5	141.9	123.6	339.2	308.4	114	306	616.7	485	221.9	146.9	2924.1
1971	31.3	126.7	24.3	124.9	297	449.6	461	265	688	594	357	139	3557.8
1972	0	44.5	42	164.5	688.8	602.8	625.8	678.5	840.1	741.65	175	29.2	4632.9
1973	5.7	26.9	144.5	151.1	325.3	431.5	599.1	745.3	756	399.9	103	10.1	3698.4

1974	0	8	19.2	54.5	104.7	760	742.2	520.7	585.3	304.9	136.9	15	3251.4
1975	0	96	114.1	172.3	384.8	467	350.5	502.5	786	278	88.8	198.5	3438.5
1976	28.8	17.5	75	390	462.1	366.5	811.5	377.5	1233	468.2	377.5	23.4	4631.0
1977	11.4	81.9	92.6	37.5	356.9	584.6	228.5	507.1	760.2	510.9	125.5	91.6	3388.7
1978	86.9	97.6	144.7	331.7	350.5	628	340.2	525.1	755	1145.1	111.6	15.5	4531.9
1979	56.4	26.5	62.8	247.1	424.9	699.2	750.5	906.3	922.2	490.2	172.5	40.1	4798.7
1980	0	78.4	242.6	185.4	427.6	448.6	936.3	700.9	741.6	374.5	235.4	34.9	4406.2
Total	593.3	1338.2	2117.9	3836.9	7329.5	13117.0	13036	10516.3	16960.9	11779.7	6350.8	2227.7	
Average	27.0	60.8	96.3	174.4	333.2	596.2	592.5	478.0	771.0	535.4	288.7	101.3	4054.7

3.4 GEOLOGICAL SETTING

Geologically, the study area is located in the middle on the western edge of the Buchanan Quadrangle in the south eastern part of the Bassa Basin bordered by the Pan-African Province towards the north (Figure 3-6). The Buchanan Quadrangle is part of the Guinean Shield of West Africa and characterized by low-lying topography dotted with hills in the coastal area; it contains mountains a few hundred meters high inland.

The outcropping units are mainly Precambrian and much younger surficial deposits. Due to the tropical weathering that has created a thick laterite and fluvial and deltaic deposits cover, which supported dense vegetation and rain forests were formed covering most of the rocks in the Buchanan Quadrangle (Tysdal and Thorman, 1983).

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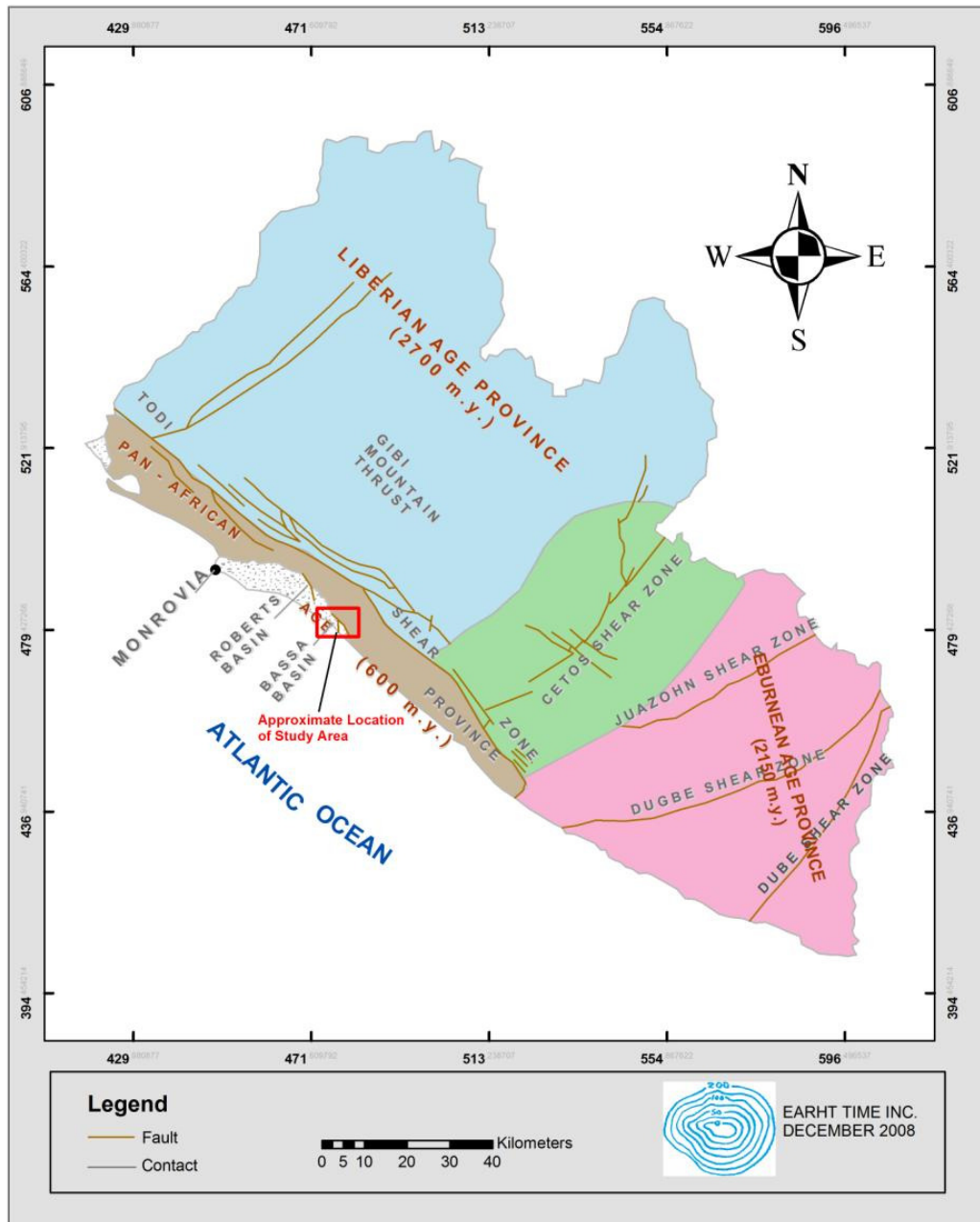


Figure 3-6: Geological provinces of Liberia (Tysdal and Thorman, 1983).

3.4.1 Stratigraphy

The largest outcropping formation in the study area is the Leucocratic Gneiss (gn1). It is present in the northern and northeastern parts. Those rocks are considered to be

Precambrian in age. It usually occupies low relief. The gn1 has a typical mineral assemblage of quartz, two feldspars and biotite. Foliation is mainly defined by Biotite orientation.

The second major outcropping formation is the Melanocratic gneiss (gnm). It is Precambrian in age. It outcrops northeast of the study area and extends in the northwest-southeast direction. This unit is distinguished by medium to dark-colored orthopyroxene and clinopyroxene-bearing hornblendic rocks that are mainly dioritic in composition. These rocks form discontinuous bodies interbedded with gneiss that ranges from biotite-quartz diorite to granodiorite in composition. The gneiss makes up more than half the rock in the northwestern part of the unit, but dark rocks dominate the southeastern part of the unit.

Few other outcropping formations surrounding the port facility include the Farmington River Formation (Kfc), Edina Sandstone (Te), Amphibolite (am), and Lagoonal and Beach Deposits (Ql).

The Port of Buchanan is located on Beach deposits (Qb) that are composed mainly of unconsolidated deposits of white quartz sand that form a veneer in savannahs near the coast. Brown sand as much as 2 metres thick was observed locally beneath the white sand near Buchanan and Bafu Bay. Rosenblum and Srivastava (1970) described similar white sand in the Monrovia area. The unit also includes beach ridges and intervening lagoon deposits between River Cess and Greenville (see van Giethuysen, 1970). The ridges range to 5 m in height, 100 m in length, and trend parallel to the coast. The sand layers, which are mostly quartz, dip toward the ocean at about 5°.

3.4.2 Structure

3.4.2.1 Folds

Broad mesoscopic folds both synform and antiform, characterize the Buchanan quadrangle, but synforms are the more common. Aerial photographs and magnetic maps (Behrendt and Wotorson, 1974a), in addition to field data, were used extensively to delineate the folds. Mesoscopic isoclinal folds were noted only in the composite gneiss unit gn2 in the southeasternmost part of the quadrangle.

3.4.2.2 Faults and shear zones

Two directions of faulting are prominent in the quadrangle. Northeast-trending faults, represented by the Cestos shear zone is a near vertical structure separation melanocratic gneiss, diorite, and schist to the east from leucocratic gneiss on the west. The sheared rocks are commonly more resistant to erosion than nonsheared rocks and control the course of the Cestos River; they range from protomylonite to ultramylonite. Topographic features are strongly aligned within the zone, and folds to the west terminate abruptly at the margin of the zone.

The Todi shear zone (Thorman, 1972; 1977) trends northwest and commonly dips steeply southwestward of is vertical. Rocks observed along the zone include both protomylonite and mylonite. The sheared rocks are commonly resistant to weathering and erosion, more so than nonsheared rocks, and form prominent and abundant outcrops in the river beds.

Long segments of individual faults within the shear zone are defined by (1) abrupt change in magnetic pattern and, locally, a coincident change in radiometric intensity; (2) strongly alined drainage pattern; (3) abrupt change in strike of rocks across the shear zone; and (4) near the Cestos River, by abrupt truncation of a prominent northeast-trending ridge. The location of the southeastern end of the shear zone is uncertain.

3.5 BIODIVERSITY AND ECOLOGICAL STATUS

Generally, the coastal and marine biodiversity includes:

- Avifauna;
- Fisheries;
- Mammals; and
- Herpetofuana.

The site is well represented by abundant plants and animals. The flora consists of low bush, grasslands, remnants of tropical coastal mangrove species, and phytoplankton (green & blue a), while the fauna includes resident birds, turtles, crustaceans, invertebrates, and host of other organisms. The most common turtles reported in the area are represented by *Dermochelys coriacea* and *Caretta caretta* (MOA, 1999). Additionally, green and black snakes, rats, hare hog, rodents are endemic to the vicinity.

The site provides a well-defined passage and transit for migratory birds. The avifauna is represented by long-tailed hawk (*Urotriorchis macrourus*), common bulbul (*Pycnonntus barbatus*), palmnut vulture (*Gypohierax angiogenesis*), palm bulbul (*Thescelocichala leucopleura*), brown sunbird (*Anthreptes gabonicus*), and cowbird (*Molthrus ater*).

Fishery is one of the marine resources providing income and employment in the area. The economically harvestable fishing resources in relations to the area include croaker, grunter, sea bream, mackerel, snapper, sole, graper, tuna, and various sardines. In addition, principal marine resources of vital nutritional and economic importance are shrimps, rock lobsters, crabs, and oysters. These fishing practices include casting of nets, spearing, angling, trapping, and sometimes hand gathering.

The agricultural biodiversity found within or around the project area consists of vegetables (cabbage, okra, pepper, bitter ball); food crops (rice, banana, plantain); perennial crops (coconut, oil palm, sweet orange); and different germplasm of tubers (cassava, yam, etc.). Specifically, the agricultural richness of the County is well represented by oil palm, rubber tree species, insects, pests, pollinators, and inland fishery species.

Ecologically, the area hosting the port of Buchanan but not limited only to the port area, reveals typical features of coastal vegetation (savannah woodland). The coastal vegetation is characterized by mangrove swamps. A remnant of the red mangrove species (*Rhizophora racemosa*) found within the vicinity of the site is indicative of coastal vegetation.

