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This is the Strategic Environmental Assessment (SEA) referenced in the Project Summary for Liza Phase 1 of development of production facilities within the Stabroek Block, Offshore Guyana, which has been submitted by Esso Exploration and Production Guyana Limited (EEPGL).

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Strategic Environmental Assessment

Exploration Drilling in the Stabroek Petroleum Prospecting License Area

Esso Exploration and Production Guyana, Limited
March 2014

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David W. Blaha

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LIST OF ACRONYMS AND ABBREVIATIONS

BOPE	Blow Out Prevention Equipment
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
CPACC	Caribbean Planning for Adaptation to Climate Change
CREE	Center for Rural Empowerment and the Environment
CSC	International Convention for Safe Containers
EEPGL	Esso Exploration and Production Guyana, Limited
EA	Environmental Assessment
EPA	Environmental Protection Agency
ERM	Environmental Resources Management, Inc.
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EEZ	Exclusive Economic Zone
FAL	Convention on Facilitation of International Maritime Traffic
GGMC	Guyana Geology and Mines Commission
GloBAL	Global Bycatch Assessment of Long-lived Species
GMRP	Guyana Magrove Restoration Project
ICZM	Integrated Coastal Zone Management
IFC	International Finance Corporation
IMO	International Maritime Organization
ITCZ	Inter Tropical Convergence Zone
ITLOS	International Tribunal Law of the Sea
IUCN	International Union for the Conservation of Nature
Km	Kilometers
LME	Large Marine Ecosystem
M	Meters
MARAD	Maritime Administration Department (Guyana)
MOA	Ministry of Agriculture (Guyana)
NADF	Non-Aqueous Drilling Fluid
NGO	Non-Governmental Organization
NEAP	National Environmental Action Plan

OIMS	Operations Integrity Management System
OGP	Oil and Gas Producers
OSRP	Oil Spill Response Plan
PA	Petroleum Agreement
POP	Persistent Organic Pollutant
SEA	Strategic Environmental Impact Assessment
SEDAC	Socioeconomic Data and Applications Center
SIA	Social Impact Assessment
SOLAS	International Convention for the Safety of Life at Sea
SPAW	Protocol on Specially Protected Areas and Wildlife (SPAW)
STCW	International Convention on Standards of Training, Certification and Watchkeeping
ToR	Terms of Reference
UNISDR	United Nations International Strategy for Disaster Relief
UNFCCC	United Nations Framework Convention on Climate Change
WBDF	Water Based Drilling Fluid
3D	Three Dimensional

1.0 INTRODUCTION

1.1 BACKGROUND

The marine area offshore Guyana is thought to contain petroleum resources and has been the subject of exploration for over 50 years. Esso Exploration and Production Guyana, Limited (EEPGL) is the Operator of the Stabroek Petroleum Prospecting License Area (referred to hereafter as the Stabroek Block), the largest petroleum prospecting license area offshore Guyana, and is currently exploring for commercial accumulations of hydrocarbons trapped in deepwater reservoirs. EEPGL has identified two potential Areas of Interest called Sorubim and Liza within the Stabroek Block. EEPGL proposes to drill up to two exploration wells in the Stabroek Block.

Guyanese law requires EEPGL to apply for an Environmental Authorisation from the Environmental Protection Agency to drill the proposed wells. The application for Environmental Authorisation must be supported by a Strategic Environmental Assessment (SEA) of the proposed drilling activities. EEPGL has prepared one SEA for both proposed wells.

1.2 PURPOSE

This SEA identifies and assesses the likely environmental and social impacts associated with EEPGL's proposal to drill up to two exploration wells within the Sorubim and Liza Areas of Interest, and operating a shorebase on mainland Guyana to support the offshore exploration activities. Environmental and social impacts of exploration drilling in each area of interest are likely to be similar for most resources, but the SEA discusses any differences in the likely impacts between the two Areas of Interest.

1.3 SEA STUDY TEAM

The SEA team is composed of staff with extensive offshore oil and gas, natural resources assessment, and international impact assessment experience combined with local Guyanese experts in coastal and marine ecology, social issues, geotechnical engineering, natural resource management, and Guyanese environmental regulations. Table 1.1 identifies the key team members as well as the local environmental, social and engineering experts.

Table 1.1 SEA Core Team

Name	Role	Education
	Project Management Team	
David Blaha	Project Director	BS, Biology; MS, Environmental Management
Jason Willey	Project Manager	BS, Biology; MS, Environmental Science and Policy
Katherine Gardner	Senior Advisor	MS, Environmental Management; BS, Civil Engineering
James Viray	Client Liaison	MA, International Affairs & Development; BA International Relations
	Biological Resources Team	
Daniel Takahashi	Biological Resources Lead	BS, Biology; MS, Environmental Science
Jessica Stephens	Biological Resources Support	BS, Marine Fisheries
	Physical Resources Team	
Adeyinka Afon	Physical Resources Lead	BS, Chemical Engineering; MSE, Environmental Process Engineering
	Social Resources Team	
Matthew Kuniholm	Social Resources Lead	BA, International Relations; BA, Biology; MS, Environmental Science and Policy
	GIS and Data Management	
Joan Huston	GIS and Data Management	BA, English; MS, Urban and Regional Planning
	Local Guyanese Environmental and Regulatory Subcontractor – G-SEC	
Charles Ceres	Local Environmental and Regulatory Support	BS, Civil Engineering; MS Geotechnical Engineering
Hance Thompson		BS, Biology; MS, Environmental and Earth Resources Management

2.0 PROJECT DESCRIPTION

2.1 HISTORICAL PETROLEUM ACTIVITY OFFSHORE GUYANA

Petroleum exploration offshore Guyana began in the late 1950's and peaked in the late 1960s. Several companies drilled a combined nine wells offshore Guyana in ten years between 1965 and 1975. Of these wells, only Abary-1 well, drilled in 1975 in what is now known as the Kanuku license area found oil and gas shows, and flowed 37° API light oil.

Exploration activity offshore Guyana decreased substantially from the mid-1970s through the early 2000s , although several companies continued limited exploration activities.

A border dispute between Guyana and Suriname was also settled by the United Nations International Tribunal of the Law of the Sea (ITLOS) in September 2007. Despite the increased operational certainty that the agreement provided for operators offshore Guyana, no further drilling took place offshore Guyana until 2012, when two wells were drilled. .

The encouraging results from these wells led to additional planned exploration through 2016 by another operator. The Ministry of Natural Resources and the Environment stated that these new wells could reach depths of 18,000-21,500ft (Stabroek News, 2012).

2.2 GEOLOGY AND RESOURCE EVALUATION REPORTS

Significant research has been completed to evaluate the potential for petroleum resources offshore Guyana. Three-dimensional (3D) seismic data gathered as a result of multiple commercial proprietary surveys are being utilized to define and develop drillable prospects. Acquisition of proprietary 3D seismic data on the Stabroek Block took place from late November 2012 to early February 2013 and processing of the 3D data was completed in early October 2013. Key prospects are located in water depths that range from 1,000 to 2,300 meters, with potential total well depths of 5,000 to 6,500 meters. Initial results from the seismic interpretation and other assessment work conducted elsewhere in the Guyana Basin indicate the presence of source rocks and suggest that portions of the Guyana Basin are currently generating hydrocarbons.

2.3 PROJECT LOCATION

2.3.1 Guyana

Guyana is located between 1˚ 10′ and 8˚ 33′ North latitude 56˚ 20′ and 61˚ 22′ West longitude. It is bordered on the North by the Atlantic Ocean, on the East by Suriname, to the West and North-West by Venezuela, and to the South and South-West by Brazil. Guyana is one of eight countries that occupy a portion of the Amazon River Basin. It is the westernmost of the three countries, together with Suriname and French Guiana, which are often referred to together as the "Guianas" (Repsol, 2009). Guyana occupies the north central portion of the Guiana Shield, which is constitutes the northern portion of the South American Plate.

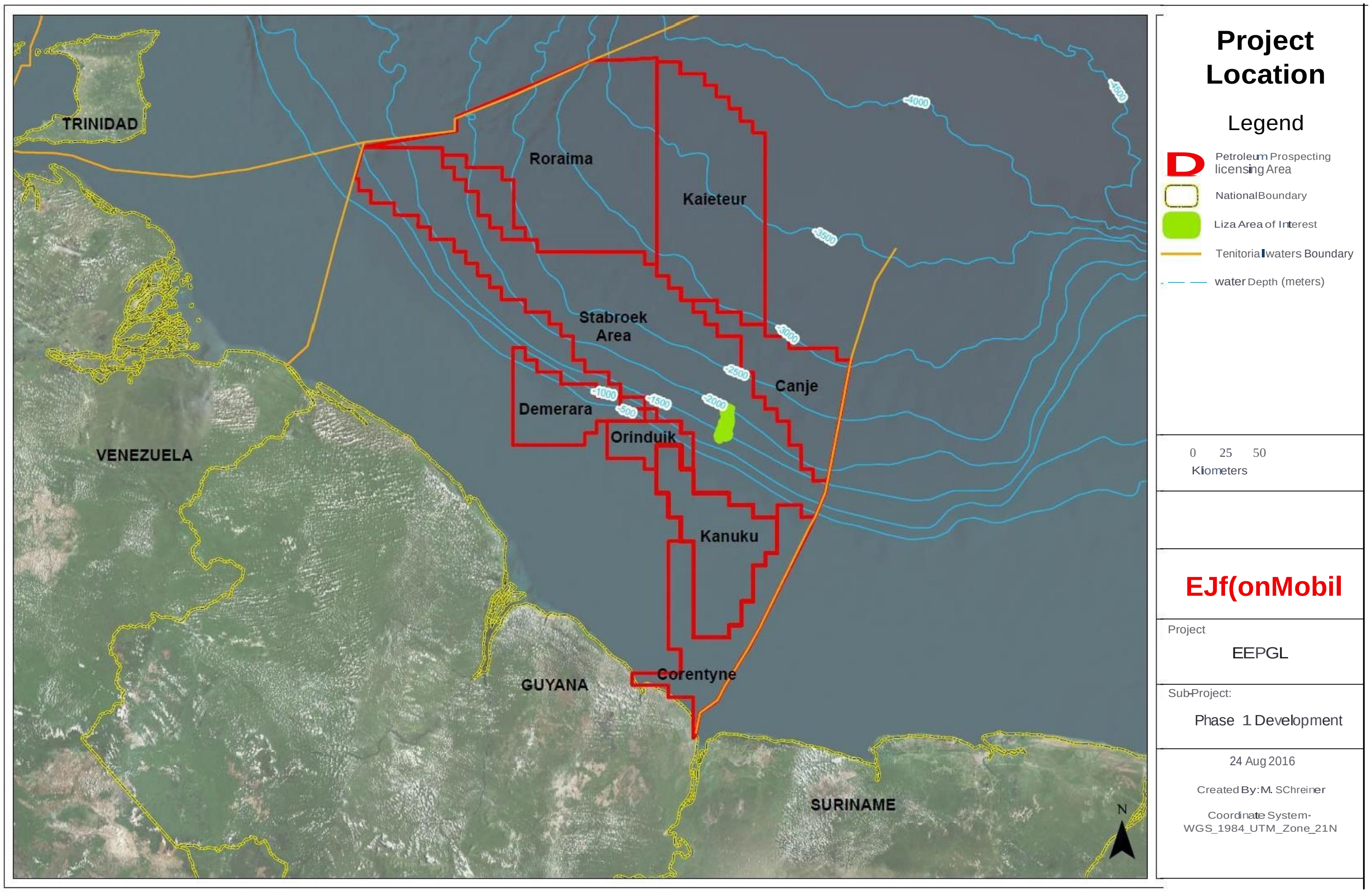
2.3.2 *The Guyana Basin*

The Guyana Basin (also sometimes referenced as the Suriname-Guyana Basin) is a sedimentary basin spanning coastal areas of Suriname, Guyana and eastern Venezuela. The thickest and widest parts of the basin are located offshore, but the extreme southern portion of the basin extends onshore along the coasts of Suriname and Guyana. The crystalline Proterozoic outcrops along the northern edge of the Guiana Shield mark the southern extent of the Guyana Basin (Staatsolie, 2013).

2.3.3 *The Stabroek Block*

The Stabroek Block is situated roughly parallel to the entire length of the Guyanese coast, from the border with Suriname to the east to Venezuela in the west and is located 130-180 km off the coast. EEPGL currently holds a 10 year exploration license from the Government of Guyana on the Stabroek Block. It is one of eight petroleum exploration blocks currently awarded offshore Guyana. At approximately 2.7 million hectares, the Stabroek Block is the single largest petroleum exploration block offshore of the country. Its eastern extremity abuts the Kanuku and Corentyne blocks to the south and Surinamese territorial waters to the east. The central portion of the Stabroek block is approached from the south by the Demerara Block. The Roraima block abuts the central and extreme western portions of the Stabroek Block to the north. Figure 2.1 illustrates the location of the Stabroek Block.

Figure 2.1 Location of the Stabroek Block



The Stabroek Block is located on the continental slope between Guyana's continental shelf and the deep marine plain of the tropical North Atlantic Ocean east of the Lesser Antilles. Guyana's entire continental shelf and slope, including the Stabroek Block, are influenced by the Guiana Current. This current is a result of the North Brazil Current, which transports warm, turbid water north from the mouth of the Amazon River across the coastal northern South America. As described in Sections 5.1.1 through 5.1.3, Guyana's nearshore oceanography, bathymetry, water quality, and sedimentology are largely determined by the interaction of the Amazonian waters of the Guiana Current with the marine waters of the tropical North Atlantic and discharge from the Orinoco River.

2.4 POTENTIAL HYDROCARBON PRODUCTIVITY OF THE GUYANA BASIN

The United States Geological Survey's (USGS) world petroleum assessment published in 2012 estimates the undiscovered resources of the Guyana Basin at 13.6 billion barrels of technically recoverable undiscovered oil. This amount ranks the Guyana Basin third in the entire Caribbean and South American regions in terms of total estimated oil resources, behind the Santos and Campos Basins, both offshore of Rio de Janeiro in southern Brazil. The USGS also estimates that the Guyana Basin contains 10,836 billion cubic feet of technically recoverable undiscovered natural gas, which places it 13th among the 31 basins evaluated by the USGS in the Caribbean and South American region in 2012.

2.5 DESCRIPTION OF THE PROJECT AND ALTERNATIVES

Although currently untested, geologic models indicate a potential working hydrocarbon play in the Stabroek Block. The closest known hydrocarbon accumulations are located onshore Suriname and offshore Venezuela. There are currently no wells in the Stabroek Block, but data from existing wells from other areas surrounding the block demonstrate the presence of Cretaceous source rocks in the shallow waters of the Guyana shelf located landward of the Stabroek Block. Geologic models suggest that the Cretaceous source rocks are mature and presently generating hydrocarbons in portions of the deepwater basin offshore Guyana. Tertiary and Upper Cretaceous turbidites deposited in deepwater settings are the Stabroek Block's potential reservoir rocks.