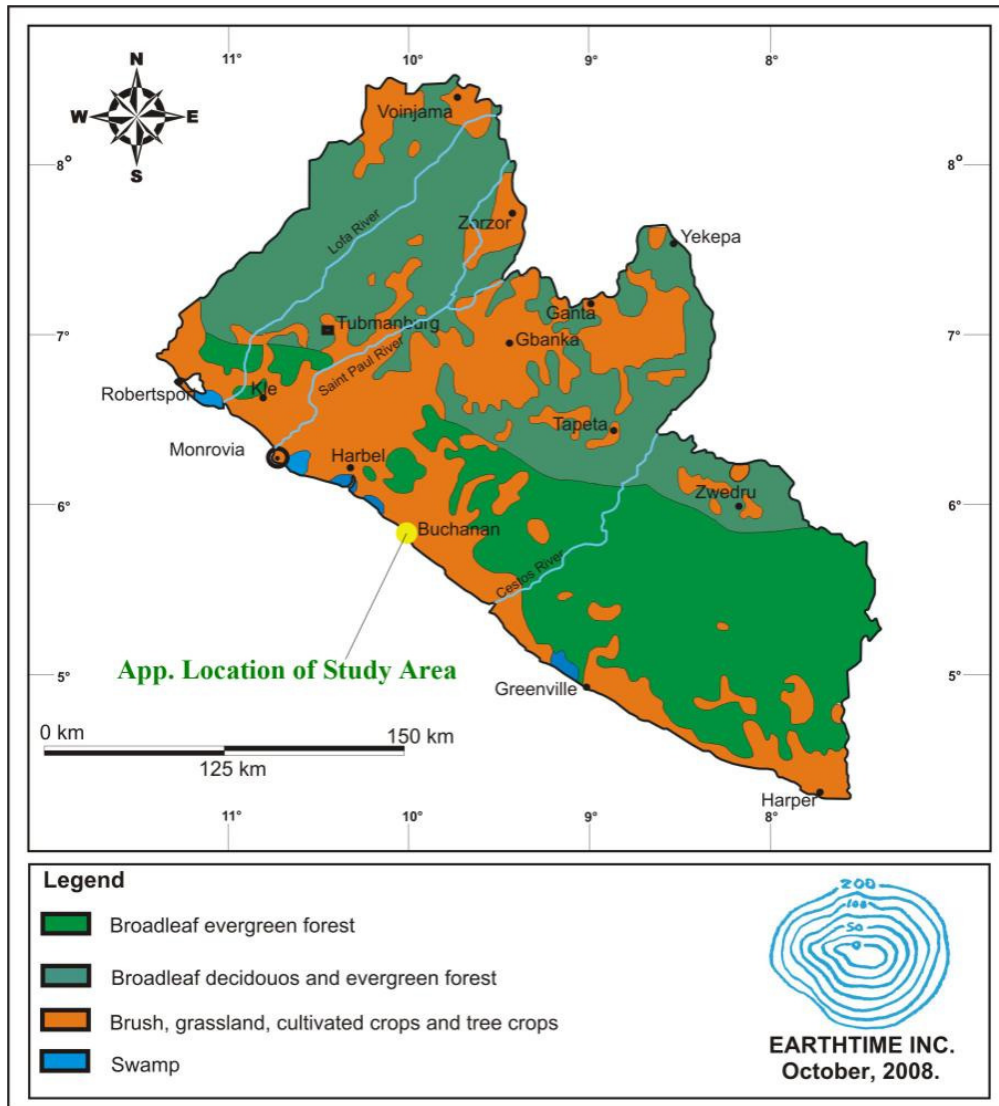


Figure 3-7: Vegetation Cover in Liberia.

3.6 SOCIO-ECONOMIC STATUS

The Buchanan port is located in Bassa County. The County is the third largest in Liberia and borders with four counties: Margibi on the northwest, Bong on the north, Nimba on the east, and River Cess on the southeast. Besides, on the southwest of the county lies the Atlantic Ocean (Figure 3-1). The county is of significant geopolitical importance and was severely devastated by the civil war.

Borttaget: Figure 3-1

The county has six statutory districts, nine administrative districts, three cities, and forty-five clans. The county also has three cities (Buchanan, Edina, and St. John River).

The hierarchy of administrative officers in counties is administered by superintendents, cities are headed by mayors, and townships and districts are headed by commissioners. The county's population as estimated by Liberia Institute of Statistics and Geo-Information Services (LISGIS) is 224,839 with a fairly close gender distribution: 111,861 males and 112,978 females. The port of Buchanan is located within the commonwealth district which has a population of 34,270 with a practically close gender distribution of 16,984 males as compared to 17,286 females (NPHC, 2008).

The Bassa language is a Niger-Congo language spoken by about 350,000 people in Liberia (GOL, 2008). The Bassa, Kpelle, Gbandi, Kru, Gola, Gio, Grebo, Krahn, Lorma, Mano, Vai, and Sapo are the twelve ethnic groups residing in the county (CFSNS, 2006). In the context of tribal density, the two principal ethnic groups endemic to the county are the bassa and kpelle. Bassa-speaking groups are in majority, making up 94% of the county's population. Moreover, other ethnic groups in the county comprise the Kpelle (5%), and the Kissi (1%), Kru (0%) and small numbers of other groups. Fanti fishermen and traders are also a part of the population, mostly settled in coastal towns or commercial centers.

Christians and Muslims are estimated to be about 93 percent and 5 percent respectively, while the other 2 percent are animist (Grand Bassa CDA 2008-2012).

The County is divided into seven health districts (Owensgrove, District #1, #2, #3, #4, Buchanan, and Camp wood). There are 31 functional health facilities in the County according to the County Health Team. The Government-owned Buchanan Hospital (the county's major referral healthcare facility) is located in upper Buchanan and the

formerly known LAMCO Hospital is presently managed by ArcelorMittal. The governmental hospital as well as all other clinics in the County is supported by international non-governmental organizations, with the government playing a leading role through the Ministry of Health and Social Welfare (MoHSW). On the contrary, it is worth mentioning that these medical facilities are not fully functional and need adequate rehabilitation, trained and well-paid practitioners and supplies for full operation as a means of alleviating numerous medical complications, ranging from shortage or exit of doctors, medication, high associated costs, poor service, salaries, etc.

Prior to the civil war, the County had a vibrant economy. Transnational corporations such as the Liberian American Mining Company (LAMCO)/Liberian Mining Company (LIMINCO), the Liberian Agricultural Company (LAC), the Palm Oil Plantation Liberian Incorporated (LIBINC), and National Milling Company were the largest employers.

Moreover, the harbor of Buchanan, Liberia's second largest port, was very active and operational to that of what it is today.

At present, ArcelorMittal, a multi-national corporation that signed a 25-year contract with the Government of Liberia to mine iron ore in Yekepa, is expected to create job opportunities in several domains through the rehabilitation of the damaged Yekepa-Buchanan rail road. In addition, the Buchanan Renewables Group, a Dutch renewable resource and power generation Group with operating subsidiaries in Liberia signed an agreement with the National Port Authority (NPA) to remove numerous shipwrecks and improve the functionality of Liberia's four major ports, is expected to create more specialty and unskilled jobs for the people living in the area and County.

Buchanan Renewables Group can also be considered to be a relatively large employer as presently provides over 600 jobs in several domains such as managers, professionals, machines operators (heavy excavator, cranes, scrap handlers, winch, etc.), vehicle operators, generators, light and support equipment specialists, technicians, nurses, unskilled laborers, mechanics, accountants, secretaries, etc. It is expected that Buchanan Renewables Energies (Liberia) will provide more jobs during the salvage operations phase and hire the services of additional contractors for the project.

The area surrounding the port of Buchanan where the salvage operation will be undertaken hosts a number of well-established wholesale and retail businesses varying from food products, building materials, dry goods, petroleum products, arts and crafts, tailoring, video shops, mobile phone dealers, currency exchangers, street vendors, barding shops, drink shops, transport unions, local construction groups to scores self-managed or financed enterprises. Moreover, there are GSM companies (Lonestar, Cellcom, Comium, and LiberCell) as well as banking institutions ranging from LBDI, Ecobank, AccessBank, etc.

3.6.1 Water Transport

Water transport is not well developed in coastal Liberia. However, there are two major transport links- the seaports link with the international world and sea ports link with other coastal ports. There is very low coastal transport link connecting coastal towns and few inland villages by rivers.

Most of the imported goods to Liberia pass through the Free Port of Monrovia. The other ports handle mainly exports, logs, and formerly iron ores. Ships transport goods from Monrovia to Harper, Buchanan and Greenville but this transport link is less due to low economic activities taken place between these centers that would require well organized transport network. Although ships in many cases carry

passengers from Monrovia to other coastal centers yet this is not a constant transport means.

Locally, citizens with boats and hand-dug canoes usually transport goods between coastal towns with coconuts, mangrove woods, and the transport of fishermen to fishing grounds. The number of people engaged in this sector is unknown.

4 PROJECT DESCRIPTION

Buchanan Renewables will be engaging in a large port improvement operation, focusing on the Port of Buchanan. The operation will include rehabilitation activities in the Port of Buchanan, ship wreck removal from various ports in Liberia (as prioritized by the National Port Authority), and ship breaking activities

Given the nature and un-predictability of this kind of work, this plan includes only a general description and timeline, as well as general methodologies of work. This kind of work is primarily about technical problem solving, applying a wide range of equipment and techniques to safely remove debris and wrecks and adjusting the approach as new information emerges. The timeline and the methodology will evolve as the project unfolds and as the technical work continually develops new information about the current state of each wreck and each task. However, BR will attempt with best efforts to keep the general timeline, work program, and budget intact.

4.1 GENERAL WORK PLAN

Over the last number of months BR has focused on sourcing, procuring and mobilizing the wide range of specialty equipment that will be necessary to complete the overall project. This equipment will arrive in several consignments, with the first and largest consignment having already arrived in February 2008.

This first consignment has most of the necessary equipment to begin work on the close-to-shore Wrecks. This consignment also includes most of the equipment for dredging as well as conducting detailed technical surveys to confirm initial research. The overall scope of the project has been segmented into several pieces and a general plan was developed to accomplish the mission. These segmented parts include:

- Wreck Removal

- Ship Breaking
- Port Rehabilitation Plan

4.1.1 Wreck Removal

There will be a team dedicated to the removal of wrecks and general debris that clog the Liberian Ports including the Port of Buchanan. There are currently in excess of 50 wrecks to be removed, most of which are close to shore or in shallow water in and around the ports of Monrovia, Buchanan, Greenville and Harper. The majority of the ships are fishing boats, tugs and light cargo ships that need to be removed in order to increase the safety and functionality of the ports.

The wreck removal team will focus on several tasks concurrently. These tasks, which are outlined below, may be undertaken from the barge or the main facility in Buchanan, BR's pontoon or a temporary site on shore, depending on the location of the wrecks:

- Diving to verify existing surveys of the wrecks and conduct any additional surveying required for wreck removal.
- Re-floating all vessels that can be floated by patching up wholes and pumping out water in a strategic manner. These ships will then be towed to Buchanan using the tug, where they will be processed for scrap.
- Using a crane to remove ships and dismantling ships in situ that cannot be re-floated and transporting the scrap to be fully processed at the main facility in Buchanan.

All waste will be dealt with according to EPA recommendations and standards. Most of the wrecks have been in the water for a long period of time, as well as subject to theft, thus a great deal of the ships' contents, including diesel, have been extracted or already dispersed. BR diver surveys, however, will identify any waste

products on each ship prior to and during wreck removal and scrapping. Any diesel still on the ship will be pumped out into a sealed container and either reused or disposed of by an EPA certified waste management company. In cases in which a risk of pollution is identified, ships will be surrounded by booms to contain oil or other pollution, which can then be collected and disposed of appropriately.

The basic equipment required for wreck removal activities includes:

- Diving equipment (a portable dive center with umbilical lines, cameras, communication devices);
- Hydraulic, submersible, and diesel pumps; and
- A 300 tonne crane, a fully equipped pontoon, a tug, and materials and spare parts for patching ships and maintaining equipment.

A general schedule for wreck removal follows:

- Lift the Torm Alexandra and tow it to the Port of Buchanan for ship breaking.
- Remove other wrecks that are beached or close to shore in Buchanan and Monrovia and, in most cases, tow wrecks to Buchanan for ship breaking.
- Remove the 17 sunken ships, and other wrecks including the Jetty's, as well as other obstacles that the NPA would like removed – to be confirmed with NPA.
- Remove wrecks in Greenville and Harper.
- Remove other decommissioned equipment and debris from all the ports if additional capacity and as requested by NPA.

4.1.2 Ship Breaking

Ship breaking activities will be conducted primarily at the BR's main ship breaking facility in Buchanan; however, it may also take place in situ if wrecks cannot be

floated or lifted and towed to Buchanan. In these cases, the scrap will be processed or semi-processed on the pontoon and transported to Buchanan for final processing.

Ships processed at the main ship breaking facility will be towed into the V-shaped slipway in Buchanan using the tug and in some cases the pontoon. They will be pulled up onto the slipway using winches and heavy equipment. When the ship is on shore, BR staff will conduct an inspection to assess the most effective and safest way to break the ship. The ship will be processed into pieces of approximately 5m x 2m using large shears (excavator) and plasma cutters. The scrap will be stockpiled in the scrap storage area using the scrap handler and a magnet.

Ships processed in situ will either be cut into pieces following the same process and using the same equipment outlined above; however, they will be processed from the barge by locating it adjacent to the particular wreck. Such ships may be processed into 5m x 2m pieces directly or partially processed and transported to Buchanan for final processing.

The processed scrap will be transported from the holding area to the commercial quay using dump trucks and scrap trailers. It will be stockpiled and loaded onto a bulk carrier using the equipment on the ship and possibly the scrap handler and magnet.

Booms will be used to surround the ships breaking as necessary. No fuel tanks will be punctured until fully examined, pumped and ventilated. Once this is complete, they will be cut through mechanical means to keep operations as safe as possible. Fuel that is pumped from the ships will be stored in large, clearly marked storage tanks and will be either reused or disposed of by an EPA certified waste management company. Any non-toxic waste will be gathered and removed by an EPA certified waste management company.

The equipment required for ship breaking consists primarily of large shears on heavy excavators, plasma cutters, cranes, scrap handlers, magnets, a permanent winching dock, dump trucks and scrap trailers, generators, lights and support equipment.

The ship breaking will commence as soon as wreck removal ends and will take place for the entire length of the project, which is approximately one year.

4.1.3 Port Rehabilitation Plan

While the salvage operation commences, BR plans to make minor fixes to the commercial quay in the Port of Buchanan so as to allow larger bulk vessel to safely berth at the quay. With direct coordination with NPA technical staff, these improvements will include:

- Dredging: BR has procured dredging equipment and it intends to begin dredging the quay using the dredger and the pontoon. BR will dredge the entrance of the port, the area along the commercial quay, and other areas, as necessary, to ensure a draft of approximately 12m.
- Basic port improvements: BR will make other improvements as necessary to support its operations. It will coordinate its activities with the NPA technical staff and will develop the detailed plans prior to commencement. Such improvements are likely to include the installation of fenders and bollards along the commercial quay, as well as the installation of navigational aids in and around the port area.
- Other improvements: other improvements may include the rehabilitation of port access roads and the acquisition and operation of 1-2 tug boats, as well as the acquisition and installation of a loading conveyor system. The specific nature of the improvements, however, will be determined by BR in consultation with the NPA.

4.2 FACILITY PLAN

BR's primary operating facility is be on a small parcel of land along the coast, adjacent to the entrance of the Port of Buchanan, which was selected and is being developed in consultation with the NPA. The area was historically brushland with a sea entrance blocked by a large fishing trawler. Removing the trawler will make a natural slipway, which will be constructed into a V-shaped slipway. The area will be fenced off and fully lit, thereby providing some lighting for the Port facility as well. It will be comprised of the following:

- A V-shaped slipway that will be constructed by excavating dirt and stone from the existing slipway to build a V-shaped slipway approximately 100m in length and 30m wide. The material that is excavated out of the slipway, particularly the rock, will be used to firm the floor of the yard. Any excess material will be stockpiled and used for regular maintenance of the slipway.
 - In order to build the V-shaped slipway, BR will first remove and scrap the old shipping vessel that is currently blocking access to the sea.
- A small workshop (40ft by 60ft) made of a steel frame with a zinc roof and several storage containers for supplies
- A site office in a converted container
- A scrap storage area
- A small security booth
- A fuel point consisting of a bunded fuel tank and a purpose built, double-skinned digital refueling station. The secondary containment for the fuel tank is sufficient to hold the full capacity of the tank
- Port-a-toilets that will be emptied by a designated waste management company
- Waste oil tanks for waste oil that is pumped out of ships and disposed of by an EPA certified waste management company

- Fire and first aid stations

Given the location of a number of the wrecks in the Liberian ports, BR will also operate off of its pontoon, which is be approximately 90m x 60m and will contain temporary accommodation in converted containers, a small kitchen, workshop, and warehouse, and a scrap processing area, and a fire and first aid station.

5 IMPACT ANALYSIS

Maritime development in terms of ship wreck removal and breaking and port rehabilitation may have a wide range of effects on the environment. The impacts are addressed in accordance to the port improvement . The proposed project will encompass a multitude of activities, including wreck removal, ship breaking, sea dredging, and access road construction.

The main human receptors are the workers at the port, who do not exceed 40 people. The nearest towns to the port are around 4 Km away.

This chapter highlights expected environmental impacts associated with the execution of the project. The magnitude of these impacts varies with time and site management. The environmental issues that are typically associated with the phases of the project are presented in [Table 5-1](#). The impacts of the parameters listed below are assessed by relying mainly on a qualitative, comparative approach.

Formaterat: Kontrollera inte stavning eller grammatik

Borttaget: Table 5-1

Table 5-1: Classification of Potential Environmental Impacts.

Project Phase	Nature & Duration of Impacts	Potentially Impacted Parameters
Port Improvement (Construction)	Temporary (1yr)	<ul style="list-style-type: none"> <input type="checkbox"/> Seawater quality <input type="checkbox"/> Marine ecosystem <input type="checkbox"/> Soil and water <input type="checkbox"/> Air Quality <input type="checkbox"/> Noise <input type="checkbox"/> Traffic <input type="checkbox"/> Solid waste generation <input type="checkbox"/> Landscape and visual intrusion <input type="checkbox"/> Health and safety <input type="checkbox"/> Socio economics

5.1 SEAWATER QUALITY

The quality of seawater will be adversely affected by construction activities that will be carried out during the execution of the project. There are two main impacts on

seawater quality: 1) increased turbidity and suspended sediments (SS) during the dredging works; and 2) discharges of waste into the sea including but not limited to oil or chemicals from ship wrecks as well as from storage tanks and machinery used on-site, in addition to wastewater.

5.1.1 Dredging

Dredging works are predicted to increase turbidity and suspended sediment (SS) concentrations in the marine waters adjacent to the works area. Around 84,000 m³ of silt will be removed over an area of 200 × 350 m². During dredging, fine sediments will be suspended in the water column. They may then be transported away from the works area by tidal currents to form sediment plumes. The quantities of fine sediments lost to suspension during dredging will primarily depend on the dredging rate and method. SS plumes being transported to sensitive areas such as bathing beaches and fishing areas may cause the ambient SS concentration to increase. The resulting SS level will determine the adversity of the impact. Among the important chemical impacts of SS are changes in oxygen concentration, uptake and release of nutrients and toxins. It is generally recognized that some oxygen loss will occur when any sediment is exposed to oxygenated water, but the magnitude of the loss will depend on the particular sediment and the chemical and physical factors in the dredging and disposal environment. In view of the relatively low production rates and the slightly open character of the water body, these effects are expected to be low. The quality of the sediments to be dredged at the Port of Buchanan has been investigated. The laboratory results (Annex A) showed that the sediments in the entire project area are clean. The sediment samples exhibited high concentrations of iron, aluminum, calcium and sodium. Elevated iron levels are expected since the local soil is high in iron content (40-67% Fe) and since the port has been utilized as an iron ore loading area. When compared to international soil and sediment guidance values for evaluating soil contamination, the quality of the

sediment samples is considered acceptable for industrial usages. Furthermore, when tested for petroleum hydrocarbons, the sediments within the port of Buchanan were found to have levels that fall below the Canadian Council of Ministers of the Environment (CCME) guidance limits for petroleum hydrocarbons within fine soils, for both agricultural and commercial uses, and for commercial usage of coarse soils. In addition, no significant Polychlorinated Biphenyls (PCBs) were found within the samples¹. Accordingly, significant release of contaminants from these sediments is not expected.

5.1.2 Port Improvement Activities

Pollution related to port improvement activities can be caused by the equipment used, such as dredgers, cranes, etc., and at the port improvement site, such as storage and waste areas, etc. Tug boats and dredgers will probably bunker at the site. During bunkering oil spillage is the main incident through which the aquatic environment may be affected. Fuel spillage might occur primarily by overflow and to a less extent during coupling and uncoupling of the hose. Accidental spillage of oil or fuel can occur due to operations carried out with insufficient care, leaks (in storage tanks, pipes, hoses), or accidents. Another impact on seawater quality during the port improvement phase is the generation of significant amounts of dirt and dust, particularly during access road rehabilitation. In addition, lubricants and solvents are commonly used in similar port improvement projects. These may impact seawater quality, particularly following rainfall events during which, runoff will occur and carry the pollutants to the sea.

5.1.3 Ship Wreck Removal & Breaking

An additional impact associated with ship wreck removal and ship breaking is the accidental leakage of oil or other pollutants remaining within these ships. Hazardous

¹ CCME Soil guidelines for PCB's is 0.5mg/kg in agricultural areas and 33mg/kg in commercial/ industrial areas

materials on board can include ammonia and other refrigerants, asbestos, zinc plates (used as a sacrificial anode for corrosion), and an infinite variety of cargo. Potentially toxic metals, including copper and tin-based antifouling paints may be a concern. In addition to coatings on the hull of the vessel, there may be bulk paints and other hazardous materials stored in the vessel's paint or boatswain's locker (Michel and Helton, No Date).

5.2 MARINE ECOSYSTEM

During the execution of the project, several activities may negatively impact the marine ecosystem including, (1) increased turbidity and suspended sediments associated with dredging, (2) disturbance of benthic ecosystems upon the removal of sunken ship wrecks, and (3) the accidental release of oil and other toxic liquid waste during ship wreck removal and ship breaking.

5.2.1 Dredging

During port improvement, the dredging activity will increase the concentration of SS in the coastal waters. This fine material causes turbidity and sedimentation, which have a multitude of negative impacts on sea life. Finely divided SS may kill fish directly by:

- ❑ Interfering with respiration by clogging the gills of the fish;
- ❑ Inhibiting growth or egg and larval development;
- ❑ Interfering with natural movements;
- ❑ Reducing the availability of food; and
- ❑ Preventing successful reproduction by blanketing spawning sites.