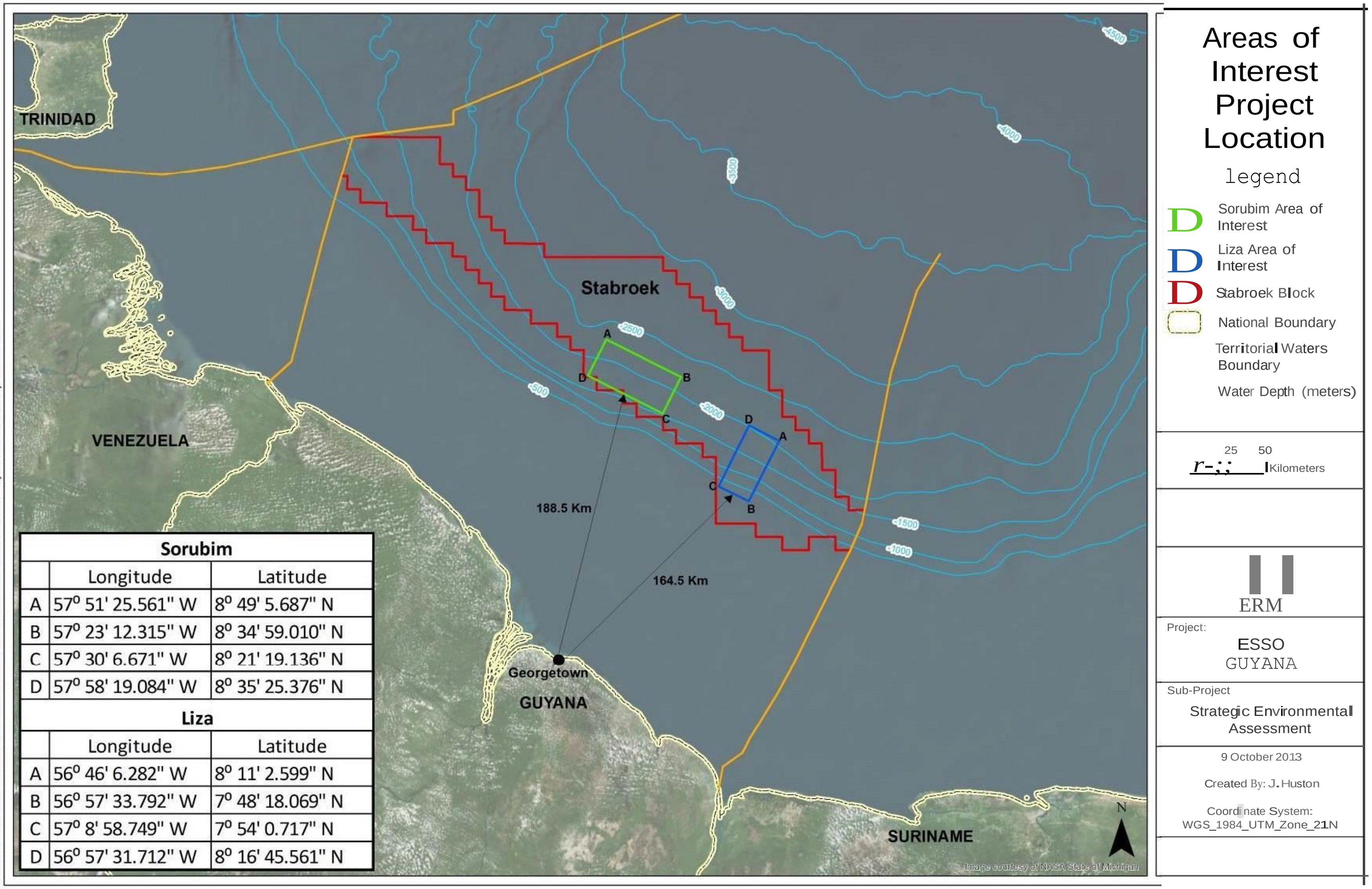
2.6 PROCESS DESCRIPTION

EEPGL currently holds a 10 year exploration license from the Government of Guyana on the Stabroek License Area, which is situated roughly parallel to the entire length of the Guyanese coast, approximately 130 to 180 km offshore. One of eight petroleum exploration blocks currently awarded offshore Guyana and with an area of approximately 2.7 million hectares, the Stabroek Block is the largest.

EEPGL has identified two prospective areas in the Stabroek Block (the Sorubim and Liza Areas of Interest) and proposes to plan for the drilling of up to two wells (up to one well per area) in the block to further evaluate the petroleum resources in the Stabroek Block. The primary objective of the drilling program is to evaluate the prospects identified previously by seismic surveys.

The Sorubim Area of Interest is located near the geographical centre of the Stabroek Block in approximately 1,700-2,400 m of water. The Liza Area of Interest is located southeast of the Sorubim Area of Interest near the eastern terminus of the block. Water depths in the Liza Area of Interest range from 800-2,150 m. Figure 2.2 illustrates the positions of the Sorubim and Liza Areas of Interest within the Stabroek Block, and provides the coordinates for the corners of each area.

Figure 2.2 *Locations of Sorubim and Liza Areas of Interest*



Sorubim

	Longitude	Latitude
A	57° 51' 25.561" W	8° 49' 5.687" N
B	57° 23' 12.315" W	8° 34' 59.010" N
C	57° 30' 6.671" W	8° 21' 19.136" N
D	57° 58' 19.084" W	8° 35' 25.376" N

Liza

	Longitude	Latitude
A	56° 46' 6.282" W	8° 11' 2.599" N
B	56° 57' 33.792" W	7° 48' 18.069" N
C	57° 8' 58.749" W	7° 54' 0.717" N
D	56° 57' 31.712" W	8° 16' 45.561" N

EEPGL has not yet determined the exact number of exploration wells to be drilled, or their exact locations. At this point, it is vital to EEPGL to maintain maximum flexibility in terms of the number and location of the wells because of the complex interactions of geological, oceanographic, technical engineering and commercial factors that determine the most advantageous drilling scenario. To ensure that the full range of potential environmental and social impacts are considered while at the same time ensuring maximum operational flexibility, this Strategic Environmental Assessment (SEA) considers the impacts of drilling a single well in each area of interest. The three potential alternatives to this scenario include:

- Drilling one well in the Liza Area of Interest only;
- Drilling one well in the Sorubim Area of Interest only; or
- Drilling no wells in the Stabroek Block.

Likely environmental and social impacts of the offshore activities required for a two-well drilling campaign will include short term impacts on marine water quality, air quality, noise, and disturbance of marine fauna, and marine navigation. Potential positive effects would include localized short-term economic benefits from demand for goods and services to support the Project, and long-term financial and social benefits of oil and gas production if commercial resources are discovered.

In the event that only one well is ultimately drilled, the positive and negative effects would likely be similar to a two-well drilling campaign, but they would have a smaller magnitude and extend over a smaller geographical area. If no wells are drilled, the impacts from the drilling program on the environment would not occur, but the potential long-term financial and social benefits of oil and gas production would also not be realized. Even if no wells are drilled in the Stabroek Block, the current environmental and social conditions will likely not persist indefinitely due to impacts from other industries, vessel activity, pollution, and natural changes in the marine environment.

Likely environmental and social impacts of activities at the shorebase will include short term impacts on air quality, noise, and traffic. Operation of the shorebase will also have short-term economic benefits associated with additional demand for goods and services. Similar to the effects of the offshore activities, the positive and negative effects of the shorebase will be maximized under the two-well scenario. The effects of the offshore and onshore components of the Project are discussed in detail in Section 6 and summarized in Section 7.

Details of the proposed drilling operations are provided below, including brief descriptions of the mobilization process, drilling procedure, and demobilization procedure. The drilling rig, contractor, and conceptual design have not been finalized to date. EEPGL is currently in the process of evaluating design criteria and options for the well(s).

2.6.1 *Well Planning*

Well planning is the first phase of the well development process. Key components of well planning include:

- Conducting a geotechnical site investigation and pressure prediction for the specific drill well locations;
- Choosing casing points and designing a drilling fluid program to enable overbalanced drilling (further described in Section 2.7.2);
- Designing well data collection and well logging while drilling programs to monitor local pore pressure;
- Designing casing and wellhead equipment; and
- Designing Blowout Prevention Equipment (BOPE) for the anticipated operating environment.

The well design process involves a multi-functional team using a systematic method to plan and design a well and formation evaluation protocol to meet program objectives. The well planning process can commonly take a year to complete. Based on the geological assessment, lead areas are identified, along with notional well centers, associated water depth, total depth and pressure considerations. Based on these the well design is further optimized through the completion of the geotechnical survey, shallow hazard evaluation and site clearance assessments. This is followed by well planning evaluations to optimize the final well design with the proper casing, pipe setting points, detailed mud package, rig selections and drilling execution plans to safely drill the well and meet the objectives.

EEPGL has developed an Integrated Pressure Prediction Process (IP3) team consisting of geophysicists, geologists, drilling engineers, and computer modellers. The IP3 team integrates analysis from available proprietary data including: seismic data, well data from analogous and offset wells, and regional models to predict pore pressure and fracture gradients, and to develop a detailed understanding of the reservoir. The use of advanced technology will enhance the prediction of formation behaviour as wells are drilled, and allows the engineer to plan a well that reduces the risk of a well control incident. Engineers use pressure predictions to design drilling mud programs with sufficient hydrostatic head to overbalance the formation pressures from surface to total well depth.

Other factors influencing the mud weight program are shale conditions, fractures, lost circulation zones, salt mobility, and stuck-pipe prevention. The well casing program is designed to allow for containment and circulation of a formation fluid influx out of the wellbore. Casing is designed to contain the maximum anticipated pressures during a well control event. The design of the Sorubim and/or Liza well(s) has not been completed, but some preliminary design parameters are available. Table 2.1 provides the available information on the anticipated physical design of the well(s).

Table 2.1 Physical Design Parameters of Sorubim and Liza Wells

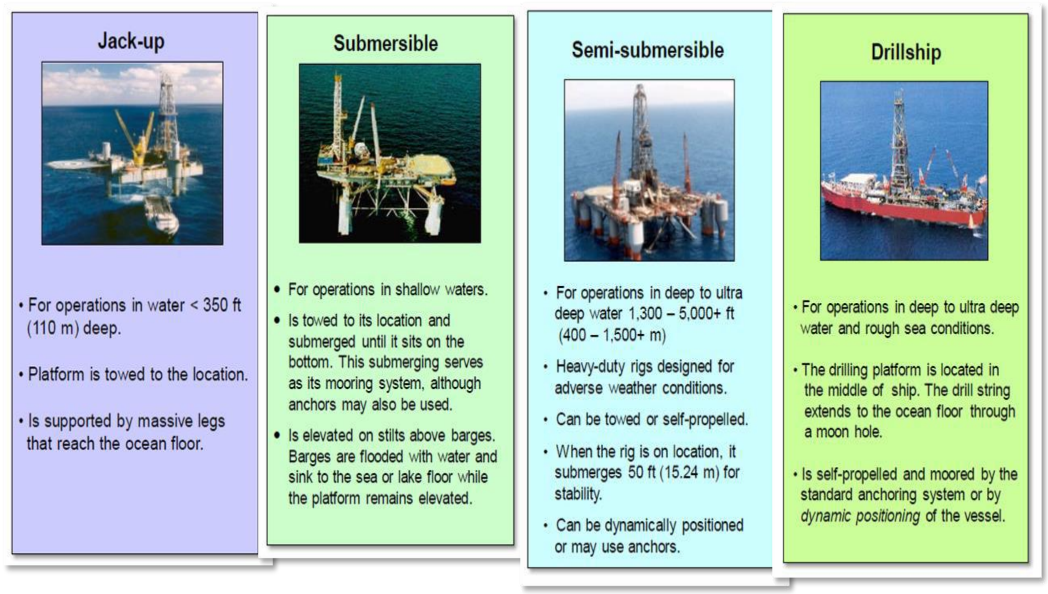
Parameter	Physical Data
Water Depth	1,000–2,300 meters
Total Depth	5,000-6,500 meters
Pressure	12-15 ppg EMW (pounds per gallon Equivalent Mud Weight)
Temperature	200-275 ˚F bottom hole temperature

Well planning also includes the procurement of services and equipment and writing of detailed procedures necessary to execute the operation. This includes the identification and selection of required support facilities, a shorebase, aviation and medical service facilities, procurement of a rig and development of oil spill response and waste management plans further discussed in Section 4.4

2.6.2 *Rig Selection, Procurement and Mobilization*

Before drilling can commence, a rig must be selected and secured. Rig requirements will be influenced by the operating environment and subsurface conditions that are present. Rig selection criteria will include: safety statistics, rig location and availability, historical non-productive time statistics, capacity (hoisting, rotating, power, variable deck load, bulk and liquid storage, etc.), water depth rating, station-keeping capability, and well control equipment. The rig will be equipped to comply with the water pollution control standards required by the International Maritime Organization (IMO) International Convention for the Prevention of Pollution by Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78). Based on the water depths present across the Liza and Sorubim Lead Areas, either a semisubmersible or drill ship will be required as shown in Figure 2.3.

Figure 2.3 Common Drill Rig Types



The rig selection and procurement process for the project is still on-going. The rig may need to be mobilized from another area along with those support vessels capable of anchor handling, supplying the rig, performing standby duties, and providing oil spill response capabilities.

Before a rig is accepted, a thorough rig acceptance test process is conducted to locate and correct any issues that could affect the integrity of the operations. This includes inspection of blow-out prevention equipment, fluid handling equipment, drill string components, hoisting equipment, and station keeping equipment. Also, inspections of the safety systems, marine systems and structural components of the rig are conducted as part of the pre-mobilization review and internal safety checks required by EEPGL's Operations Integrity Management System (OIMS) prior to drilling.

2.6.3 *The Drilling Process*

This section describes the major pieces of equipment and the processes required to develop a subsea exploration well. Further drilling details and information on materials to be used, anticipated time line and duration of activities and safety measures to be employed will be prepared and provided prior to commencement of drilling for submittal to the GGMC in accordance with the Guyana Petroleum Exploration and Production Act of 1986.

2.6.3.1 *Drill Rig, Drill String, and Casing Program*

The drill rig provides the operational base and power needed to bore the well into the Earth's crust. Together the bits, tubulars, and various instruments and devices connecting the bit to the rig are collectively referred to as the drill string. The drill rig advances the drill string into the well, and provides the torque to turn the bit in the borehole. All of the equipment used to assemble and manipulate the drill string, such as the travelling equipment and rotating system, will be housed on the drill rig. Much of the discussion provided in this section is based on typical information for the types of drill rigs customarily used for offshore deepwater exploration drilling programs.

The drilling process uses drilling bits of different sizes to drill a series of telescoping holes from the seabed to the planned well total depth. Drill pipe is continuously added to the top of the string from the rig as the string advances into the borehole. Once each hole section has been drilled, casing is run into the well and cemented in place.