Suspended particles also serve as a transport mechanism for pesticides and other toxic substances readily absorbed onto fine clay particles. These toxins may be

released during dredging activities and they include heavy metals, hydrocarbons, and pesticides, which are harmful to marine species and to humans. However, the laboratory results (Annex A) showed that the sediments in the entire project area are clean. When tested for petroleum hydrocarbons, the sediments within the port of Buchanan were found to have levels that fall below the Canadian Council of Ministers of the Environment (CCME) guidance limits for petroleum hydrocarbons within fine soils, for both agricultural and commercial uses, and for commercial usage of coarse soils. In addition, no significant Polychlorinated Biphenyls (PCBs) were found within the samples². Accordingly, significant release of contaminants from these sediments is not expected, so this impact is expected to be insignificant. Another impact of dredging is excessive sedimentation that may smother and destroy benthic ecosystems. Toxic chemicals may also be introduced into the marine environment by direct discharge and runoff from the port improvement site. These chemicals may have serious debilitating effects on the marine ecosystems.

However, since Buchanan Renewables will be using a suction dredger rather than grabs, a trailer dredger, or a dredger with a propeller, the spread of sediments will be significantly controlled, as they will be suctioned. Furthermore, since Buchanan Renewables will not be using barges, but rather pumping the sediments straight from the dredger to the designated disposal area through pipes, the risk of splashing and leakage of material during loading and transport will be minimized.

5.2.2 Wreck Removal

Wreck removal will involve vessels resting on the seafloor, mostly from having been grounded in shallow water. Protection of seafloor or benthic habitats is of concern for operations in shallow water, as is the case in the Port of Buchanan, since these areas are more productive biologically and because shallow water wrecks may be

² CCME Soil guidelines for PCB's is 0.5mg/kg in agricultural areas and 33mg/kg in commercial/ industrial areas

unstable and may break up more rapidly in the higher energy environment and additionally may pose greater concerns for navigation and human health and safety. As such, the removal of sunken ship wrecks, will have a positive impact, however, it has to be conducted with the proper mitigation measures to prevent further damage to the valuable near-shore benthic habitats.

Another important environmental concern associated with ship wreck removal is the cargo, fuel, and other hazardous materials remaining on the wrecks. Operational and catastrophic releases of oil and hazardous materials threaten water-column resources (e.g., fish, shellfish, marine mammals, eggs and larvae of many species) and water-surface resources (e.g., marine birds, sea turtles, marine mammals, nekton). Spilled oil can release dissolved fractions into the water column during releases from submerged vessels, as well as form surface slicks that threaten both water-surface and shoreline resources. Aqueous liquids, such as acids and bases, can have acute, toxic impacts to water-column resources. Wrecks can contain many persistent chemicals, such as mercury in thermometers, organotin in paint, etc. In the case of the project, most wrecks have been in the water for a long time, and subject to theft. Thus, a great deal of the ships' contents, including diesel, have been extracted or already dispersed. However, appropriate mitigation measures need to be ensured to avoid accidental spillage of pollutants during wreck removal.

5.3 SOIL AND WATER

Port improvement activities, particularly rehabilitation works, may generate significant amounts of dirt and dust. In addition, lubricants and solvents are commonly used in similar port improvement projects. These may impact surface water, groundwater and seawater quality particularly following rainfall events. During such events, runoff will occur and carry pollutants to undesirable locations.

These impacts are confined to the relatively short period of the port improvement/rehabilitation process and can be mitigated effectively. Detailed impacts on sea water quality were outlined in Section [5.1](#).

Borttaget: 5.1

5.4 TRAFFIC

During ship wreck removal and ship breaking, there will be no significant impact on traffic in the project area and its vicinity, as these activities are primarily based at sea. The on-land transport of the scrap material may generate some additional traffic, however it is not expected to be significant, as the Buchanan port is already prepared for the transport of cargo. During port rehabilitation activities, traffic on the access road will also not be negatively impacted, since the only activity that will be implemented is road grading. As traffic on this road is insignificant, traffic delays due to re-routing are not expected.

During the operation phase, the projected increase in maritime activity at the rehabilitated port is expected to result in an increase in traffic within the port and along the Monrovia-Buchanan Highway and the access road leading to Upper Buchanan. Currently, the conditions of these roads are not optimal and the anticipated increase in cargo traffic may cause their deterioration. However, Monrovia-Buchanan Highway is being improved as part of a World Bank funded project, which will reduce the negative impact of the projected increase in cargo traffic. Furthermore, with the new railway line that connects Buchanan to the North coming soon into operation, the pressure on the highway will be reduced.

5.5 AIR QUALITY

During ship wreck removal and ship breaking activities, minimal negative impacts on local air quality are expected. Expected emissions of NO_x, CO, PM₁₀, and CO₂ from equipment used on site such as diesel pumps and tug boats with diesel engines, as well as winches, scrap trailers and generators are expected to have a

temporary and limited impact since they will mostly be at sea, far from possible sensitive receptors.

Access road rehabilitation may temporarily cause visible dust emissions but not a detectable influence on ambient air quality values. Emissions during road rehabilitation are a function of the excavation scheme, building demolition and the machinery used on-site. Since rehabilitation activities will be limited to road grading, shaping, and compacting, with no building demolition or excavation, emissions will consist primarily of particulate dust matter released as a result of earth removal activities, and to a lesser extent of emissions from the on-site usage of heavy construction equipment. As for the dredging activities, their associated dust emission is limited since the dredged marine mud has high moisture content. Furthermore, their transport on unpaved roads at the port is not expected to result in significant dust emissions as dredging is expected to take place during the rainy season. As it is well known from projects of the same type and magnitude, for this phase, it is expected that low negative impacts on air quality will occur in and around the immediate vicinity of the site under improvement, particularly if proper management measures are adopted as described below in the impact mitigation.

5.6 NOISE

Wreck removal, ship breaking, and port rehabilitation activities are expected to result in temporary elevated noise levels, mainly emanating from the machinery used such as pumps, tug boats, excavators, dump trucks, scrap trailers, generators, etc. Noise from such operations is different from noise from other sources for two main reasons: (1) It is caused by many types of equipment, and (2) the resulting adverse effects are temporary because the operations are relatively short term. [Table](#)

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5-2: Maximum construction equipment noise levels at 15 and 30 m from source (EPA, 1972. cited in Canter, 1996).

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Activity	Source	Maximum Sound Pressure Level(dBA)	
		15 meters	30 meters
Earth-moving	Compactors (rollers)	74	71
	Front loaders	83	80
	Backhoes	92	89
	Tractors	94	91
	Scrapers, graders	92	89
	Pavers	89	86
	Trucks	94	91
Materials Handling	Concrete mixers	85	82
	Concrete pumps	83	80
	Cranes, movable	84	81
	Cranes, derrick	90	87
Stationary	Pumps	71	68
	Generators	83	80
	Compressors	86	83
Impact Equipment	Pneumatic wrenches	87	84
	Jackhammers and rock drills	96	93
	Impact pile drivers, peaks	104	101
Other	Vibrator	81	78
	Saws	81	78

depicts maximum typical sound levels associated with construction equipment as measured at a distance of 15 meters. The inverse square wave divergence concept for a point source was adopted to estimate noise levels at 30 m, which is the distance from the point source to the center of gravity of the buildings or receptors closest to the port improvement site.

Borttaget: Table 5-2: Maximum construction equipment noise levels at 15 and 30 m from source (EPA, 1972. cited in Canter, 1996).
Activity ... [1]

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	<i>Pavers</i>	89	86
	<i>Trucks</i>	94	91
Materials Handling	<i>Concrete mixers</i>	85	82
	<i>Concrete pumps</i>	83	80
	<i>Cranes, movable</i>	84	81
	<i>Cranes, derrick</i>	90	87
Stationary	<i>Pumps</i>	71	68
	<i>Generators</i>	83	80
	<i>Compressors</i>	86	83
Impact Equipment	<i>Pneumatic wrenches</i>	87	84
	<i>Jackhammers and rock drills</i>	96	93
	<i>Impact pile drivers, peaks</i>	104	101
Other	<i>Vibrator</i>	81	78
	<i>Saws</i>	81	78

Note that the noise levels for all equipment exceed the WHO and World Bank standards for industrial areas (Table 5-3) and for most exceed the Occupational Safety and Health Administration (OSHA) standard for an 8-hr exposure (90 dBA). While these levels may be a nuisance to workers on-site, they are not expected to influence residential areas, which are at least 4 km away from the port. Hence, proper mitigation measures should target minimizing exposure of workers at the port.

Borttaget: Table 5-3

Table 5-3: Noise level guidelines (WHO 1999; World Bank 2007)

<i>Area classification</i>	<i>Maximum accepted noise level dBA</i>	
	Daytime	Nighttime
Residential, institutional, educational	55	45
Industrial, commercial	70	70

5.7 SOLID WASTE GENERATION

Ship wreck removal and ship breaking will generate significant quantities of steel scrap material that require appropriate handling and disposal. The scrap will be sorted and processed at an on-site facility at the Port of Buchanan.

Additionally, port rehabilitation activities will generate dredged/excavated marine sediment, excavated material, construction waste, chemical waste, and general refuse. Dredged sediments, excavation material, will be used to help with remediation of some of the areas suffering from soil erosion near the port. In fact, it is planned to use dredged soil and rich organic silt ideal for cropland remediation to build up eroded and low-lying area grass and shrubland (i.e. below sea-level). It is also planned to use sandy material for the development of the market area in Buchanan or to Port of Buchanan or County for usage. This minimizes the volume of construction waste produced that requires handling. As for chemical wastes and general refuse, these require proper waste management to minimize their potential impact.

5.8 LANDSCAPE AND VISUAL INTRUSION

The site consists of old port facilities and abandoned ship wrecks and is poor in vegetation and animal life. Visual intrusion at the proposed site is inevitable during the port improvement phase. The presence of abandoned equipment or material, soil heaps, and borrow pits present an unsightly view. However, such an impact is temporary and minimal given the current deteriorated condition of the site. In fact, project execution activities are expected to have a positive impact on landscape and visual intrusion, whereby port facilities will be rehabilitated, all ship wrecks will be removed, and low-lying erosion prone area will be filled with rich organic silt from the dredging activities.

5.9 HEALTH AND SAFETY

Health and safety at the port improvement site are considered primarily in terms of potential exposure and accident occurrence (direct and indirect) to workers on-site, pedestrians, and vehicle operators or passengers. Occupational health and safety risks are the most significant during port improvement, and they arise from storage and handling of dangerous materials and in the operation of heavy equipment close to traffic, power, and watercourses. Proper mitigation measures can significantly reduce health and safety risks during the port improvement phase. As such, specific health and safety guidelines related to the project activities should be adopted and properly followed by the contractor.

5.10 SOCIO-ECONOMICS

During the execution of project activities, port operations and navigations may be hindered due to the presence of dredging equipment, barges, etc. However, this impact is temporary and insignificant since the current activity at the port is minimal compared to its actual potential. Ship wreck removal and port rehabilitation is expected to revive the activity at the Port of Buchanan, Liberia's second largest port. This is expected to provide new jobs, whereby Buchanan Renewables and other organizations operating in the area will increase their marine trade activity via the Port of Buchanan, among other companies. Accordingly, an influx of commerce to Buchanan as a whole is anticipated, as well as the attraction of more investment to Liberia. This will result in an increase in revenue to the NPA and the government.

5.11 SUMMARY OF IMPACT ANALYSIS

Analysis of impacts that may be incurred by the execution of the project revealed that the greatest negative environmental impacts will be associated with sea water

quality, marine ecosystem, and solid waste generation, during both the port improvement and operation phases. Negative impacts on sea water quality and marine ecosystem during operation may be significantly reduced by implementing proper waste management and oil spill plans. [Table 5-4](#) summarizes qualitatively the significance of environmental impacts associated or expected with both the port improvement and operation phases, based on expert judgment.