Cements, produced in a combustion process using a specialized blend of limestone and clay, are used to support the casing and isolate formations. With increasing depth, temperature and pressure, additives are required to ensure that the cement slurry maintains its required properties. Additives can be subdivided into six functional groups: (i) density control additives (ii) setting time control additives, (iii) lost circulation additives, (iv) filtration control additives, (v) viscosity control additives, and (vi) specialty additives. Casing is run into the borehole and cemented in place after each successive well section is drilled.

After each cementing operation, the cement unit must be thoroughly cleaned to ensure that it is fit for use when needed. Effluent from the cleaning operation may be discharged to prevent cement setting in the system.

Under certain circumstances, it may be necessary to drill a sidetrack section to the well. The drill bit is directed at an angle to the main wellbore, and a new wellbore segment is drilled towards the total depth of the well. This procedure may be implemented for mechanical reasons when it becomes impractical to continue drilling the initial wellbore, or it may be implemented to gather additional samples or information not gathered in the initial wellbore.

2.6.3.2 *Drilling Fluid Handling System*

A drilling fluid is circulated through the inside of the drill string to the bit. The primary function of the drilling fluid system is the removal of cuttings from the well and the control of formation pressures. Other functions of the drilling fluid system include:

- Sealing permeable formations;
- Controlling pressure within the formation;
- Maintaining wellbore stability;
- Cooling, lubricating and supporting the drill bit and assembly;
- Transmitting hydraulic energy to tools and bit; and
- Transporting cuttings to the surface.

Another important function of the drilling fluids system is related to the control of fluid volume during the well drilling. The comparison of the volume of fluid pumped into the well with the volume that returns to the rig allows for the monitoring of fluid losses or fluid gains inside the well; respectively indicating either a loss of drilling fluids to the formation or an inflow of formation fluids into the well.

The drilling fluid is designed to have specific properties and is prepared by mixing solid additives and chemicals to specified concentrations. Drilling may be carried out using Water-Based Drilling Fluids (WBDF), Oil and Gas Producers (OGP) Group 3 low toxicity Non-Aqueous Drilling Fluids (NADF), or both.

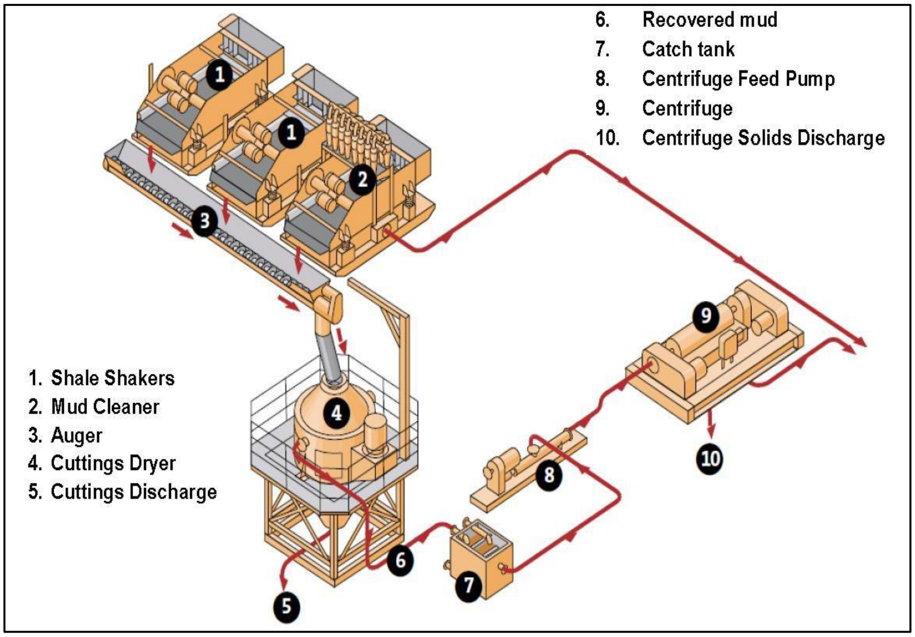
The drill rig will be equipped with a drilling fluid handling system comprised of equipment that circulates drilling fluid (mud) through the well and provides treatment of drilling fluid to remove cuttings and gas. Drilling fluid handling systems include a high-pressure system that circulates mud through the well, and low-pressure storage and treatment systems.

2.6.3.3 *Solids Control and Fluid Recovery*

Drilling fluids recovered from the well will be treated to remove solids and/or gas entrained in the fluid during the drilling phase. A solids control system will separate drill cuttings and particles of solids from the circulating drilling fluid system. The cuttings are solid fragments derived from the cutting of rocky formations by the drill bit and are transported to the surface by the drilling fluid. Once the marine riser is installed, the flow of drilling fluid returning from the well will be directed to the solids control system. The removal of solids from the returning flow enables reuse of the base fluid.

Thus, the solid removal system performs an important role in the drilling operation by maintaining optimal drilling fluid properties, reducing the volume of base fluid required and reducing fluid properties of drilling waste generated. Gas will be removed from the drilling fluid by means of a degasser and will be vented to the top of the rig. A view of a typical solid control / fluid recovery system is shown in Figure 2.4.

Figure 2.4 Typical Solid Control / Fluid Recovery System



(Source: MI-Swaco)

2.7 *WELL CONTROL*

Exxon Mobil Corporation's well control philosophy is focused on blowout prevention using safety and risk management systems, management of change procedures, global standards, and trained experienced personnel. EEPGL has a mature Operations Integrity Management System (OIMS) that emphasizes attention to Safety, Well Control, and Environmental Protection (see Section 3.4.1). This includes proper preparation for wells (well design, well control equipment inspection and testing), detecting the influx early, closing-in the well efficiently (personnel training and proficiency drills), and circulating out kicks with kill weight mud in a controlled manner.

2.7.1 *Integrated Well Control System*

The following key aspects of well control are common to all EEPGL drilling projects, and will be implemented during EEPGL's drilling campaign in the Stabroek Block:

- Designing wells and drilling procedures based on offset data and integrated pore pressure prediction (described above in Section 2.6.1);
- Planning mud densities to control reservoir pressure;
- Installing Blowout Prevention Equipment (BOPE) as a secondary well control mechanism and frequently inspecting and testing the stack and control system;
- Specialized training, equipment, and procedures that meet or exceed regulatory requirements; and
- Installing multiple well flow monitoring devices, and implementing strict well monitoring practices to maximize the likelihood of detecting and shutting in on a hydrocarbon influx prior to surface or mudline release.

Effective well control begins at the well planning stage, which is described in Section 2.6.1. Each of the subsequent aspects of EEPGL's integrated well control program listed above is described in further detail below.

2.7.1.1 *Planning Mud Densities to Control Reservoir Pressure*

Blowout prevention while drilling and operating wells relies on a number of interrelated processes and procedures. Drilling will be performed using an overbalanced mud weight[i] to control the well. Drilling fluids will provide primary well control during execution operations, as they are designed to exert enough hydrostatic pressure on the wellbore to exceed pore pressures, thereby preventing undesired fluid flow into the wellbore. Insufficient mud weight could lead to an underbalanced condition, and may, in turn, result in an influx of formation fluids. Excessive mud weight may result in lost circulation to a weak formation, which could in turn lead to a drop in fluid level and an underbalanced condition. A range of mud weights will be used as the well is drilled to provide the proper well control for the formation conditions encountered.

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[i] In overbalanced drilling, the pressure exerted by the mud column exceeds formation pressure, preventing formation fluids from entering the well.

2.7.1.2 *Utilizing Blowout Prevention Equipment (BOPE)*

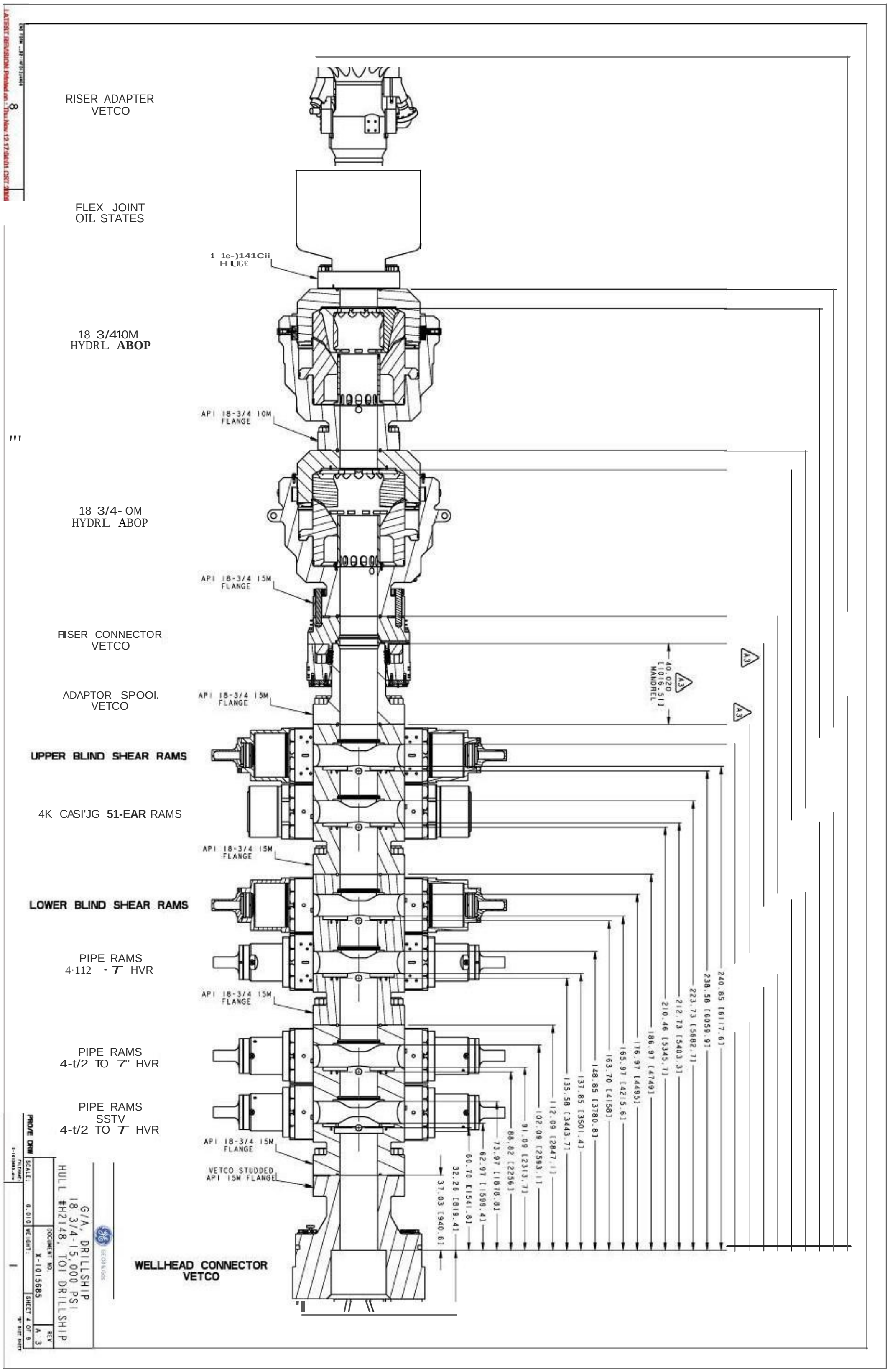
The blowout preventer (BOP) will provide secondary well control during drilling operations once the riser has been installed. Constant monitoring of the total fluid circulating volume and other drilling parameters (as described below) will ensure that an influx of formation fluid into the well is quickly detected. If an influx of formation fluid occurs, secondary well control methods will be applied. The drill pipe will be shut in by a downhole check valve near the bit and a surface-mounted safety valve, and the well annulus will be shut in using the BOP. In the event that primary well control is lost, actuation of the BOP will contain the influx of formation fluid and then allow safe circulation of the influx out of the wellbore. Specifically the BOP's main functions include:

- Closing around the drill string, casing or liner and allowing circulation;
- Closing and sealing open holes and allowing volumetric well control operations;
- Stripping the drill pipe using the annular preventers;
- Hanging-off drill pipe and controlling the wellbore; and
- Shearing cable or drill pipe

BOPs are hydraulically activated closing devices. They are typically installed in series, and BOPs installed on a well are often referred to collectively as the "BOP stack". BOPs consist of both ram and annular-type preventers.

The BOP stack provides capability to shut-in the well. With the well shut-in and with controlled back-pressure, kill-weight drilling fluid can be circulated through the well via the drill stem, annulus, and the choke and/or kill lines to achieve the necessary bottom hole pressure and stop the flow of fluids from the reservoir into the well. Figure 2.5 shows a typical BOP system configuration.

Figure 2.5 *Typical Blowout Preventer System*



2.7.1.3 *Well Control During Riserless Hole Drilling*

EEPGL will conduct a shallow drilling hazards evaluation to identify and characterize shallow drilling hazards at proposed wells from the mudline down to the surface casing setting depth. Surface locations are chosen to avoid potential seafloor and subsurface drilling hazards, including shallow hydrocarbon bearing intervals and shallow water flow zones. Shallow hazard assessments include thorough analysis of proprietary seismic data (seismic facies identification, amplitude analysis, and geological structure mapping) and the integration of relevant offset well information. EEPGL will have contingency plans in place to address shallow flows while drilling the riserless sections of any well.

2.7.1.4 *Well Control While Drilling Below the Surface Hole*

During drilling operations below the surface hole (after conductor casing has been set) the primary well control barrier will remain the hydrostatic pressure of the drilling fluid, but the full BOP stack will be necessary due to potential for an influx from hydrocarbon zones. Should an influx occur, the BOP will be used to close in the well.

2.7.2 *Specialized Training, Equipment and Procedures*

EEPGL requires certified well control training for drilling supervisors, operations superintendents, drilling engineers, contractor rig drillers, tool pushers and other appropriate personnel through an operations training program with a professional organization. The curriculum consists of training in blowout prevention technology and well control. Successful completion results in participant certification.

All EEPGL rig supervisors and engineers are certified in well control. All rig supervisors, the operations superintendent, engineering manager, and field drilling manager will be experienced professionals. Rig crews will be trained to identify warning signs of hazards and to avoid escalation. On the job proficiency drills are routinely conducted to ensure an influx can be detected.

Specialized proprietary tools will be available to the drilling crews during drilling operations. Logging While Drilling (LWD) and Pressure While Drilling (PWD) tools will provide real time data on conditions within the well to the drilling crew. Engineers and geologists will monitor drilling data to identify and react to escalating trends.

Prior to rig acceptance, comprehensive inspection and testing programs are performed on the drill rig. Routine functional and pressure testing during drilling operations is conducted in compliance with EEPGL requirements. BOP drills will be performed on a frequent basis to ensure the well can be shut in quickly and properly. Certified training of personnel will include hands-on simulator practice for recognizing an influx, well shut-in, and circulating the influx out of the wellbore. Well specific shut in procedures will be posted on the rig. Table 2.2 summarizes key features of three types of training drills that are commonly performed during drilling operations.