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Borttaget: Table 5-4

Table 5-4: Summary of impacts

Potential Impact	Port Improvement
Seawater quality	--
Marine ecosystem	--
Soil and water	-
Traffic	-/0
Air quality	-
Noise	--
Landscape and visual Intrusion	-/0
Waste Generation	--
Health and Safety	-
Socio-Economics	+
+++ High positive impact	--- High negative impact
++ Moderate positive impact	-- Moderate negative
+ Low positive impact	- Low negative impact
0 Neutral impact	

6 MITIGATION MEASURES

As discussed in Chapter 5, various potential environmental impacts are associated with the different phases of the project, particularly the execution phase. The magnitude of these impacts varies with time (temporary vs. permanent) and site management. The environmental issues that are considered with the proposed project components are presented in [Table 6-1](#).

Borttaget: 5

Formaterat: Kontrollera inte stavning eller grammatik

Borttaget: Table 6-1

Table 6-1: Classification of environmental impacts by project phase.

<i>Project Phase</i>	<i>Nature & Duration of Impact</i>	<i>Parameters To Be Considered</i>
Design	Short term impact (< 1 year)	<ul style="list-style-type: none"> <input type="checkbox"/> Seawater quality <input type="checkbox"/> Marine ecosystem <input type="checkbox"/> Soil and water <input type="checkbox"/> Air quality <input type="checkbox"/> Noise <input type="checkbox"/> Traffic <input type="checkbox"/> Waste generation <input type="checkbox"/> Landscape and visual intrusion <input type="checkbox"/> Health and safety <input type="checkbox"/> Socio economics
Port Improvement	Short term impact (< 2 years)	<ul style="list-style-type: none"> <input type="checkbox"/> Seawater quality <input type="checkbox"/> Marine ecosystem <input type="checkbox"/> Soil and water <input type="checkbox"/> Air Quality <input type="checkbox"/> Noise <input type="checkbox"/> Traffic <input type="checkbox"/> Natural resources <input type="checkbox"/> Waste generation <input type="checkbox"/> Landscape and visual intrusion <input type="checkbox"/> Health and safety <input type="checkbox"/> Socio economics

In order to eliminate or reduce adverse environmental impacts, mitigation measures should be adopted as part of the project requirements and tender documents for both, project consultants and contractors. Mitigation measures are highly dependent

on the significance of the predicted impact, the nature of the impact (permanent vs. temporary), or the phase of the project (port improvement vs. operation). This section proposes and discusses mitigation measures that should be implemented at all stages of the project, including the design, and port improvement, with an emphasis on the most significant impacts. The discussion is presented as a function of environmental issues rather than project component.

6.1 SEAWATER QUALITY AND MARINE ECOSYSTEM

As mentioned earlier, the two main impacts on seawater quality from project execution activities are: 1) increased turbidity and suspended sediments during the dredging works; and 2) discharges of waste such as oil or chemicals from ship wrecks as well as from storage tanks and machinery used on-site, in addition to wastewater into the sea. Polluted seawater will adversely influence marine habitats. Hence, appropriate mitigation measures should be implemented to ensure that potential water quality impacts be minimized to levels that are not predicted to cause unacceptable impacts to sensitive receivers in the receiving waters.

At the design phase, screening analysis of site environs and ecology in order to identify any potentially sensitive habitats, such as fish spawning and migration sites, adjacent to the project site should be completed, noting that the Port of Buchanan is an operational port. Furthermore, a detailed assessment of ship wreck status is crucial to get information about which method to choose for remediation. Ship wrecks should be screened for the presence and volume of oil, chemicals, and other hazardous material to plan their safe removal accordingly.

6.1.1 Impact of Dredging

During port improvement, the contractor should execute the following activities to mitigate the impacts on seawater quality associated with the release of suspended sediments from dredging activities (ERM, 2000):

- Adoption of construction sequencing and work procedures to minimize seabed disturbance;
- Control of the rate of dredging to minimize the sediment loss rate;
- Building of seawalls or any other suitable barriers as required to intercept the transport of SS away from the project area;
- Scheduling dredging activity during periods that do not interfere with fish spawning or intense migration.

6.1.2 Impact of Runoff, Wastewater, and Spillage from Equipment

The impact of the runoff from the port improvement site on seawater quality can be minimized by the construction of storm drains with adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers should be provided on site to properly direct storm water to such silt removal facilities. Silt removal facilities, channels and manholes must be maintained and the deposited silt and grit ought to be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times. Wastewater originating from workers on-site should be collected in appropriate sewers and disposed at facilities approved by EPA; there will be no direct discharge of wastewater.

6.1.3 Impact of Ship Wreck Removal

An additional impact during project execution is the destruction of benthic habitats upon removing sunken ship wrecks. To minimize such impacts, the following mitigation measures should be followed (Michel and Helton, no date):

- For vessels stranded close to shore, it is recommended to dismantle the vessel in place rather than dredge or drag a vessel across an extensive shallow habitat;
- Regarding the salvage vessel anchoring systems, identify and avoid sensitive seafloor habitats (e.g., coral reefs, sea grass, hard bottom communities), if possible, and design anchoring systems to minimize the number of anchors needed and control drag;
- Regarding towing systems, use floating lines, especially in areas with sensitive benthic habitats;
- In shallow water, avoid using the propulsion systems of salvage tugs where the prop wash can scour the bottom. Tugs should be moored and a ground tackle system should be used to provide maneuvering and pull;
- Under the conditions where the only access to vessels grounded very close to shore requires construction of access platforms, minimize impacts to intertidal and shallow subtidal habitats by using the smallest footprint for access platforms and using elevated systems rather than solid-fill causeways;
- Regarding debris removal, it is important that all vessel debris be removed during the salvage operations. Fishing lines, nets, hooks, etc. can cause damage to benthic habitats by scouring and can entrap and kill wildlife. Plan for floatable debris (wood and insulation and other floatables) that needs to be contained or recovered when cutting up or refloating vessels.

Another significant impact associated with ship wreck removal is the elimination of available oil and chemicals on the wreck. Appropriate mitigation techniques should be employed depending on the wreck condition and type and volume of oil (Hassellöv 2007). In the case of relatively intact wrecks, especially in shallower waters, it may be preferable to salvage the entire wreck. When this is not practically feasible, oil should be pumped out using methods that are relatively controlled, with

little risk of uncontrolled spill. Even if tanks are successfully emptied there may be some oil left in piping or between the hull and the tank. Flanges can either be welded or bolted to the tank. After attachment of a flange, with further possible connections of hoses or pumping equipment, low viscosity oils can be directly pumped through a vacuum pump and a long hose. Another alternative suitable for light oils is centrifugal pumps, which, in spite of their relatively low weight, offer a large pumping capacity. When dealing with oils of higher viscosity, positive-displacement pumps such as screw pumps can be used. Another strategy that has been suggested is to add something that completely solidifies the oil, after which the oil is left in the wreck. Finally, if the wreck is in poor condition and does not allow for drilling or welding without immediate risks for the construction to collapse, construction of a large tailored tent or umbrella over the entire wreck or containment booms around the wreck could be used to trap the leaking oil. It is also possible to accelerate the leakage through additional holes, after putting the construction in place. The oil is trapped at the top of the tent, from where it can be pumped to a container. This method requires calm conditions and relatively small wrecks without too many protruding details.

The supervising consultant will have the responsibility of ensuring the implementation of these measures by the contractor.

6.2 SOIL AND WATER

The most appropriate mitigation measures to ensure minimal water quality impacts include provisions for proper surface drainage during both the port improvement and operation phases, and the minimization of on-site water and chemical usage (oil lubricants and fuel) and soil exposure time during the port improvement phase. Note that there are no provisions or regulations in Liberia for the proper disposal of oil lubricants and fuel used by the construction equipment. These wastes when mixed with other construction waste are typically disposed of in a landfill and as

such they will be handled similar to what is described in Section 5.3. After completion of port improvement activities, the Contractor should clear the working and port improvement sites. All forms of waste should be removed, whereas places with soil pollution (if any) should be treated.

6.3 TRAFFIC

Negative impacts of the project on traffic flow in the project area are limited. Though these impacts are not very significant, as discussed in Section 5.3, various mitigation measures could be employed to further reduce and even eliminate them. Mitigation measures include providing alternate routing schemes during all phases of project execution, particularly during the rehabilitation of the port access roads.

Borttaget: 5.3

6.4 AIR QUALITY

Dust emission is the major air quality impact during the port improvement phase. To prevent or minimize such emissions, various control measures need to be adopted and included within the port improvement contracts and be considered as requirements from contractors. They include:

- ❑ Proper site enclosure through appropriate hoarding and screening.
- ❑ On-site mixing and unloading operations.
- ❑ Proper handling of cement material.
- ❑ Maintaining minimal traffic speed on-site and on access roads to the site.
- ❑ Covering all vehicles hauling materials likely to give off excessive dust emissions.
- ❑ Ensuring adequate maintenance and repair of construction machinery and vehicles.
- ❑ Avoiding burning of material resulting from site clearance.
- ❑ Covering any excavated dusty materials or stockpile of dusty materials entirely by impervious sheeting.

- Proper water spraying when necessary.
- The provision of water troughs at entry and exit points where necessary to prevent the carryover of dust emissions, beyond the port improvement site.

Furthermore, the following air quality management procedures for application to land-based activities are recommended:

- Keeping transfer equipment (e.g. cranes, forklifts, and trucks) in good working condition.
- Encouraging reduction in engine idling during on- and off-loading activities.
- Encouraging storage planning to avoid or minimize re-storage and reshuffling of cargo.

Moreover, VOC emissions from fuel storage and transfer activities should be minimized by means of equipment selection, such as the use of floating top storage tanks or vapor recovery systems for fuel storage, loading / offloading, and fueling activities (depending on the type of material to be stored), and adoption of management practices such as limiting or eliminating loading / unloading during poor air quality episodes or implementing tank and piping leak detection and repair programs.

- Dust emissions from dry bulk materials storage and handling facilities should be minimized by: Covering transport vehicles carrying dry material/cargo that may emit dust.
- Regularly sweeping docks and handling areas, truck / rail storage areas, and paved roadway surfaces.

6.5 NOISE

As indicated in the impact analysis, noise levels emitted during the port improvement phase significantly exceed international noise level standards. Typical mitigation measures during port improvement to minimize noise levels include:

- Choice of inherently quiet equipment.
- Proper site logistics and planning.
- Proper maintenance of equipment.
- Limiting site working hours if possible.
- Informing the local when noisy activities are planned.
- Placing muffling devices that will reduce vibration.
- Scheduling noisy activities during the morning hours.
- Enforcing noise monitoring.
- Keeping equipment speed as low as possible.
- Restricting access to the site for truck traffic outside of normal construction hours.

The noise control measures will be included within the port improvement contracts and be considered as requirements from contractors.

□

6.6 SOLID WASTE GENERATION

Project execution will result in processed scrap from ship breaking and sediments from dredging. Scrap material will be stored in a designated area on-site, while dredged silt will be re-used for the remediation of some areas suffering from soil erosion near the port. Disposal of material should be coordinated with EPA certified waste management companies. Consideration should be given whenever feasible for waste material recycling and re-use. Ensuring proper waste disposal measures will be the responsibility of the contractor.

□

6.7 LANDSCAPE AND VISUAL INTRUSION

There is no major visual intrusion in the project area caused by the project. At the end of the port improvement phase, the contractor shall be responsible for repairing, replanting, and performing other remedial measures when unnecessary destruction is done. This includes the clearance of all equipment, spoil heaps, and other materials after port improvement.