Table 2.2 Key Aspects of Training Drills

Type of drill	Key aspects
Trip Drills and Pit Drills	• Unannounced • Purpose is to reduce time for driller, drill crew and mud loggers to detect and react to trip tank or pit level changes
Power Choke Drills	• Performed after setting casing • Conduct crew training using the power choke and manual back-up (i.e. practice bringing on pumps and adjusting choke to control backpressure)

2.7.2.1 *Monitoring the Well*

The mud weight (the primary well control mechanism) will be monitored and adjusted based on actual wellbore requirements. Automatic and manual monitoring equipment will be installed to detect abnormal variation in mud system volumes and properties, and drilling parameters. Systems and processes in place for early detection of formation fluids will include:

- Setting the rig and mudlogger Pressure, Volume, Temperature (PVT) and Flo-Sho alarms to the lowest practical limits;
- Close monitoring of the standpipe pressure and Pressure While Drilling (PWD) equipment while drilling;
- Use of trip tanks for monitoring of fluid displacements during trips; and
- Gas monitoring systems

If an influx of formation fluid into the wellbore occurs, the BOP will be used to immediately shut in the well.

2.8 VERTICAL SEISMIC PROFILING

Proprietary Vertical Seismic Profile (VSP) data may be collected to improve velocity modelling and reduce uncertainty in reservoir mapping. VSP surveys can be used to correlate the surface-seismic data to the information on the physical properties and characteristics of the hydrocarbons gained from drilling the well. VSP data, along with check shots and well logs, provide further time/depth information from which to improve knowledge and understanding of the structure and stratigraphy of the reservoir.

A VSP survey requires a source (commonly an air gun) and a receiver. Data is acquired by the receiver which is installed within the wellbore. The source may be located with zero offset from the well (directly above the wellbore), at a fixed offset (a defined lateral distance from the well), walk away (at a range of offsets), or walk above (at zero offset to the down hole well location). The final scope of such a survey and specific geophysical tools to be used is still under review. Appropriate marine mammal protective measures would be taken to ensure that resulting marine sound generated during the survey does not adversely impact marine mammals through the utilization of marine mammal observers to monitor for the presence of such species and the maintenance of an offset or buffer zone from such sources.

2.9 WELL TESTING

Production well testing is not part of the drilling plan base case and testing may not occur in the first well even if hydrocarbons are encountered. If well testing does occur, it would be used to determine the productive capacity, pressure, permeability or extent (or a combination of these) of a hydrocarbon reservoir. This would normally consist of wireline testing and the recovery of fluids. During such a test, formation fluids are brought to the surface where pressure, temperature and flow rate measurements are made to evaluate the characteristics of well performance.

A production well test is performed by isolating the zone of interest with temporary packers. One or more valves are opened to produce the reservoir fluids through the drill pipe and allow the well to flow for a time. Fluids are separated and measured on the platform. Following testing, hydrocarbons are sent to a flare boom with a burner to ensure as complete destruction of liquids as possible. Flaring may be initiated using diesel or similar fuel to ignite the mixture. More than one flare boom can be used to ensure that burning can be done downwind of the platform, and water misters may be used to mitigate heat exposure on the rig.

At the end of a production well test, the operator kills the well, closes the valves, removes the packers and trips the tools out of the hole. Depending on the requirements and goals for the test, it may be of short (one hour or less) or long (several days or weeks) duration.

2.10 WELL PLUGGING AND ABANDONMENT

Once drilling activity is completed, the well will be abandoned. Cement will be used to secure the well casing and isolate the wellbore from the formation. A cement plug will also be set near the surface to cap the well. Notice of the intent to abandon the well and the specific techniques to be used will be provided to the GGMC and prior consent received in accordance with the Guyana Petroleum Exploration and Production Act 1986 requirements.

2.11 INFRASTRUCTURE AND FACILITY REQUIREMENTS

EEPGL expects to use an existing local Guyanese shorebase to supply the necessary materials and equipment to the offshore operations described in Section 2.6. A final facility has not been selected at this time, but EEPGL anticipates that it will be located within the Georgetown Port or on the Berbice River.

Field reconnaissance trips are on-going and will continue to be performed to verify the adequacy of existing infrastructure on the Guyana coast for all onshore requirements. Required facilities will include pier/port/quayside space with sufficient draft for receipt of cargo vessels bringing materials to the shorebase and marine support and transport vessels to be used to service the drill rig. A dedicated berth and secure warehousing space for indoor and outdoor storage of materials and goods, trucking, stevedoring, freight forwarding, customs logistics, receiving, inspection and associated container handling and storage operations will also be required.

Daily activities and operations to be performed at the shorebase will include:

- Use of cranes and other heavy lifting equipment;
- Bulk storage of chemicals and fuels including drilling fluids;
- Possible operation of a cement and mud plant to support offshore drilling operations; and
- Secure handling and storage of wastes pending final recycling, treatment, or disposal.

Emergency preparedness and oil spill response supplies will be staged at the shorebase as needed along with those to be maintained on the drill rig, response and support vessels. Additional pipe yards or further offsite storage/warehousing facilities may be necessary depending on holding times for long lead items, and space restrictions or security considerations for select goods and materials needed in advance of drilling.

In addition to the shorebase, support and supply vessels will require sufficient water depths to transit between the well site(s) and the shorebase. Although EEPGL currently has no plans to dredge as part of the Project, some dredging by the shorebase owner/operator may be required to allow safe passage of the vessels. The need for dredging will be determined based on the draft of the vessels and the minimum water depths available on the approach to the shorebase.

2.12 PROJECT TIMELINES

EEPGL's 10-year license term on the Stabroek Block is divided into three periods. Each period has two phases and work commitments vary from phase to phase. The current phase (1st Renewal Period, Phase One) began in June 2012 and expires in June 2014. As described above, the subsequent phase (1st Renewal Period, Phase Two) covers June 2014 to June 2015 and includes a 1 well commitment. If EEPGL decides to enter 1st Renewal Period, Phase Two it must drill a well to comply with the terms of the Agreement.

At this time, the proposed timing for drilling the prospective well(s) is uncertain. It is anticipated that 60 to 90 days will be required to complete each well once the rig is in place. EEPGL is still in the process of determining the exact schedule for the project, but Table 2.3 provides a preliminary sequence of major scheduling milestones for the drilling program and preparatory activities leading up to the drilling activities.

Table 2.3 Preliminary Project Schedule

Activity	Timeframe
Acquire proprietary 3D seismic data	4th quarter 2012 through 1st quarter 2013 (completed)
Proprietary Geological and Geophysical Survey - Geotechnical Site Investigation and Environmental Baseline Survey (EBS)	1st – 2nd quarter 2014
Identifying and securing contractors (drill operators, shorebase, logistical support staff and vessels, etc.)	4th quarter 2013 through 3rd quarter 2014
Mobilization of drill rig to the Stabroek Block	4th quarter 2014
Drilling first well	1st quarter 2015
Vertical Seismic Profile (VSP)	TBD
Drilling second well	TBD
Well Testing	Not planned

2.13 RISK MANAGEMENT SYSTEMS, EQUIPMENT AND PROCEDURES

EEPGL is committed to conducting business in a manner that is compatible with the environmental and economic needs of the communities in which we operate, and that protects the safety, security, and health of our employees, those involved with our operations, our customers, and the public. This risk management programme is described in Section 3.4

3.0 ADMINISTRATIVE FRAMEWORK

The environmental compliance element of the Project will be regulated under several statutes. These statutes contain measures that must be implemented to ensure compliance with applicable policies, guidelines, and legislation in Guyana.

This section reviews the relevant legislations and policies in Guyana that are applicable to the Project and is divided into three subsections. The first subsection describes the national environmental legal framework, which consists of laws which apply to environmental issues in a general context such as the Constitution of Guyana, as well as specific national laws that focus specifically on environmental issues such as the Environmental Protection Act of 1996. This subsection also identifies several resource-specific environmental laws that are more narrowly focused and have either a direct or indirect relevance to the Project.

The following subsection describes the national policy framework, consisting of strategies and policies that apply to the Project. These strategies and policies articulate the government's management goals with respect to various environmental issues, but do not convey the same regulatory power to the government as the statutes described in the first subsection.

Additionally, Guyana is a signatory to a number of international and regional conventions and protocols aimed at addressing environmental concerns. The third and final subsection discusses the international conventions and protocols that are relevant to the Project.

3.1 NATIONAL LEGAL FRAMEWORK

This section provides an overview of the key pieces of legislation currently in force in Guyana that could pertain to resources that could be affected by the Project.

3.1.1 National Constitution of Guyana

Guyana is governed according to the Constitution of the Co-operative Republic of Guyana, as amended. The constitution took effect in 1980 and expressly provides for protection of the environment. Article 25 establishes "improvement of the environment" as a general duty of the citizenry. In addition, Article 36 reads as follows:

"In the interests of the present and future generations, the State will protect and make rational use of its land, mineral and water resources, as well as its fauna and flora, and will take all appropriate measures to conserve and improve the environment." (OAS, 2013).

3.1.2 The Environmental Protection Act

In 1996 the Environmental Protection Act (hereinafter referred to as the Act) was enacted to implement the environmental provisions of the Constitution. The Act is Guyana's single most significant piece of environmental legislation because it articulates national policy on important environmental topics such as pollution control, the requirements for environmental review of projects that could potentially impact the environment, and the penalties for environmental infractions. It also provides for the establishment of an environmental trust fund. Most importantly, the Act authorized the formation of the Environmental Protection Agency (EPA), and establishes the EPA as the lead agency on environmental matters in Guyana (FAO, 2013). The Act further mandates the EPA to oversee the effective management, conservation, protection and improvement of the environment (EPA, 2012). It also requires the EPA to take the necessary measures to ensure the prevention and control of pollution, assessment of the impact of economic development on the environment, and the sustainable use of natural resources.

3.1.3 The Guyana Geology and Mines Commission Act

The Guyana Geology and Mines Commission Act was enacted in 1979 and authorized the government to establish the Guyana Geology and Mines Commission (GGMC). The GGMC promotes and regulates the exploration and development of the country's mineral resources. The GGMC has a dedicated petroleum division, but petroleum related activities also occur in other divisions, such as the Geological Services division and the Environment Division. The GGMC's most important role with respect to the Project is related to EEPGL's Prospecting License, under which offshore drilling would be conducted.

3.1.4 *Resource-Specific National Environmental and Social Laws*

Several additional Guyanese environmental laws with more narrowly defined scopes pertain to specific biological or physical natural resources. Other laws which have a primarily public health-related focus are also indirectly related to the environment. A few of Guyana's environmental statutes were enacted prior to the 1980 Constitution and were subsequently incorporated into the newly formed national legal framework, but most were enacted after 1980. Table 3.1 identifies these laws and summarizes their relevance to the Project.

Table 3.1 Resource-Specific Environmental and Social Laws

Title	Objective	Relevance to the Project
	Biological Resources	
Aquatic Wildlife Control Regulation, 1996	Regulates fishing and related activities in Guyana territorial waters.	Section 33(1) of the Fisheries Act authorizes the prohibition and/or regulation of deposition or discharge of substances harmful to fish, including wastewater.
	Physical Resources	
Petroleum (Exploration and Production) Act	Identifies persons allowed to hold prospecting licenses, establishes process for obtaining prospecting licenses, and requirements in the event petroleum resources are discovered. Also regulates activities related to the storage, transportation, use, sale, and testing of petroleum.	Exploration-multiple nexuses to the Project, including the process for obtaining a license and the requirements of the license. Production-Sections 5 and 10 regulate the keeping and usage of petroleum in machines, respectively.
Environmental Protection Water Quality Regulations, 2000	Focused on setting effluent standards, reporting requirements, penalties for violations of standards, and permitting requirements for discharges.	Regulates discharges of controlled substances, which could include substances used during the Project.
Environmental Protection Air Quality Regulations, 2000	Sets ambient air quality standards, reporting requirements, penalties for violations of standards, and permitting requirements for stationary and mobile sources.	Regulates discharges of several pollutants which could be emitted during the Project, including smoke, particulates, and carbon monoxide.
Environmental Protection Hazardous Waste Regulations, 2000	Establishes requirements for generating, handling, and disposing of hazardous waste as well as penalties for violations of these requirements.	Identifies wastes subject to regulation, including several types of waste that could be produced by the Project.

Title	Objective	Relevance to the Project
Toxic Chemicals Control Act No. 13 of 2000	Provides for the formation of a Pesticides and Toxic Chemicals Control Board. Establishes requirements for registration, licensure, and trade in pesticides and toxic chemicals. Amended in 2007 to provide rules for the exportation of pesticides and toxic chemicals.	Establishes regulations pertaining to the use of toxic chemicals and pesticides. Pesticides will not be required for this Project, but small amounts of toxic chemicals may be used.
	Public Health	
Occupational Safety and Health Act, 1997	Legally defines the responsibilities of workers and management with respect to keeping workplaces safe.	Would generally apply to workers and Project-related activities on the Project site(s).
Food & Drug Regulations (Food and Drug Act)	Regulates the sale, advertisement, preparation, and handling of food products. Regulates the manufacture, advertisement, trade, and administration of pharmaceuticals. Also provides Ministry of Health authority to inspect facilities to establish compliance with sanitation standards.	Governs the preparation of food and provision of drugs at Project facilities.
National Trust Act	Stewardship of historic resources and places of cultural significance	Governs the management of any building, structure, object, or other man-made or natural feature that is of historic or national cultural significance that could be impacted by the Project. Includes shipwrecks and other marine features.

3.2 *NATIONAL POLICY FRAMEWORK*

Guyana's government has articulated national policies on several environmental and social topics that are relevant to the Project. This section provides an overview of the key government policy documents pertaining to resources that could be affected by the Project.

3.2.1 *National Development Strategy*

The National Development Strategy (NDS) sets priorities for Guyana's economic and social development policies for the next decade. The draft document contains careful technical analysis of problems and future prospects in all sectors of the economy and in areas of social concern. The NDS contains six volumes. Volumes 3 and 5 are the most relevant to the Project. Volume 3 of the NDS sets government policy with regard to the environment as well as social equality issues. It identifies 12 distinct "features" of Guyana's natural resources and environment, and sets policies governing the management of each feature. Relevant features to this Project covered under Volume 3 include the coastal zone, fisheries, waste management and the pollution control, and environmental impacts of private-sector activities (NDS, 1997).

Volume 5 relates in part to the energy sector. It describes the condition of the energy sector in Guyana, reviews past government policies related to the energy sector, identifies challenges facing the energy sector in Guyana, and describes the government's vision for development and regulation of the sector into the future (NDS, 1997).

3.2.2 National Environmental Action Plan

Guyana's National Environmental Action Plan (NEAP) articulates the national government's approach to managing the environment from the perspective of economic development. The NEAP considers the issues of environmental management, economic development, social justice, and public health to be inextricably linked. It identifies deforestation, pollution, and unregulated gold mining as historically minor but growing environmental problems, and identifies private sector investment as one of the primary opportunities to generate the necessary capacity within Guyana to 1) provide an appropriate level of public services to its citizens; 2) reduce and/or eliminate the avoidable environmental degradation that occurs when resource development occurs in a regulatory vacuum, and 3) reduce unsustainable uses of natural resources due to the socioeconomic pressures of widespread poverty.