6.8 HEALTH AND SAFETY

Health and safety at the site are considered primarily in terms of accident occurrence (direct and indirect) to workers on-site, pedestrians, and machine operators or passengers during the port improvement. In the absence of national health and safety guidelines for construction projects, contractors need to follow international guidelines and procedures to ensure worker and community health and safety. Occupational health and safety measures should include:

- Provision of protective clothing and accessory such as overalls, welding goggles, helmets, protective boots/shoes, gloves, hearing protecting devices, lifesaving vests, etc. for workers at the port improvement sites;
- Ensuring that workers working near the water's edge can swim and that lifesaving rings are available at the worksite, near water;
- Ensuring that the protective material is being used wherever it is required;
- Ensuring that especially sensitive or dangerous areas (like areas exposed to high noise levels, areas for especially hazardous work etc.) are clearly designated;
- Ensuring that all maintenance work necessary for keeping machines and other equipment in a good state will be regularly carried out.;

- Ensuring that the workers (and especially those doing hazardous work or otherwise exposed to risks) are qualified, well trained and instructed in handling their equipment, including health protection equipment.

Regarding hazardous substances, the following measures should be implemented by the company:

- Ensuring that hazardous substances are being kept in suitable, safe, adequately marked and locked storing places;
- Ensuring that containers of such substances are clearly marked, and that material safety data sheets are available;
- Ensuring that all workers dealing with such substances are adequately informed about the risks, trained in handling those materials, and in first aid measures to be taken in the case of an accident;
- Designating an area where contaminated materials and hazardous waste can be stored for proper disposal according to environmental guidelines.

Regarding waterborne and water-related diseases substances, the following measures should be implemented by the company:

- The adoption of good housekeeping practices for ensuring hygiene on site;
- The elimination of pools of stagnant water, which could serve as breeding places for mosquitoes and other insects;
- The provision of bednets for workers living on site. Ideally, these nets should be treated with an insecticide;
- The appropriate elimination of waste of all types, including wastewater.

Furthermore, the company will have to ensure adequate health services, including medical services for sick workers as well as emergency services in case of an accident. Accordingly, an on-site health unit needs to be established. This unit

should be adequately equipped, especially for providing first aid. It should be run by a medically trained person. There should be at least two persons trained in first aid. One person should be there at all times to deal immediately with serious injuries. In addition, a referral and evacuation plan should be in place. An agreement must be made with a referral hospital (in Buchanan) for cases in which medical treatment is required which cannot be given by the medical staff on site. This plan must also ensure the availability of an ambulance for speedy evacuation of accident victims.

6.9 SOCIO-ECONOMICS

Ship wreck removal and port rehabilitation is expected to improve port infrastructure and functionality and hopefully revive the role of the Port of Buchanan as Liberia's second largest port. Considerable job creation is expected at the level of the port itself, the wholesale and retail shops in the vicinity of the port, and Buchanan city as a whole. It is recommended to give priority in employment, particularly for unskilled workers, to residents of Buchanan and neighboring areas.

6.10 SUMMARY OF MITIGATION MEASURES

As indicated earlier, impact analysis showed that potential environmental impacts will occur during the port improvement, particularly with respect to seawater quality, marine ecosystem, solid waste generation, and noise emissions. These impacts, in addition to air quality, traffic, visual intrusion, and health and safety, can be reasonably controlled by adopting proper management and planning procedures.

Table 6-2, and Table 6-3 present a summary of the proposed elements of the Mitigation Plan that will be considered in the various phases of the project. Implementation responsibility is also included. As for the cost of the mitigation, it will be allocated as such:

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Borttaget: Table 6-2

Borttaget: Table 6-3

- During the design phase, mitigation cost will be included in the final design preparation.
- During the port improvement phase, mitigation cost will be included with port improvement costs.

The schedule of implementation of the mitigation measures will be consistent with the project execution phases.

Table 6-2: Summary of proposed elements of the mitigation plan during design phase.

Impact	Mitigation measure	Detailed attribute	Responsibility	Cost
DESIGN PHASE (PREPARATORY AND FINAL)				
Seawater Quality & Marine Ecosystem	<ul style="list-style-type: none"> <input type="checkbox"/> Screening analysis of site environs and ecology in order to identify any sensitive habitats <input type="checkbox"/> Detailed assessment of ship wreck status and screening for on-board presence of oil and hazardous material <input type="checkbox"/> Design for proper dredging and filling activities <input type="checkbox"/> Provisions for proper surface and ground water drainage 	Providing a detailed inventory of the available ship wrecks along with the presence of oil and other hazardous material and the removal methods to be adopted.	Environmental officer	Included in final design preparation
Traffic	<ul style="list-style-type: none"> <input type="checkbox"/> Development of re-routing schemes if required 		Environmental officer	Included in final design preparation
Air quality	<ul style="list-style-type: none"> <input type="checkbox"/> Assessment of existing standards and regulations <input type="checkbox"/> Assessment of long term strategy for emission control 		Environmental officer	Included in final design preparation
Noise level	<ul style="list-style-type: none"> <input type="checkbox"/> Assessment of existing standards and regulations <input type="checkbox"/> Consideration for porous material, flexible joints and supports <input type="checkbox"/> Consideration for sound barriers <input type="checkbox"/> Protection of buildings and sensitive receptors 		Environmental officer	Included in final design preparation
Landscape and Visual Intrusion	<ul style="list-style-type: none"> <input type="checkbox"/> Documentation of existing conditions <input type="checkbox"/> Blending color(s) of paint <input type="checkbox"/> Blending exterior construction material <input type="checkbox"/> Blending architectural features 		Environmental officer	Included in final design preparation
Waste Generation	<ul style="list-style-type: none"> <input type="checkbox"/> Locate nearby disposal sites and dispose waste through EPA certified waste disposal company <input type="checkbox"/> Explore waste material recycling or re-use 		Environmental officer	Included in final design preparation

Health and safety	<input type="checkbox"/> Develop and/or review and update general health and safety plans		Environmental officer	Included in final design preparation
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Table 6-3: Summary of proposed elements of the mitigation plan during port improvement phase.

<i>Impact</i>	<i>Mitigation measure</i>	<i>Detailed attributes</i>	<i>Responsibility</i>	<i>Cost</i>
PORT IMPROVEMENT PHASE				
Seawater quality	<ul style="list-style-type: none"> <input type="checkbox"/> Implementation of proper dredging and filling practices <input type="checkbox"/> Control of the rate of dredging and filling <input type="checkbox"/> Building of seawall or barrier to the dispersion of SS if required <input type="checkbox"/> Proper surface and ground drainage <input type="checkbox"/> Proper bunkering techniques for dredgers, tugs, and other equipment to minimize fuel spills <input type="checkbox"/> Minimize chemical usage (lubricants, solvents, petroleum products) <input type="checkbox"/> Eliminate available oil, chemicals, and hazardous material on the wreck before ship breaking 		Environmental officer	Included in port improvement
Marine ecosystem	<ul style="list-style-type: none"> <input type="checkbox"/> Limit dredging and filling activity during critical spawn-and-set periods for fish <input type="checkbox"/> Dismantle vessels that are close to the shore in place rather than dredge or drag them across an extensive shallow habitat <input type="checkbox"/> Identify and avoid sensitive seafloor habitats and design anchoring systems to minimize the number of anchors needed and control drag. <input type="checkbox"/> Use floating lines for towing <input type="checkbox"/> Avoid using the propulsion systems of salvage tugs in shallow water. Tugs should be moored and a ground tackle system should be used to provide maneuvering and pull <input type="checkbox"/> Use the smallest footprint for access platforms and use elevated systems rather than solid-fill causeways <input type="checkbox"/> Remove all vessel debris during the salvage operations 		Environmental officer	Included in port improvement

Impact	Mitigation measure	Detailed attributes	Responsibility	Cost
Traffic	<ul style="list-style-type: none"> <input type="checkbox"/> Public communication <input type="checkbox"/> Re-routing schemes if required <input type="checkbox"/> Extended port improvement hours 		Contractor/ Environmental officer	Included in port improvement
Air quality	<ul style="list-style-type: none"> <input type="checkbox"/> Site and stock pile enclosure <input type="checkbox"/> On-site mixing in enclosed or shielded areas <input type="checkbox"/> Proper unloading operations <input type="checkbox"/> Water damping of stockpiles when necessary (dry conditions) <input type="checkbox"/> Sealing of completed earthworks and re-vegetation as soon as possible <input type="checkbox"/> Medium and heavily used haul routes permanently surfaced <input type="checkbox"/> Damping unsurfaced haul routes <input type="checkbox"/> Keep hauling routes free of dust and regularly cleaned <input type="checkbox"/> Minimal traffic speed on-site with proper enforcement <input type="checkbox"/> Maintenance and repair of construction machinery 	<ul style="list-style-type: none"> <input type="checkbox"/> Cleaning of hauling sites daily before construction works resume <input type="checkbox"/> Maintaining on-site traffic speed below 20 Km/hr 	Environmental officer / Contractor	Included in port improvement
Noise level	<ul style="list-style-type: none"> <input type="checkbox"/> Control of timing of noise emissions <input type="checkbox"/> Proper road maintenance <input type="checkbox"/> Enforcement of speed limits <input type="checkbox"/> Employ low noise machinery, or machinery with noise shielding and/or sound absorption materials <input type="checkbox"/> Proper maintenance of equipment and machinery 		Environmental officer/ Contractor	Included in port improvement
Waste generation	<ul style="list-style-type: none"> <input type="checkbox"/> Waste transport and disposal by EPA certified waste management companies 	<ul style="list-style-type: none"> <input type="checkbox"/> Proper permits should be obtained from the EPA and the Buchanan City Authority 	Environmental officer / Contractor	Included in port improvement
Landscape and visual intrusion	<ul style="list-style-type: none"> <input type="checkbox"/> Clearance of all equipment, spoil heaps, and other materials after port improvement <input type="checkbox"/> Blending color(s) of paint <input type="checkbox"/> Blending exterior construction material <input type="checkbox"/> Blending architectural features <input type="checkbox"/> Implementing appropriate landscaping 		Environmental officer / Contractor	Included in port improvement

<i>Impact</i>	<i>Mitigation measure</i>	<i>Detailed attributes</i>	<i>Responsibility</i>	<i>Cost</i>
Health and safety	<ul style="list-style-type: none"> <input type="checkbox"/> Provide protective clothing and accessories <input type="checkbox"/> Ensure that workers working at water's edge can swim and that lifesaving rings are available at the worksite, near water <input type="checkbox"/> Create buffer zones <input type="checkbox"/> Install proper warning signs <input type="checkbox"/> Ensure adequate on-site health services 	<ul style="list-style-type: none"> <input type="checkbox"/> Install warning signs close to the port improvement site <input type="checkbox"/> Establish an on-site health unit 	Environmental officer / Contractor	Included in port improvement
Socio-economics	<ul style="list-style-type: none"> <input type="checkbox"/> Give employment priority to local workers 		Environmental officer / Contractor	Included in port improvement

phase.

7 ENVIRONMENTAL MONITORING

Environmental monitoring will be undertaken during the execution and operation phases of the project, with the aim to:

- Verify the predicted environmental impacts;
- Monitor the performance of the project and the effectiveness of mitigation measures;
- Determine project compliance with national and international requirements and standards; and
- Take remedial action if unexpected problems and unanticipated impacts arise.

The following sections describe the monitoring program that will be undertaken during the project execution and operation phases. Monitoring locations during both the port improvement and operation phases will be limited to the port site boundaries, since there are no sensitive receptors in the immediate vicinity of the project site. [Figure 7-1](#), shows the locations of selected monitoring stations referred to in the text below. Note that locations J, K, L and M are not illustrated in the figure as they depend on the variable locations of the port improvement activities.