The NEAP is directly relevant to the Project in several ways. It identifies the coastal zone, which will support Project activities, as an area in need of focused management action due to the concentrated human population along the coast and the susceptibility of the coastal environment to both natural and human-induced degradation. It identifies private sector-led development projects as a mechanism to build capacity and ultimately support more responsible environmental management. Finally, it identifies petroleum resources as a potential target for development.

3.2.3 Integrated Coastal Zone Management Plan

Guyana's Integrated Coastal Zone Management (ICZM) process is an ongoing initiative to promote the wise use, development and protection of coastal and marine resources; enhance collaboration among sectorial agencies, and promote economic development. In 2001, the Integrated Coastal Zone Management committee produced an Action Plan for Integrated Coastal Zone Management after two years of study. The Plan, which has been approved by Cabinet, addresses policy development, analysis and planning, coordination, public awareness building and education, control and compliance, monitoring and measurement and information management (GLSC, 2006). Apart from preparing the plan and having it approved by the Cabinet, other coastal-zone related tasks currently being undertaken by the Government include strengthening of the institutional setup for integrated coastal zone management; a public awareness campaign to increase public understanding of the vulnerability of the coastal zone to sea level rise and climate change; and the creation of a database of coastal resources to facilitate improved integrated coastal zone management.

Under the Caribbean Planning for Adaptation to Climate Change (CPACC) project Guyana has also conducted a socioeconomic assessment of sea-level rise as part of a wider vulnerability assessment and developed a Climate Change Adaptation Policy and Implementation Strategy for coastal and low-lying areas.

3.3 INTERNATIONAL CONVENTIONS AND PROTOCOLS

Guyana is signatory to a number of international agreements and conventions relating to environmental management and community rights. The international conventions are not always translated into national legislation. The key agreements relevant to the Project to which Guyana has acceded or is a signatory are listed in Table 3.2.

Table 3.2 International Agreements Relevant to Environmental and Social Issues in Guyana

Agreement/ Convention	Objective	Status	Relevance to Project
Air Quality			
United Nations Framework Convention on Climate Change (UNFCCC)	Promote international cooperation to limit average temperature increases and resulting changes in climate. Promote international cooperation to adapt to these impacts.	Acceded and ratified in 1994	Provides for controls on greenhouse gas emissions within Guyana's territory (maritime and land), and establishes national policy regarding adaptation to climate change.
Pollution Prevention			
MARPOL 73/78	Regulates various forms of marine pollution, including oil and fuel, noxious liquid, hazardous substances, sewage, garbage, air emissions, and ballast water.	Acceded in 1997	Affects the handling and disposition of controlled substances from the rig and support vessels.

Agreement/ Convention	Objective	Status	Relevance to Project
International Convention for Safe Containers (CSC)	Promote the safe transport and handling of containers through generally acceptable test procedures and related strength requirements, and facilitate the international transport of containers by providing uniform international safety regulations, equally applicable to all modes of surface transport.	Acceded in 1997	Regulates the manufacture, use, and integrity of containers used on board the rig and support vessels.
Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal	Reduce and control the movements of hazardous waste between nations and discourage transfer of hazardous waste from developed to less developed countries.	Acceded in 2001	Would apply to the Project only if hazardous waste generated in Guyana were disposed outside Guyana, or if hazardous waste was brought into Guyana from a foreign state for disposal during execution of the Project.
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Provides a mechanism for formally obtaining and disseminating decisions of party nations as to whether they wish to receive future shipments of listed chemicals, and for ensuring compliance with these decisions by exporting party nations.	Acceded June 2007	Would apply to the Project only if chemicals and/or pesticides listed under the convention were shipped into or out of Guyana.
Stockholm Convention on Persistent Organic Pollutants (POPs), as amended	Requires party nations to take measures to eliminate or reduce the release of persistent organic pollutants.	Acceded September 2007	Would apply to the Project only if POPs were released to the environment during the course of project-related activities in Guyana.
Ecological/Environmental Quality			
The Cartagena Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region	Provide framework for international protection and development of the marine environment across the Caribbean region.	Acceded and Ratified in 2010	Sets general goals for protection for the marine environment, especially from pollution.

Agreement/ Convention	Objective	Status	Relevance to Project
Protocol on Specially Protected Areas and Wildlife (SPAW)	Protocol supplementing and supporting the Cartagena Convention. Requires signatories to adopt an ecosystem approach to conservation. Provides mechanism for compliance with the Convention on Biological Diversity.	Acceded and Ratified in 2010	Elaborates on the wildlife goals established in the Cartagena Convention and Convention on Biological Diversity.
Convention on Biological Diversity	Promotes biological conservation within the framework of sustainable development and use of biological resources, and the fair and equitable sharing of benefits of genetic resources.	Signed in 1992, ratified in 1994	Discourages activities that would negatively impact biodiversity.
Labor/Health/Safety			
International Convention for the Safety of Life at Sea (SOLAS)	Specifies minimum standards for the construction, equipment and operation of vessels, compatible with their safety. Allows governments of participating states to inspect vessels flagged in other participating states to ensure compliance.	Acceded in 1997	Affects construction, operation, and equipment on board the rig and support vessels.
Convention on the International Regulations for Preventing Collisions at Sea (COLREG)	Officially recognizes the importance of traffic separation in the marine environment and codifies basic measures to accommodate traffic separation, including safe speed, signalling conventions, and general vessel conduct.	Acceded in 1997	Governs operation of rig and support vessels.
International Convention on Standards of Training, Certification and Watchkeeping (STCW)	Obligates crews operating vessels flagged in signatory states to adhere to minimum standards relating to training, certification and watchkeeping. Requires signatory states to submit detailed information to IMO concerning administrative measures taken to ensure compliance with the convention.	Acceded in 1997	Affects required capabilities of crew on board the rig and support vessels, and provides for inspection by Guyanese authorities to ensure compliance.
Convention on Facilitation of International Maritime Traffic (FAL)	Prevent unnecessary delays in maritime traffic arising from burdensome documentation requirements, and establish uniform formalities and other procedures to permit transboundary maritime commerce and travel.	Acceded in 1998	Facilitates entry of rig and support vessels into Guyana.

Agreement/ Convention	Objective	Status	Relevance to Project
Miscellaneous			
United Nations Agenda21	Promote sustainable development through various initiatives.		

3.4 *CORPORATE REQUIREMENTS AND GUIDELINES*

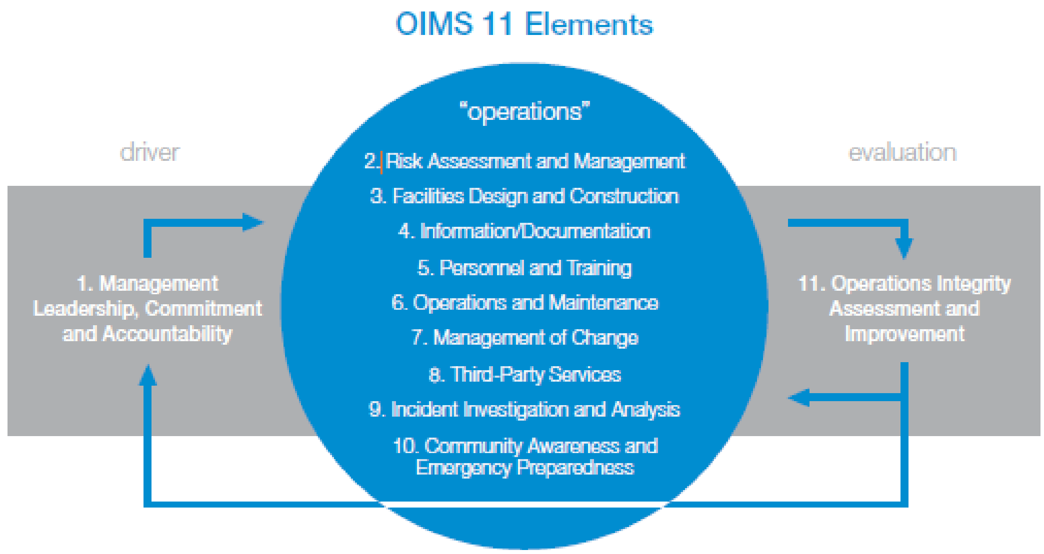
3.4.1 *Operations Integrity Management System (OIMS)*

EEPGL is committed to conducting business in a manner that is compatible with the environmental and economic needs of the communities in which it operates, and that protects the safety, security, and health of its employees, those involved with its operations, its customers, and the public. These commitments are documented in its Safety, Security, Health, Environmental, and Product Safety policies. These policies are put into practice through a disciplined management framework called the Operations Integrity Management System (OIMS). The Company's management framework is consistent with the OIMS process and its requirements for all Company affiliated operations.

EEPGL's OIMS Framework establishes common expectations used by affiliates worldwide for addressing risks inherent in its business. The term Operations Integrity (OI) is used to address all aspects of its business that can impact personnel and process safety, security, health, and environmental performance.

Application of the OIMS Framework is required across all Company affiliates, with particular emphasis on design, construction and operations. Management is responsible for ensuring that management systems satisfying the Framework are in place. The scope, priority and pace of management system implementation will be consistent with the risks associated with the business activities being planned and performed. Figure 3.1 below provides a high level description of the OIMS Framework and its essential Elements.

Figure 3.1 Operations Integrity Management System



3.4.2 *Risk Assessments and Hazard Recognition*

Comprehensive risk assessments are used to reduce safety, health, environmental and security risks and mitigate the consequences of incidents by providing essential information for decision-making.

Risk is managed by identifying hazards, assessing consequences and probabilities, and evaluating and implementing prevention and mitigation measures. A risk assessment will be performed for this project in order to identify and address potential hazards to personnel, facilities, the public and the environment. Assessed risks are addressed by specified levels of management appropriate to the nature and magnitude of the risk, and decisions are clearly documented. A follow-up process is in place to ensure that risk management decisions are implemented.

4.0 *THE STRATEGIC ENVIRONMENTAL ASSESSMENT PROCESS*

In accordance with Section 11 (2) of the Environmental Protection Act, 1996, the EPA determined that an Environmental Impact Assessment (EIA) was not required. The Applications for Environmental Authorisation for the Liza-1 and Sorubim-1 Exploration Wells were screened to assess the potential environmental impacts and it was determined by the EPA that the projects would not significantly affect the environment once relevant mechanisms are implemented to mitigate possible impacts.

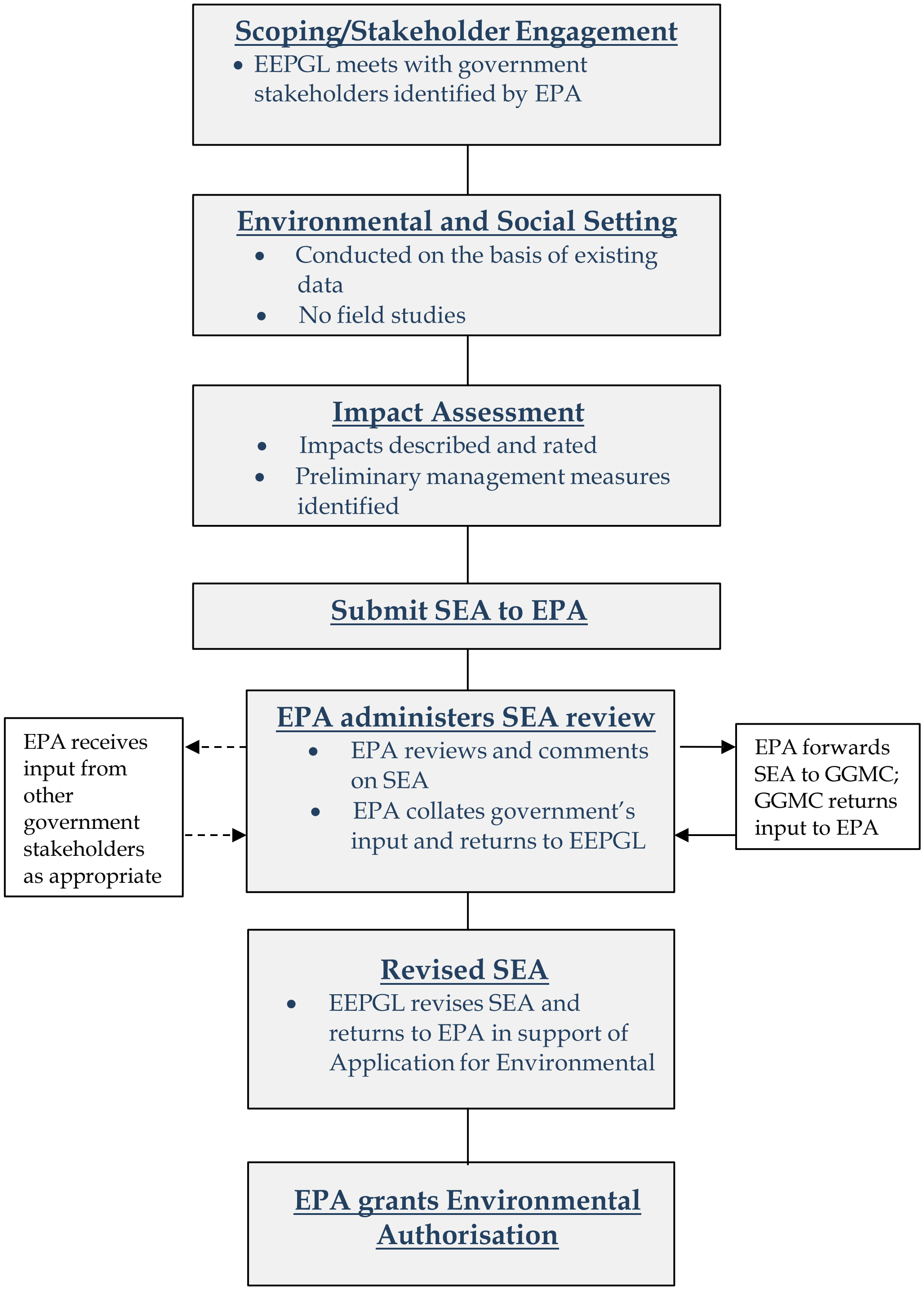
The EPA ordered that a Strategic Environmental Assessment (SEA) be conducted, which is both a compliance-oriented and a decision-making document. Its primary purpose is to support EEPGL's applications for Environmental Authorisation to execute the Project as required by the EPA. The SEA identifies potential impacts associated with the Project; assists both EEPGL and regulators identify impacts that may warrant further analysis, if the Project is implemented; and determines the appropriate level of supplementary analysis (if necessary) to document those impacts.

A Notice to the Public was issued inviting any person who may be affected by this project to submit their comments or lodge an appeal with the Environmental Assessment Board within thirty (30) days of the date of the Notice per the provisions of the Environmental Protection Act, 1996, Environmental Protection (Amendment) Act, 2005, and the Environmental Protection Regulations, 2000. No comments or appeals were received during this time.

During this period the Project Description and Draft Terms of Reference for the SEA were made available. EEPGL has and continues to engage government and non-governmental stakeholders as the approval process progresses. Figure 4.1 illustrates the proposed SEA process for the Project. The following paragraphs describe each of the major components of the process.

EEPGL has contracted Environmental Resources Management, Inc. (ERM), a global environmental and sustainability consultancy to conduct the SEA for this project. ERM has over 30 years of experience conducting impact assessments for the oil and gas industry worldwide, and has previous impact assessment experience in Guyana.

Figure 4.1 The SEA Process for the Stabroek Exploratory Drilling Project



4.1 SCOPING AND STAKEHOLDER ENGAGEMENT PHASE

The SEA process includes a limited stakeholder engagement component. As per guidance received from the EPA, public consultation is not required at the SEA stage, but engagement and consultation with government and regulatory stakeholders is encouraged and has been undertaken as part of this draft SEA. The stakeholder engagement and consultation component are on-going and important parts of the SEA process.

Government and Non-Governmental Organizations (NGOs) that have been consulted or have been identified as stakeholders in the SEA process are listed in Table 4.1. In cases where specific divisions or authorities within larger government ministries have been identified as stakeholders, these entities have been incorporated in the bulleted lists below the relevant ministry.

Table 4.1 Governmental and NGO Stakeholders

Governmental Stakeholders	Non-Governmental Stakeholders
Ministry of Natural Resources and Environment • Guyana Geology and Mines Commission • Environmental Protection Agency • Guyana Protected Areas Commission	Guyana Marine Turtle Conservation Society
Guyana Elections Commission	Guyana Mangrove Restoration Project (GMRP)
Environmental Assessment Board	Trawlers Association
Ministry of Agriculture	
Ministry of Amerindian Affairs	
National Agriculture Research and Extension Institute • Pesticide and Toxic Chemical Board	
Ministry of Culture, Youth, and Sports • National Trust of Guyana • Walter Ruth Museum of Anthropology	
Ministry of Finance	
Ministry of Foreign Affairs	
Ministry of Foreign Trade and International Cooperation	
Ministry of Housing and Water	

Governmental Stakeholders	Non-Governmental Stakeholders
• Central Housing and Planning Authority	
Ministry of Public Works • Stabroek Harbour Master • Maritime Administration • Transport and Harbours Department • Sea and River Defense Department • Civil Aviation Authority	
Office of the President • Guyana Defence Force	
Civil Defence Commission	
Ministry of Labour • Occupational Safety and Health Department	
Georgetown Public Hospital	
Ministry of Health • Environmental Health Department • Georgetown Public Hospital	

4.2 ENVIRONMENTAL AND SOCIAL SETTING PHASE

The environmental and social setting is divided into three main resource categories: physical resources, biological resources, and socioeconomic resources. Each resource category is further divided into specific resources. Each of the following resources within the physical, biological, and socioeconomic resource categories is described in the environmental and social setting:

- Physical Resources:
  - Coastal Oceanography and Bathymetry;
  - Marine Water Quality;
  - Coastal and Marine Geological Resources;
  - Air Quality.

- Biological Resources:
  - Coastal and Marine Habitats;
  - Marine Reptiles ;
  - Marine Mammals;
  - Marine Finfish;
  - Seabirds;
  - Benthic Resources;
  - Special Status Species.

- Socioeconomic and Cultural Resources:
  - Demographics;
  - Cultural and Archaeological Resources ;
  - Fisheries and Aquaculture ;
  - Navigation and Marine Transport;
  - Land Transport;
  - Tourism and Recreation;
  - Oil Industry Infrastructure.

The environmental and social setting was established based on existing information to describe the current conditions in the offshore environment in the vicinity of the Stabroek Block, as well as onshore in the coastal areas immediately south of the Stabroek Block. ERM has collected and reviewed available environmental and social data contained from external sources including the scientific literature, non-governmental organizations, research institutions, government agencies, and industry groups. To the extent that it is applicable and available, ERM has also incorporated publicly available information from previous projects of similar scope and magnitude in Guyana. Finally, the environmental and social setting also incorporates input received from the various agency stakeholders consulted during the scoping/stakeholder engagement process.

4.3 IMPACT ASSESSMENT PHASE

The Impact Assessment Phase assesses the significance of the potential impacts identified during scoping (including cumulative effects), and identifies mitigation measures that will reduce negative impacts and/or enhance benefits. During the Impact Assessment Phase, an Environmental and Social Management Plan (ESMP) has also been prepared to guide environmental and social management issues during the operational and subsequent phases of the Project. The key objectives of the SEA and ESMP are to:

- Document and contextualize the ecological and socioeconomic conditions of the study area and the potentially affected communities;
- Inform and obtain contributions from stakeholders, including governmental authorities, the public, and indigenous communities and address their relevant issues and concerns;
- Assess in detail the potential environmental and social impacts that could result from the project;
- Identify environmental and social mitigation measures to address the impacts assessed;
- Develop the ESMPs as discussed above, based on the mitigation measures developed in the SEA;
- Meet the requirements of the environmental regulations in Guyana; and
- Be consistent with EEPGL's policies and corporate values.

4.3.1 Impact Assessment Methodology

For the purposes of the SEA, an "impact" is defined as "any alteration of existing conditions, adverse or beneficial, caused directly or indirectly by the Project." Existing conditions are described in the environmental and social setting, so the impact assessment process is essentially a comparative process that identifies differences between existing and future physical, biological, or socioeconomic conditions that are directly or indirectly attributable to the Project.

Information on potential impacts, including potential cumulative effects generated from the activities required to construct and operate the Project, were obtained from various sources including consultation with the EPA and GGMC as well as other governmental and agency stakeholders, impact assessments for other similar projects worldwide; and literature and research.

To identify potential and assess impacts associated with or resulting from project activities, the project team used desk-top analysis, input from stakeholders, and professional judgment to identify and assess potential impacts and their interactions. The methodology that was used to identify and assess the potential impacts of the Proposed Projects is described in the following sections.

4.3.2 *Steps of Impact Assessment*

Impact Assessment takes place as follows:

1. Identify sources of impacts and the potential impacts themselves that are generated by any aspect of the Projects.
2. Describe the specific characteristics of each impact.
3. Rate the significance of each impact based on the characteristics described in Step 2.
4. Suggest mitigation and enhancement measures to address the impact.

4.3.3 *Why a System for Rating Impacts?*

It is standard impact assessment practice to "rate" potential impacts:

- To provide a basis for prioritization of impacts to be managed;
- To provide a method of assessing the effectiveness of proposed mitigation measures; and
- To provide a scale which shows the level of impact both before and after a proposed mitigation measure has been applied.

As described above, the SEA is intended to support EEPGL's Applications for Environmental Authorisation. This requires analytical rigor to ensure that the potential impacts associated with the Project are well documented. The SEA is also intended to assist in the identification of impacts that warrant further analysis and management (if any). This requires an accurate assessment of the relative importance of each impact. The rating process accomplishes both of these goals by rigorously and objectively describing impacts consistently across resource types.

4.3.4 *Criteria for Rating Impacts*

An impact rating is the product of two elements: (1) the magnitude of the potential impact and (2) the sensitivity/vulnerability/importance of a given impact or receptor. These elements are described in greater detail below.

4.3.4.1 *Magnitude Element*

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource or receptor. Magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood (for unplanned events only).

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to determine where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes will be regarded as essentially having no impact, and will be characterized as having a *negligible* magnitude.

Taking into account the impact characteristics identified above, the magnitude of all potential impacts in this SEA will be assigned one of the following five ratings:

- Positive;
- Negligible;
- Small;
- Medium; or
- Large.

Given the differences inherent between resources/receptors (and in many cases between different types of impacts to a given resource/receptor), the definitions of the magnitude designations (i.e., the methodologies used to combine the various impact characteristics and conclude a magnitude designation) are defined differently according to the resource/receptor (or the type of impact) in question. Methods for predicting and evaluating potential impacts cover a spectrum from those that are quantitative in nature, to those that are qualitative. Quantitative information has been integrated into the SEA where available and appropriate, but as described in Section 3.2, the SEA was based on existing information so many of the resource-specific evaluations are qualitative. If the SEA identifies specific impacts that warrant further evaluation, it is expected that the supplemental assessment(s) of those impacts would be more quantitative to the extent practicable.

4.3.4.2 *Sensitivity / Vulnerability / Importance*

A range of factors have been taken into account when defining the sensitivity/vulnerability/importance of a resource/receptor, which may be physical, biological, or social and cultural. Where the resource is physical (for example, marine water quality) its sensitivity to change and importance has been considered. Where the resource/receptor is biological or cultural (for example, a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact has been considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group has been considered. Other factors may also be considered when characterizing sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views, and economic value.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions of the designations vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations used in this SEA are:

- Low;
- Medium; and
- High.

4.3.5 *Determining the Rating*

The overall rating of the potential impacts is determined by using the following matrix (Figure 4.2). It should be noted that the matrix acts as a guide and there may be situations where its rigid application is inappropriate and where stakeholder perceptions and feedback have a significant role to play. For specific impacts where this is the case, the rating will be clearly explained in the evaluation of the impact.

Figure 4.2 does not include positive impacts because the primary purpose of the rating matrix is to identify impacts which require further analysis or mitigation, but mitigation is not required in the case of positive impacts. Magnitudes are therefore generally not assigned in the case of positive impacts unless there is ample data to support a more robust characterization, or a specific requirement to assess magnitude. It is usually sufficient to indicate that the Project will result in a positive impact, without characterizing the exact degree of positive change likely to occur.

Figure 4.2 Rating Matrix

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Based on the final impact ratings in the SEA, certain potential impacts may warrant further analysis. The Conclusions and Management section of the SEA summarizes the findings of the SEA and recommends further supplementary analyses. The scope of any such supplemental analysis will be determined on the basis of consultations between EEPGL, the EPA, GGMC, and other appropriate governmental/regulatory agencies in Guyana.

4.4 *ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN*

A key output of the SEA is the Environmental and Social Management Plan (ESMP). The ESMP will outline the project-specific management and mitigation actions aimed at avoiding and reducing the potential impacts of the Project, as identified in the SEA. The ESMP along with the supporting Operations Integrity Management System implemented by EEPGL will address those Safety, Security, Health and Environmental (SSH&E) risks associated with the Project and establish the standard operating procedures to be applied by the Project.

EEPGL and its drilling contractor will use the oil and gas industry standard tiered preparedness and response system to ensure that appropriate resources can be mobilized rapidly to provide an effective response to any release, whether the event is considered Tier 1, Tier 2 or Tier 3.

Specific components of the ESMP will include:

- Project-specific Emergency Response Plan (ERP), including an Oil Spill Response Plan (OSRP);
- Project-specific Waste Management Plan;
- Environmental and Socioeconomic Management and Monitoring requirements;
- Completion of a "Bridging" process with the drilling contractor to evaluate the contractor's SSH&E plans and ensure that any gaps in routine SSH&E management are closed.

5.0 ENVIRONMENTAL AND SOCIAL SETTING

5.1 PHYSICAL RESOURCES

5.1.1 Coastal Oceanography and Bathymetry

Oceanography

Guyana's marine environment is bounded by, and heavily influenced by, the Orinoco and Amazon Rivers in Venezuela and Brazil, respectively. During the rainy season Guyana's coastal marine waters receive heavy sediment discharges of fresh water from these major rivers, as well as Guyana's own Essequibo, Demerara and Berbice rivers (FAO, 2012).

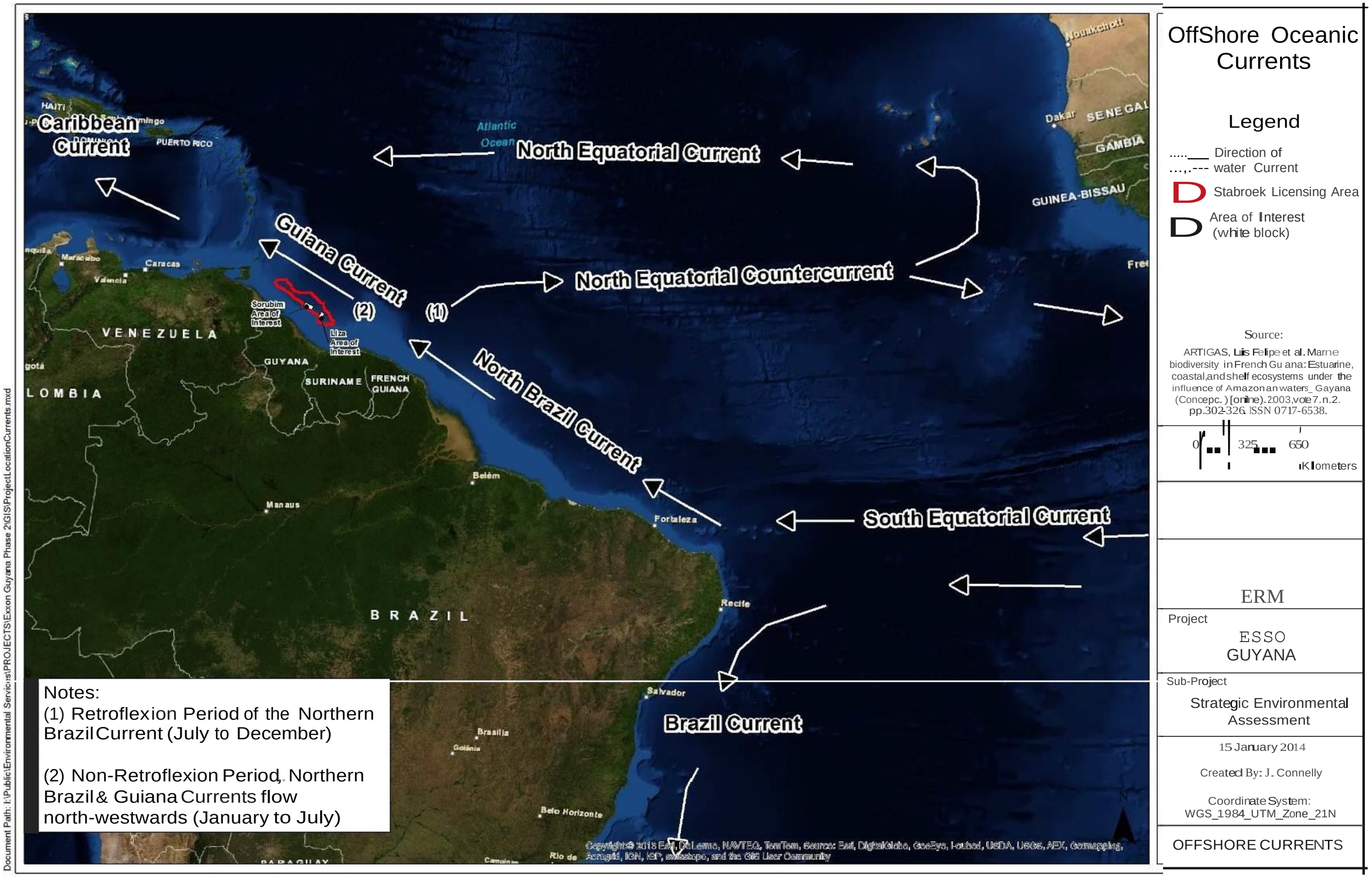
Guyana's marine waters are crossed by the Guiana Current, which derives from the North Brazil Current (NBC) flowing north along the northeastern coast of South America from northern Brazil toward the southeastern Caribbean Sea. As it reaches French Guiana, part of the NBC separates from the coast to join the North Equatorial Counter Current while the rest continues flowing northwest to form the Guiana Current. Figure 5.1 illustrates the proximity of the Guiana Current, NBC, and North Equatorial Counter Current to the Stabroek Block and the Sorubim and Liza Areas of Interest.