Borttaget: Figure 7-1

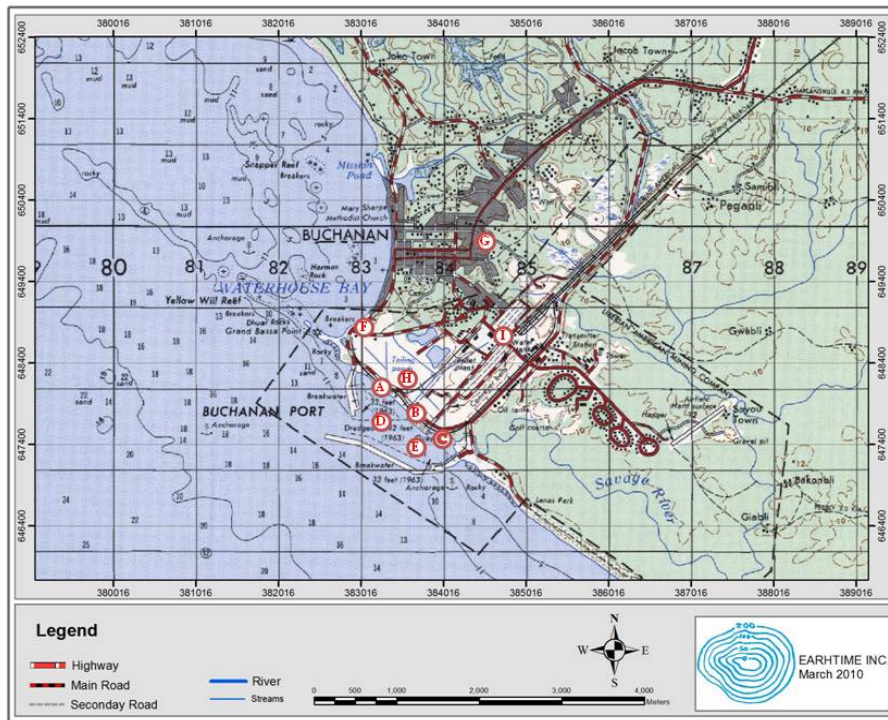


Figure 7-1: Layout plan for monitoring stations.

7.1 PORT IMPROVEMENT

During the port improvement phase, monitoring will be conducted at varying frequencies depending on the parameter monitored. The parameters that will be monitored on a quarterly basis include:

- Quality of seawater at the dredging site. A sample shall be obtained at a depth of 1 m and a distance of 10 m from the dredging site (Location J). The parameters to be monitored include pH, dissolved oxygen, conductivity, turbidity, suspended solids, total and fecal coliform, oil and grease, and petroleum hydrocarbons.
- Quality of seawater at two locations, 20 m from the shore (Location B) and at the port entry channel between the two breakwaters (Location D). Conduct the water sampling at three different depths including 1 meter above the bottom and below the surface as well as at mid-depth in the water. The parameters to be monitored include pH, dissolved oxygen, conductivity, turbidity, suspended solids, total

and fecal coliform, oil and grease, and petroleum hydrocarbons.

- Ambient concentration of particulate matter, carbon monoxide, nitrogen oxide, and sulfur dioxide at the pontoon (Location K).
- Ambient concentration of particulate matter, carbon monoxide, nitrogen oxide, and sulfur dioxide at one location at the port where port improvement/rehabilitation activities are taking place (Location L).
- Noise levels at the pontoon (Location K) and at the port improvement/rehabilitation site (Location L).
- Water quality of surface runoff and ground water at one location (Location M). The parameters to be monitored in water samples include pH, chemical oxygen demand, oil, conductivity, lead, copper, chromium, and zinc.
- Landscape visual inspection and photographic documentation of planting activities

The parameters that will be monitored on a continuous basis include:

- Health and safety is to be monitored at the port site throughout the project execution period through inspection/supervision and photographic documentation in addition to the maintenance of a record of injuries and accidents, specifying their underlying cause and describing their location.

Table 7-1: Summary of proposed monitoring plan

Parameter	Location	Samples	Frequency	Phase	Responsibility
Seawater quality (pH, DO, conductivity, turbidity,	At dredging site, 20 m offshore (B), and at the port entry channel between the 2 breakwaters (D); (3 depths)	Four samples/location	Monthly	Port improvement	BR
Suspended solids, TC, FC, oil and grease, and petroleum hydrocarbons)	At dredging site, 20 m offshore (B), and at the port entry channel between the 2 breakwaters (D); (3 depths)	Four samples/location	Quarterly	Port improvement	BR
Marine ecology	Sediments in vicinity of dredged area	Subtidal dive survey	Twice per year	During Operation	BR
Air quality (PM, CO, NO _x , SO ₂ , VOC)	Site under improvement & pontoon	Four samples/location	Quarterly	Port improvement	BR
Noise (L _{eq} , L _{min} , L _{max})	At pontoon and at improvement site	Four samples/location	Quarterly	Port improvement	BR
Surface and groundwater (pH, BOD, COD, oil, conductivity, Pb, Cu, Cr, and Zn)	At port improvement site	Four samples/month	Monthly	Port improvement	BR
Landscape	At port proper	Visual inspection	Quarterly Bi-annually	Port improvement Operation	BR
Health and safety	At port improvement and other works sites	Visual inspection	Continuous	Port improvement	BR

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7.2 MONITORING PLAN IMPLEMENTATION

In order to ensure the proper implementation of the proposed environmental plan, it is essential to maintain proper environmental monitoring particularly during the port improvement phase. For this purpose, qualified personnel must be designated.

Table 7-2 provides a summary of estimated yearly staffing requirements for the implementation of the environmental monitoring plan throughout the project duration. The estimated cost is provided on a yearly basis and includes laboratory analysis fees for air and water samples.

Formaterat: Kontrollera inte stavning eller grammatik

Borttaget: Table 7-2

Table 7-2: Estimated requirements for the implementation of the Environmental Monitoring Plan.

Parameter/Activity	Staff category	Number	Schedule	Cost (USD)
PORT IMPROVEMENT PHASE				
Air quality/Noise/Seawater Quality	Environmental specialist	1	Full-time	18,000
		1	Half time	6,000
Laboratory analysis	-	-	-	30,000
Health and safety	Health and safety specialist	1	Full time	18,000
Training	Environmental Scientist/Academician	1	Periodic	12,000
Reporting	Environmental scientist	1	Part-time	8,000
Total annual monitoring cost during the port improvement phase				92,000

The environmental monitoring plan will be implemented throughout the port improvement phase and an additional two years after completion of all project activities.

7.3 DATA REPORTING

Periodic environmental monitoring reports will be prepared to analyze the data collected, assess monitoring activities and provide recommendations to ensure the effectiveness of the overall environmental monitoring and management plan during the project life span.

A comprehensive report will be generated at the end of the improvement phase to present results of monitoring activities and evaluate the adequacy of environmental control measures. The contents of the report will include the original measurements, sampling locations, time of sampling, influencing factors (weather information, activities on site), environmental quality assessment and data analysis. The reports will be submitted to the EPA.

In case of standards are being exceeded, notifications will be issued to the contractor and site engineer in order to take immediate corrective actions.

7.4 TRAINING

For environmental management to be appropriate, port improvement and operation activities should conform to the current state of the art and knowledge regarding environmental protection. This should be accomplished by hiring competent personnel with appropriate educational and professional background and instituting a periodic training program and site specific plans that are adequate for protecting the general public and the environment as well as contributing to the mitigation of potential environmental impacts.

Thus, it is required that contractors who will be involved in the port improvement as well as personnel who will be involved in monitoring activities, to attend an environmental training course prior to the initiation of project activities. The objective of this training course is to ensure appropriate environmental awareness, knowledge and skills for the implementation of environmental mitigation measures.

The training program will cover at least the following topics:

- ❑ Environmental laws, regulations, and standards
- ❑ International maritime conventions
- ❑ Pollution health impacts, with emphasis on pollution from maritime activity
- ❑ Pollution prevention measures, with emphasis on pollution from maritime

activity

- ❑ Sampling techniques and environmental monitoring guidelines (air, noise, water)
- ❑ Health and safety measures, particularly those related to port operation

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APPENDIX A

SOIL ANALYSIS LABORATORY RESULTS

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Phone: +233 (0) 22 205 045
Fax:

Tuesday, March 30, 2010

Date Rec. : 19 March 2010
LR Report: CA10298-MAR10
Reference: E002946
Copy: #2

CERTIFICATE OF ANALYSIS Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: BRTS/10/1	6: BRTS/10/2	7: BRTS/10/3	8: BRTS/10/4	9: BRTS/10/5	10: BRTS/10/6	11: BRTS/10/7
Sample Date & Time			Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
T. kjeldahl Nitrogen [as N %]	30-Mar-10	12:29	0.08	0.08	0.06	0.07	0.07	0.08	0.12
Ammonia+Ammonium [%]	25-Mar-10	12:58	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aluminum [µg/g]	26-Mar-10	13:37	18000	17000	18000	18000	18000	18000	17000
Silver [µg/g]	26-Mar-10	07:45	0.05	0.07	0.05	0.04	0.05	0.04	0.04
Arsenic [µg/g]	26-Mar-10	07:45	41	45	43	45	45	42	43
Barium [µg/g]	26-Mar-10	07:45	43	38	34	40	35	44	58
Beryllium [µg/g]	26-Mar-10	07:45	0.69	0.66	0.68	0.67	0.67	0.69	0.63
Boron [µg/g]	26-Mar-10	07:45	46	47	47	47	47	45	44
Bismuth [µg/g]	26-Mar-10	07:45	0.15	0.14	0.14	0.14	0.15	0.14	0.13
Calcium [µg/g]	26-Mar-10	13:36	25000	26000	25000	25000	25000	24000	23000
Cadmium [µg/g]	26-Mar-10	07:45	0.03	0.03	< 0.02	0.02	< 0.02	< 0.02	< 0.02
Cobalt [µg/g]	26-Mar-10	07:45	6.7	6.9	6.8	6.9	7.0	6.8	6.9
Chromium VI [µg/g]	30-Mar-10	16:08	0.08	0.08	0.08	0.10	0.07	0.08	0.07
Chromium [µg/g]	26-Mar-10	07:46	61	60	60	60	61	61	59
Copper [µg/g]	26-Mar-10	07:45	46	34	21	47	22	31	43
Iron [µg/g]	26-Mar-10	13:36	75000	71000	70000	73000	70000	72000	71000
Potassium [µg/g]	26-Mar-10	13:36	2200	2300	2300	2300	2400	2200	2200
Lanthanum [µg/g]	26-Mar-10	07:45	17	16	17	16	17	17	16

ONLINE

Page 1 of 3

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS
SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : CA10298-MAR10

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: BRTS/10/1	6: BRTS/10/2	7: BRTS/10/3	8: BRTS/10/4	9: BRTS/10/5	10: BRTS/10/6	11: BRTS/10/7
Lithium [µg/g]	26-Mar-10	07:45	26	26	27	26	27	27	24
Magnesium [µg/g]	26-Mar-10	13:36	8400	8600	8500	8300	9000	8400	8200
Manganese [µg/g]	26-Mar-10	07:45	380	410	490	390	490	390	370
Molybdenum [µg/g]	26-Mar-10	07:45	2.0	2.0	1.9	2.4	1.9	1.9	2.2
Sodium [µg/g]	26-Mar-10	13:36	14000	15000	16000	14000	16000	14000	14000
Nickel [µg/g]	26-Mar-10	07:45	15	15	15	16	16	15	16
Lead [µg/g]	26-Mar-10	07:45	30	25	25	28	24	28	35
Phosphorus [µg/g]	26-Mar-10	13:36	1200	1100	1000	1100	1100	1100	1100
Sulphur [µg/g]	26-Mar-10	13:36	6100	5300	5300	6700	5100	5200	5400
Silica [µg/g]	26-Mar-10	13:36	410	490	490	410	540	500	430
Selenium [µg/g]	26-Mar-10	07:45	0.7	0.8	0.8	0.9	0.8	0.7	< 0.7
Antimony [µg/g]	26-Mar-10	07:44	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Tin [µg/g]	26-Mar-10	07:44	2.8	1.6	1.4	2.5	1.4	2.2	4.8
Strontium [µg/g]	26-Mar-10	13:36	200	210	190	200	200	190	190
Tellurium [µg/g]	26-Mar-10	07:44	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	26-Mar-10	07:44	13	13	13	13	14	13	12
Thallium [µg/g]	26-Mar-10	07:44	0.10	0.09	0.09	0.10	0.09	0.10	0.09
Titanium [µg/g]	26-Mar-10	07:44	230	230	240	240	230	240	240
Uranium [µg/g]	26-Mar-10	07:44	1.6	1.4	1.5	1.4	1.4	1.6	1.5
Vanadium [µg/g]	26-Mar-10	07:44	85	84	85	84	85	85	80
Yttrium [µg/g]	26-Mar-10	07:44	8.5	8.5	8.5	8.5	8.7	8.6	8.3
Zinc [µg/g]	26-Mar-10	13:36	130	110	88	130	95	110	150
PCB pulp [ug/g]	24-Mar-10	12:10	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Moisture Content [%]	24-Mar-10	08:58	57.5	60.3	61.3	60.4	60.2	60.2	59.6
CCME F1 (C6-C10) [mg/kg]	24-Mar-10	08:58	< 20	< 20	< 20	< 20	< 20	< 20	< 20
CCME F2 (C10-C16) [mg/kg]	25-Mar-10	12:59	< 10	11	11	13	< 10	< 10	16
CCME F3 (C16-C34) [mg/kg]	25-Mar-10	12:59	441	373	213	388	187	211	345
CCME F4 (C34-C50) [mg/kg]	25-Mar-10	12:59	117	108	91	129	78	81	151
Chromatogram returned to baseline at nC50 [Yes / No]	25-Mar-10	12:59	YES	YES	YES	YES	YES	YES	NO

01/11/10

Page 2 of 3

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.


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Phone: 705-652-2000 FAX: 705-652-6365

LR Report : CA10298-MAR10

Petroleum Hydrocarbon analysis was conducted using analytical procedures that comply with the Reference Method for the CWS for Petroleum Hydrocarbons and have been validated for use at the SGS laboratory, Lakefield, ON site.

Quality Compliance: Instrument performance / calibration quality criteria were met and extraction and analysis limits for holding times were met.

nC6 and nC10 response factors within 30% of response factor for toluene: YES
nC10, nC16 and nC34 response factors within 10% of each other: YES
C50 response factors within 70% of nC10 + nC16 + nC34 average: YES
Linearity is within 15%: YES

If the F4G gravimetric heavy hydrocarbons have been determined, they cannot be added to the C6 to C50 hydrocarbons.

CCME Method nonconformance: % moisture in samples is >50%. Detection limit for F1 analysis is elevated due to moisture content in samples.


Dianne Griffin
Project Specialist

01/11/10

Page 3 of 3

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

APPENDIX B

METHODOLOGY STATEMENT – TORM ALEXANDRA



METHODOLOGY STATEMENT – TORM ALEXANDRA As at 1 March 09

TASK

Safely Remove Torm Alexandra from Freeport of Monrovia.

WORK PLAN

- Method:** Torm will be lifted and towed
- Equipment:**
Dive equipment
Large cranes
Maximum volume capacity pumps
Octopus Apparatus to remove mud & silt build up inside and outside the vessel
- Tow location:** Torm will be towed (by tug) and will be brought to the ship-breaking site located in Buchanan
- Ship-breaking:** The vessel will be scrapped using various heavy equipment with shears as well as plasma cutting equipment.
- Scrap sorting:** The various varieties of scarp will be sorted and handled at the ship-breaking site in Buchanan.

ENVIRONMENTAL & HEALTH AND SAFETY

- Oil and Fuel:** All oil and fuel have already been removed from the Torm
- Other:** Any other hazardous material will be dealt with IAW or environmental and health and safety methods. We will contact NPA for locations to dispose of any hazardous material.

COORDINATION AND CONTACT INFORMATION

Weekly Meetings: BR will hold weekly meeting with the Technical Director to provide regular updates, to solve technical problems, to coordinate port traffic, and to provide the plan and work statements for the up-coming week.

BR Technical Manager: Harry Baines (+231 685 7142); and Ken Turk (+231 77 96 2419)

NPA Technical Manger: Jonathan (+231 659 2460)

EQUIPMENT LIST and PERSONNEL

Once confirmation survey has been completed, equipment and personnel will be assigned to the job. BR will provide a daily log of the machines and men that were used.

SUBCONTRACTORS

BR may need to use machines from BR Technical Services above and beyond what was procured for this task. BRTS will keep an accurate log and costs associated with this task.

MEDICAL PLAN

BR will have its trauma medics on standby in case of an accident. BR will implement its medical protocols should an incident occur.

SECURITY AND ACCESS PLAN

BR will place its own security on NPA property to safeguard its equipment and other property.

FACILITIES NEEDS FROM NPA

Once survey is complete, BR Technical staff will coordinate any facilities needs with NPA Technical staff.

APPENDIX C

METHODOLOGY STATEMENT – WRECKS IN BUCHANAN

METHODOLOGY STATEMENT – WRECKS IN BUCHANAN As at 1 March 09

TASK

Safely Remove all wrecks in and around the Port of Buchanan.

WORK PLAN

- Equipment:** Heavy duty excavators with shear and scarp handling attachments
Large cranes
Large winches, pulleys, shackles and wire rope
Other heavy equipment required to cut and drag ships
- Location:** Various locations in and around the Port of Buchanan. Locations easily identified.
- Survey:** Divers will conduct survey to confirm existing information on the wrecks
- Removal:** Cut and drag method. BR will construct temporary access to the “close-to-shore” wrecks and will use large machines with specialized cutting shears.
- Ship-breaking:** The vessels will be scrapped using various heavy equipment with shears as well as plasma cutting equipment.
- Scrap sorting:** The various varieties of scarp will be sorted and handled at the ship-breaking site in Buchanan.

ENVIRONMENTAL & HEALTH AND SAFETY

- Oil and Fuel:** All oil and fuel have already been removed from these wrecks
- Other:** Any other hazardous material will be dealt with IAW our environmental, health and safety standards and practices. We will contact NPA for locations to dispose of any hazardous material.

COORDINATION AND CONTACT INFORMATION

Weekly Meetings: BR will hold weekly meetings with the NPA Technical Director to provide regular updates, to solve technical problems, to coordinate port traffic, and to provide the plan and work statements for the up-coming week.

BR Technical Manager: Harry Baines (+231 685 7142); and Ken Turk (+231 77 96 2419)

NPA Technical Manger: Jonathan Massaquoi (+231 659 2460)

EQUIPMENT LIST and PERSONNEL

Once the confirmation survey has been completed, equipment and personnel will be assigned to the job. BR will provide a daily log of the machines and personnel that were used.

SUBCONTRACTORS

BR may need to use machines from BR Technical Services above and beyond what was procured for this task. BRTS will keep an accurate log of any machine use and of costs associated with this task.

MEDICAL PLAN

BR will have its trauma medics on standby in case of an accident. BR will implement its medical protocols should an incident occur.

SECURITY AND ACCESS PLAN

BR will place its own security on NPA property to safeguard its equipment and other property. It will rely on the cooperation of NPA officials to ensure BR employees and equipment have the access to port facilities necessary to undertake the activities outlined above.

FACILITIES NEEDS FROM NPA

Once the survey is complete, BR technical staff will coordinate any facilities needs with NPA technical staff.

APPENDIX D

LETTER OF APPLICATION AND RESPONSE FROM EPA



Mr. Jerome Nyenka
Acting Executive Director
Environmental Protection Agency
4th Street, Sinkor
Monrovia, Liberia

July 10, 2009

Dear Mr. Nyenka,

RE: Application for an Environmental Permit for Buchanan Renewables' Port Project

We present our compliments and wish to kindly apply for an Environmental Permit for a port improvement project we are undertaking as part of an agreement we have with the National Port Authority. The purpose of the project is to improve the viability of the ports in Liberia, which are fundamental to the development of Liberia's local and export economy.


As part of this port improvement project, we aim to strengthen port facilities by undertaking two key activities:


- (1) Removing and breaking the shipwrecks currently blocking the entrances, quays and other facilities in Liberia's ports; and
- (2) Improving port facilities, primarily in the port of Buchanan, by undertaking activities such as installing new bollards and navigational aids, dredging, rehabilitating port roads and, among other things, securing 1-2 tug boats. The specific activities and the nature of each activity will be defined in consultation with NPA officials.

By undertaking this initiative, Buchanan Renewables hopes to make a significant contribution to creating a more attractive investment climate in Liberia by improving the functionality of Liberia's ports, as well as by facilitating its own biomass export business. It not only seeks to create ports, which are attractive to its own customers, but it also seeks to demonstrate the viability of doing business in Liberia to other potential investors. Buchanan Renewables aims to undertake these activities in the most environmentally sound way possible and, as such, is looking forward to the advice and recommendations of the EPA.

Please kindly advise as to what is required to proceed with obtaining an Environmental Permit for this project.

Respectfully,


Alexandra Baillie
Deputy Country Director


13/07/09

Buchanan Renewables
Congo Town, Monrovia, Liberia
Tel: +231 777 98 4 17/18



Office of the Executive Director

ENVIRONMENTAL PROTECTION AGENCY
P. O. Box 4024
4TH Street, Tubman Blvd., Sinkor
1000 Monrovia 10, Liberia



October 14, 2009

ED/EPA-06/0122/09/RL

Dear Sir:

I present my compliments and wish to acknowledge receipt of your application for environmental permit for your port project.

Please be informed that the undertaking for which you have applied requires an Environmental Management Plan that will address the activities summarized below:

- Installing new bollards and navigational aids,
- Dredging and
- Rehabilitation of port roads

I am attaching herein for your consideration:

- Draft list of certified local Independent EIA Evaluators 2009
- Environmental Assessment form.

The individuals herein listed are the only duly certified people in Liberia to conduct environmental impact assessment, prepare environmental management plans and other environmental studies. You are hereby advised select from the list of local Independent EIA Evaluators and write a introductory letter to the Agency introducing said consultant(s)

The EPA may however accept for approval work conducted by any international evaluator if verified that the individual posses testimonials of previous environmental studies, based on cross-reference from institutions such as the United Nations Environment Program, World Bank and the African Development Bank.

Please accept the assurances of our cooperation.

Kind regards.

Truly yours,

Jerome G.N. Nyenka
ACTING EXECUTIVE DIRECTOR

Alexandra Baillie
Deputy Country Director
Buchanan Renewables
Monrovia, Liberia

JGNN/vlc

Mobile: 231 5678113 Fax: 231 77523432 Email: jeronyenka@yahoo.com

Table 5-2: Maximum construction equipment noise levels at 15 and 30 m from source (EPA, 1972. cited in Canter, 1996).

Activity	Source	Maximum Sound Pressure Level(dBA)	
		15 meters	30 meters
Earth-moving	Compactors (rollers)	74	71
	Front loaders	83	80
	Backhoes	92	89
	Tractors	94	91
	Scrapers, graders	92	89
	Pavers	89	86
	Trucks	94	91
Materials Handling	Concrete mixers	85	82
	Concrete pumps	83	80
	Cranes, movable	84	81
	Cranes, derrick	90	87
Stationary	Pumps	71	68
	Generators	83	80
	Compressors	86	83
Impact Equipment	Pneumatic wrenches	87	84
	Jackhammers and rock drills	96	93
	Impact pile drivers, peaks	104	101
Other	Vibrator	81	78
	Saws	81	78