During spring tide, the current can extend as far as 300 nautical miles offshore to cover Guyana's entire continental shelf. The Guiana Current's highest velocities tend to occur along the edge of the continental shelf, which is located near the southern boundary of the Stabroek Block (Figure 5.2). Fluctuations in the Intertropical Convergence Zone and the trade winds lead to significant variation in the strength of the Guiana Current and the extent of its influence offshore, but maximum speeds generally occur in April-May, while minimum speeds commonly occur in September (Gyory et al., 2013).

Bathymetry

The width of the continental shelf offshore Guyana ranges from 150 to 165 km between the Guyana-Suriname border and the mouth of the Essequibo River, to about 75km west of the Essequibo River (NFMDP, 1995). The continental slope begins at depths from 90m to 100m (Repsol, 2009). The continental slope descends to depths of several thousand meters. The continental slope occupies the central portion of the Stabroek Block including the Sorubim and Liza Areas of Interest. Depths gradually increase across the block from approximately 200-500m in the southeastern corner of the Stabroek Block to nearly 3,000m along its north-central boundary.

Figure 5.1 Marine Currents in the Vidnity of the Project Area



5.1.2 *Marine Water Quality*

The hydrographic and isohaline conditions in Guyana's coastal marine waters are greatly affected by the outflow of the coastal rivers in the region, as described in Section 5.1.1. The large amount of freshwater discharge affects ocean salinity and temperature. Oceanic water is relatively heavy, cold, and saline compared to the fresh, warm, and lighter water of the Amazon and Orinoco plumes, which converge offshore Guyana. These convergences form oceanic fronts offshore Guyana. Freshwater lenses generated by the Amazon and Orinoco Rivers are transported across Guyana's continental shelf to points north and west. These lenses persist for months, and have been detected as far away as Barbados and Trinidad (Sherman and Hempel, 2009).

The entire region offshore Guyana is considered part of the North Brazil Shelf Large Marine Ecosystem (LME). The North Brazil LME has alternately warmed and cooled over the last few decades. A period of cooling lasted from the mid 1970's through the mid-1990's but since the mid-1990's the LME has consistently warmed (Sherman and Hempel, 2009). Although the ocean temperature has alternately warmed and cooled in recent decades, the net change in water temperature over the last 50 years equates to an average increase of +0.22 ˚C per year (Sherman and Hempel, 2009).

As described above, the marine environment offshore Guyana is affected by several coastal rivers, but the Amazon River with its average discharge of 180,000 m^3/sec (Nittrouer and De Master, 1987 in Charlier, 2001), is the most prominent factor in marine water quality in the region. Analysis of the nutrient content of the Amazonian plume has shown that there is little seasonal variation of the plume's nutrient content (silicates, 144 µmol.kg-1, phosphates, 0.7 µmol.kg-1, nitrates, 16 µmol.kg-1, etc.) (De Master and Pope, 1996 in Charlier, 2001). It has been estimated that 40 to 50% of the annual Amazon run-off transits along the coast of the Guianas.

5.1.3 *Coastal and Marine Geological Resources*

Coastal Geology

Guyana's coastline is 432 km long (NDS,1997). The Guyana Coast is a sedimentary plain that has formed from successive deposits of sediment. A series of low dunes cross the coast from east to west. These dunes are connected with submarine features that also move across the shallow continental shelf driven by the Guiana Current. These coastal/submarine ridges present a minor impediment to shipping because they require continuous dredging of a shipping channel to allow ships to reach the docks.

Marine Stratigraphy

The Guyana basin has been described as a passive margin basin associated with the rifting and opening of the North Atlantic Ocean. Part of the Guyana Basin is onshore but most of it occurs offshore. Table 5.1 summarizes the age and composition of the major geologic formations that comprise the Guyana basin (Workman, 2000; CGX, 2009).

Table 5.1 Major Geologic Formations of the Guyana Basin

Formation	Age	Composition
Corentyne	Pleistocene-Pliocene	Sand and shale
Pomeroon	Miocene-Eocene	Carbonate sand and shale
Georgetown	Maastrichtian	Sand, shale and carbonate
New Amsterdam	Maastrichtian to Lower Tertiary	Sand and shale
Canje	Cenomanian to Turonian	Organic shale
Potoco Formation	Aptian	Carbonates
Stabroek Formation	Cretaceous–Barremian	Basal shales and sands of continental origin
Precambrian Basement	Proterozoic-Hadean	Metamorphic rock

Marine Sedimentology

Fine clay and mud sediment are transported from the mouth of the Amazon River and are deposited along Guyana's coast to an average thickness of 20m across Guyana's continental shelf. Beyond this point, sand gradually becomes the dominant feature. The bathymetric profile of the continental shelf forms a generally smooth, gradual slope from nearshore to shelf edge, but a series of low mud ridges extend approximately 20 to 40 km offshore. These submarine ridges migrate along the coast at a rate of approximately 1 km/year.

Although the Amazon, Essequibo, Orinoco, and several other smaller rivers discharge large quantities of fine sediment which are subsequently transported across the continental shelf of the Guianas, analysis of the humic content, nutrient composition, and ratio of surface area to mass of Guyanese marine sediments indicate that they are nearly identical to Amazonian sediments and unlike continental Guyanese sediments (Eisma and van der Marel, 1971). This evidence strongly indicates that from a sedimentary perspective, the Guyanese continental shelf functions as a marine extension of the Amazonian delta system. At greater depths, calcarenite (coral fragment) substrates become more prevalent (Strømme and Sætersdal., 1989). The Stabroek Block occupies the transition area between the Amazonian-influenced zone and the older, deeper calcarenite zones.

5.1.4 Air Quality

There are no air quality stations in the vicinity of the Stabroek Block from which data can be derived to assess offshore air quality, so the likely air quality within the block must be inferred from its proximity to likely sources of pollution. The Stabroek Block is well offshore and far removed from any permanent sources of airborne pollution, therefore ambient air quality within the block is expected to be good.

Guyana has a wet tropical climate characterized by two pronounced wet seasons and year-round warm temperatures. This bimodal wet/dry regime is caused by the annual migration of the Inter-Tropical Convergence Zone (ITCZ) which changes latitude based on the sun's position. Northward movement of the ITCZ occurs as the sun moves into the northern hemisphere during the northern hemisphere's summer, thereby increasing solar heating and thunderstorm activity and bringing heavy rainfall between mid-April and the ending of July, with peak rainfall in June. This is known in Guyana as the primary wet season.

Guyana observes a secondary wet season during the southward migration of the ITCZ from mid-November and the ending of January, with peak rainfall in December. The intervening periods (January to April and mid-August to mid-November) are relatively dry, but rain can occur at any time of the year. Average annual rainfall totals range between 1,778mm (70in) and 2,800mm (110in) (Hydromet, 2014). During El Niño years, Guyana's long dry season is often drier and warmer than normal.

Although the ITCZ moves seasonally, it is generally located between 5 degrees North and 5 degrees South latitude. North and south of the ITCZ, atmospheric circulation and the Coriolis effect create global wind patterns including the Western hemisphere's trade winds and westerlies (NOAA, 2008). Guyana's coastal zone is located approximately between 6 and 8 degrees latitude and the Stabroek Block is located between 7 and 8 degrees latitude, both within the southern portion of the area affected by the trade winds. The influence of the trade winds produces a strongly dominant northeast wind offshore Guyana, which gives rise to the afternoon "sea breeze" that usually blows inland across coastal Guyana from the ocean in the afternoon.

Annual average temperatures in coastal Guyana are relatively constant, with an annual average daytime maximum temperature of 29.6°C and an annual average nighttime minimum temperature of 24.0°C. The average daily temperature is approximately 27° C. Relative humidity is high at 80% or more year round in the coastal zone.

5.1.5 Natural Hazards

For the purposes of this assessment natural hazards include environmental phenomena that, because of their location, severity, and frequency, have the potential to adversely affect the lives, health, property, or general wellbeing of humans.

UNISDR Risk Ratings for Guyana

The United Nations International Strategy for Disaster Reduction (UNISDR) indicates that over the last century the most common natural disasters to affect people in Guyana are droughts and floods (UNISDR, 2014; EM-DAT, 2010) (see Table 5.2).

Guyana's topography and population distribution causes its population to be vulnerable to floods. Guyana's coastline is low and flat, and most of the country's population and infrastructure (including the capital city of Georgetown) are located along the coast. Uncontrolled breaches of sea defenses due to unanticipated high tides and deterioration of the sea defense system adversely affect transportation, safety, and agricultural production.

Table 5.2 Top five years for Natural Disasters in Guyana from 1900-2014

Type of Disaster	Year	Persons Affected
Drought	1997	607,200
Flood	2005	274,774
Flood	2008	100,000
Flood	1996	38,000
Flood	2006	35,000

Source: EM-DAT, 2010.

SEDAC Risk Ratings

The United States National Aeronautics and Space Administration Socioeconomic Data and Applications Center (SEDAC)[2], has estimated global risk levels for six major categories of natural hazards: earthquakes, volcanoes, landslides, floods, drought, and cyclones. The SEDAC model divides the entire earth's surface into a two dimensional gridded surface and estimates the relative risk that each of the six types of hazard event will occur within each grid cell based on historical records. Unlike the UNISDR methodology, SEDAC's approach estimates risk levels for each of the six hazard types at sub-national scales rather than for countries as a whole, which yields region-specific risk profiles.

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2 SEDAC is one of the Distributed Active Archive Centers (DAACs) in the Earth Observing System Data and Information System (EOSDIS) of the U.S. National Aeronautics and Space Administration. SEDAC develops and operates applications that support the integration of socioeconomic and Earth science data.

SEDAC divided the total number of land grid cells across the Earth into deciles and then grouped the ten deciles into qualitative risk categories as follows:

- deciles 1 through 4 (Low Risk);
- deciles 5 through 7 (Medium/Moderate Risk); and
- deciles 8 through 10 (High Risk).

Cells with values of zero (essentially zero risk of incidence) were excluded from the analysis (Dilley et al., 2005). Table 5.3 provides the SEDAC risk rating for the shorebase for each of the six major hazard categories.

Table 5.3 Risk of Occurrence for Natural Hazards at the Shorebase

Hazard Category	Risk of Occurrence (Decile Rating)
Earthquakes	Excluded (minimal risk)
Volcanoes	Excluded (minimal risk)
Landslides	Excluded (minimal risk)
Floods	Low Risk
Drought	Low Risk
Cyclones	Excluded (minimal risk)

Regional flood hazards

The SEDAC model predicts a minimal risk of floods in the vicinity of Georgetown and low risk along the eastern Guyana coast, including Berbice. The SEDAC model identifies minimal flood risk within much of the interior of Guyana and the surrounding countries of Suriname and Venezuela. Figure 5.2 depicts the risk that a flood could occur across the region. The SEDAC model also computes proportional economic loss in the event that a flood occurs. In the event that a flood occurs in Guyana (as a whole), the risk of proportional economic loss remains minimal to low.

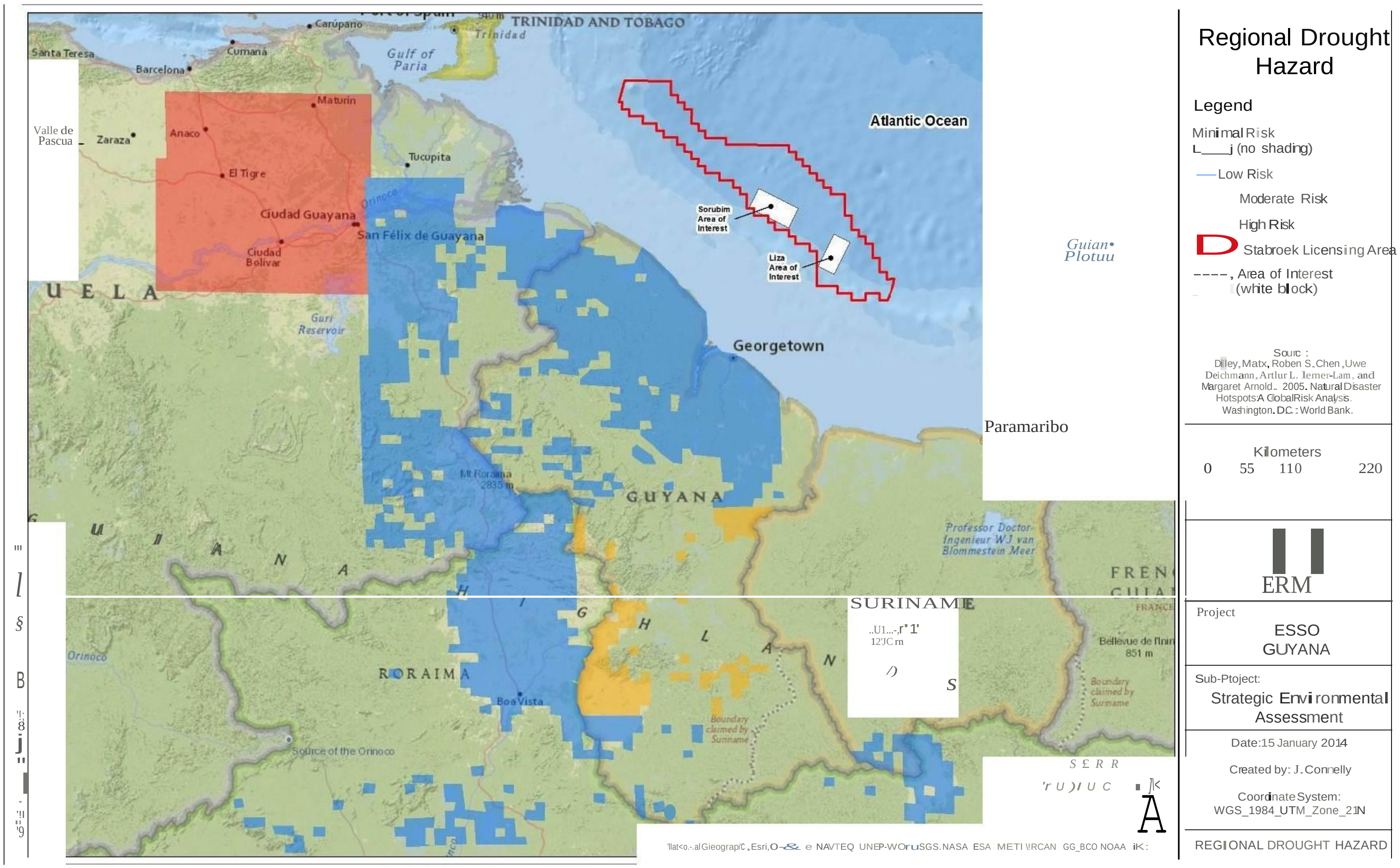
Regional drought hazards

The SEDAC model describes the local risk that a drought could occur in coastal Guyana (including the shorebase) as low, while interior regions of Guyana are mapped as minimal, low, or medium depending on location, as depicted in Figure 5.3.

The SEDAC model also computes the proportional economic risk associated with a drought. The proportional economic risk associated with a coastal drought in the vicinity of the shorebase is moderate, while the corresponding risk in southern Guyana is high. The proportional economic risk associated with a drought receives a higher rating in SEDAC's model than the risk that a drought could occur. This is fairly typical of developing countries globally. This difference in the ratings often occurs because developing countries often have relatively little capacity to respond effectively to natural disasters. Even in portions of the developing world where the chance that a disaster will occur is relatively low, the risk to life, property, and economic activity if a disaster does occur is often higher than in the developed world due to developing nations' relatively lower capacity to respond and recover after such events.

Figure 5.2 *Regional Flood Hazard in Guyana*

Figure 5.3 *Regional Drought Hazard in Guyana*



5.1.6 *Other potential natural hazards*

The SEDAC database indicates minimal risk of other natural hazards at either of the potential shorebase locations. The SEDAC methodology only rates risks on land, so it is not directly applicable to risks within the Sorubim and Liza Areas of Interest. Of the numerous major hazard types generally tracked by UNISDR and SEDAC, only cyclones/hurricanes, earthquakes, and submarine landslides have the potential to occur offshore Guyana. The area offshore Guyana is slightly south of the area most frequently affected by North Atlantic hurricanes, and the area surrounding the Stabroek Block is generally considered to be at low risk for cyclonic activity (IRICS, undated). There are no readily available seismic hazard maps for the area offshore Guyana but the Stabroek Block is located in an area that is not known for high levels of seismic activity. There are also no available assessments of mass movement hazards offshore Guyana, but a bathymetric study of the Demerara plateau, the Guiana slope and rise, and the Demerara abyssal plain offshore French Guinana and Suriname identified physical indicators of past landslides along the continental slope across the study area (Gaullier et al. 2010).

The extent to which these indicators may also be present within the Stabroek Block has not been fully established since this area was not the focus of this past study. However, the study did conclude that the bathymetry of the continental slope and Demerara plateau was more indicative of instability than the abyssal plain. The Stabroek Block is located almost completely over the abyssal plain north of the continental slope with the exception of the extreme southeastern portion of the block, which extends onto the continental slope. These results combined with the analysis of the proprietary 3D seismic data for the lead areas suggest that the overall risk of submarine landslides occurring within the Stabroek Block are likely low and within the specific Areas of Interest some localized areas of slightly higher risk may exist but not from the subduction area to the north, but rather from the continental margin to the south.

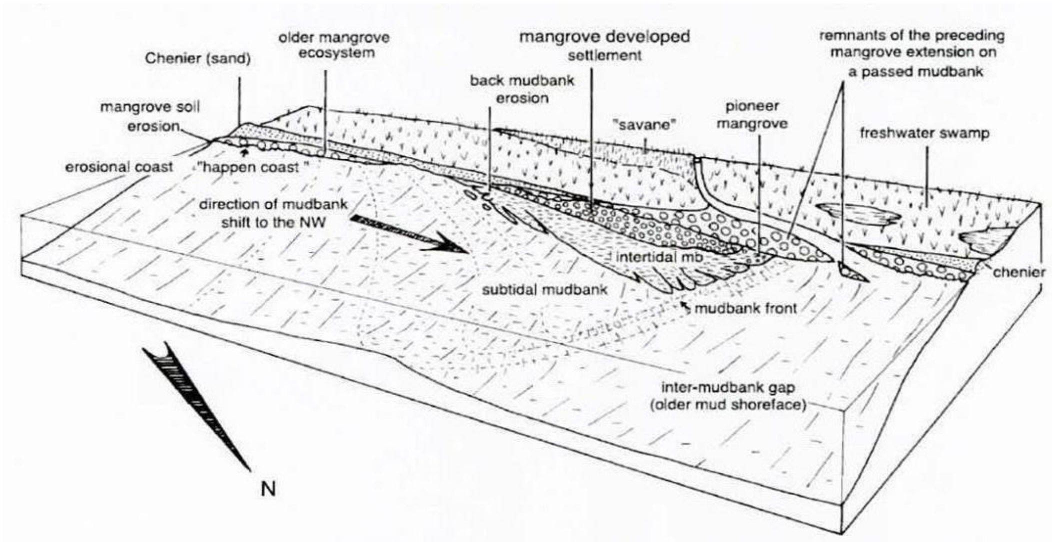
Sea Defences

Guyana's coastal plain is situated at one-meter below sea-level to sea-level, which renders the coastal plain highly vulnerable to erosion and salinization especially during spring tides (GMRP, 2010). Approximately 90 percent of the population, infrastructure, and economic activities are concentrated in the coastal plain, so protection from sea level rise and coastal flooding is a national priority. As a result, Guyana's national government has established a network of coastal protection measures that consist of a combination of hardscapes and natural buffers. This network is known collectively in Guyana as the "sea defenses."

Hardscaped defenses generally consist of an earthen embankment protected on the seaward side by a concrete slab and/or a (coping) wave wall or by rock armoring (rip-rap) (Institutional Capacity Building Activities on Guyana Sea Defenses, 2005). Most of the existing hard structures are between 30 and 70 years old, and many are in need of repair (Institutional Capacity Building Activities on Guyana Sea Defenses, 2005).

The natural sea defenses are a combination of mud banks and mangrove forests along the Guyana coastline. The mud banks are comprised of fine sediments that originate from the Amazon, and are carried by the North Brazil Current along the northern coast of South America (see Section 5.1.1). Waves from the Atlantic Ocean (swell) break on the mud banks, protecting part of the coastline from wave attack (Institutional Capacity Building Activities on Guyana Sea Defenses, 2005). The mud banks also promote further sediment accretion and mangrove growth, thereby enhancing the resilience of the natural sea defense network.

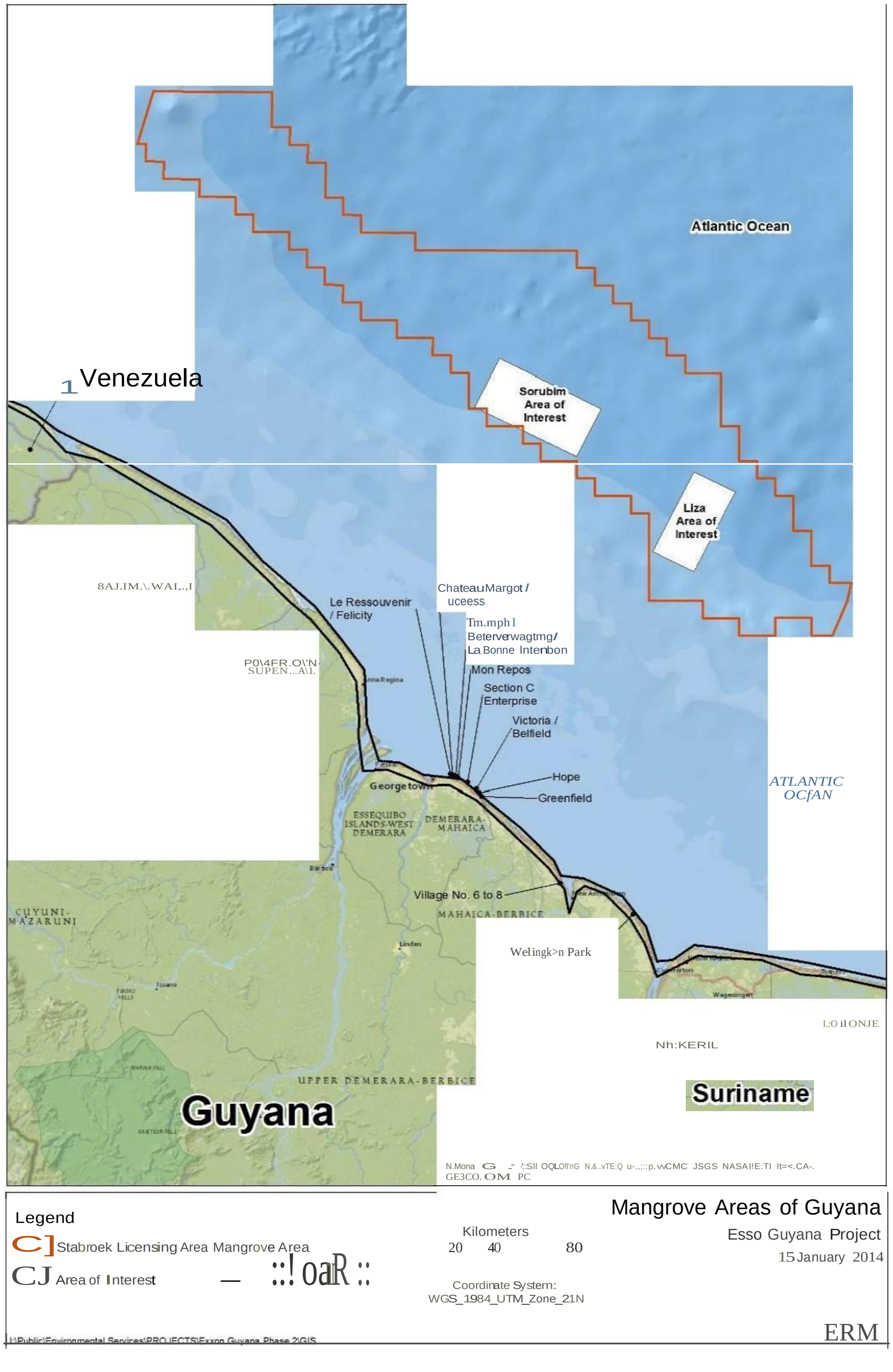
Figure 5.4 Typical Distribution of Mudbanks and Mangroves along Guyana's Coast



Source: Institutional Capacity Building Activities on Guyana Sea Defenses, 2005.

Mangrove forests along coastal Guyana also contribute to sea defense by damping wave action and protecting the coastal bank from shoreline erosion. The 2010 National Mangrove Management Action Plan identifies mangroves as the most effective protection from coastal flooding in Guyana. Many governmental and non-profit groups, such as the Government of Guyana through the Ministry of Agriculture and the Guyana Mangrove Restoration Project (GMRP) have been working together to restore mangroves along the Guyanese coast. GMRP has been operating since May 2010, with mangrove planting and protection initiatives at ten locations along the Guyanese coast (GMRP, 2010). An important aspect of the GMRP is promotion of the sustainable management of Guyana's mangrove forests (Roopsind, 2012). Eight of the ten mangrove restoration areas are located adjacent to Georgetown, while two are located near New Amsterdam, Guyana (Figure 5.5). See Section 5.2.1.3 for a biological description of mangroves in Guyana.

Figure5.5 Distribution of Mangroves along Guyana's Coast



5.2 BIOLOGICAL RESOURCES

5.2.1 Coastal and Marine Habitats

Several habitat types are present in the network of plains and low hills that comprise Guyana's coast, including mangroves, salt to brackish lagoons, brackish herbaceous swamps, swamp woods and swamp forests. The swamps are an important source of freshwater to mangrove vegetation and other flora and fauna (WWF, 2014). The coastal mangroves have been identified by numerous national and international stakeholders as vital to Guyana's biodiversity, physical security, and economy (WWF, 2014; GMRP, 2010; Ilieva, undated). Guyana has relatively few beaches, but the beaches that do occur are critically important nesting habitats for sea turtles.

Guyana's continental shelf occupies an area of 48,665 sq. km. The average width of the continental shelf is 112.6 km (NDS, 1997). The shelf is widest near the Suriname and Venezuela borders, and slightly narrower near the center, north of Georgetown. The entire continental shelf, continental slope, and the adjoining portion of the abyssal plain (including the Sorubim and Liza Areas of Interest) are part of the North Brazil Large Marine Ecosystem (LME). The North Brazil LME is an oceanic habitat unit that extends from the Caribbean Sea south to the Parnaiba River in Brazil (Ekau and Knoppers, 2003; in Sherman and Hempel, 2008). Although the North Brazil LME is considered a highly productive zone in comparison to other large marine areas, nearshore primary productivity potential is limited by turbidity, which limits light penetration. The highest primary productivity in the LME is generally found at the oceanic fronts between nutrient-rich lenses of continental water from the Amazon, Essequibo, and other large rivers and comparatively warm clear water of oceanic origins (Sherman and Hempel, 2009). Benthic physical habitats are poorly documented in the Stabroek Block. The substrate is generally composed almost entirely of mud and silt deposited by the North Brazil Current (MOA, 2013).

5.2.2 *Mangroves*

Mangroves are regarded as one of the most important ecosystems to security of the biodiversity of the entire Guiana Shield region. They occupy over 81,000 hectares of Guyana's coast but the distribution of mangroves along the coast is highly dynamic, and subject to rapid change. Six of Guyana's ten geopolitical regions have mangroves (Smithsonian, 2008) but approximately 75% of the country's mangroves are concentrated in the Barima-Waini and Pomeroon-Supenaam regions (GMRP Fact Sheet, 2010).

There are currently three species of mangrove in Guyana: *Rhizophora mangle* (Red mangrove), *Avicennia germinans* (Black mangrove), and *Laguncularia racemosa* (White mangrove). Many invertebrate inhabitants of mangrove ecosystems in Guyana live either on or in close proximity to mangrove roots and substrate and include snails, barnacles, tunicates, mollusks, polychaete worms, oligochaete worms, shrimps, crabs, sponges, jellyfishes, amphipods and isopods. These small organisms provide forage for birds, mammals, reptiles, amphibians, fish, crabs, and shrimp.

5.2.3 *Mud Banks*

The 1,500 km-long coast of South America between the Amazon and Orinoco River mouths is the world's muddiest coastline (Anthony, 2010). Mud banks extend approximately 20 to 40 km offshore to a depth of 20m (CGX Resources, 2009), and are located seaward of the mangrove swamps that fringe much of the coastline as depicted in Figure 5.4. The mud banks are rich in invertebrate fauna, including plankton and micro-plankton assemblages, algae mats (diatoms), and benthic communities of Nematodes (worms), Tanaidacea (crustaceans), and Foraminifera (amoeboid protists) (Felipe, 2003). These small organisms provide habitat for fish species, post-larval and juvenile shrimps, and crabs (Felipe, 2003), and numerous resident and migratory shore birds (CGX Resources, 2009).

5.2.4 Marine Finfish

Much of what is known about marine finfishes offshore Guyana is known from study of commercial landings. The inshore finfish community is dominated by drums, croakers, and marine catfishes, and includes other species such as snooks and tarpon. Further offshore near the interface of the turbid North Brazil Current with oceanic water, the finfish community is more complex, consisting of pelagic, highly migratory species such as tunas, jacks, and mackerels in the upper water column and snappers and groupers in the demersal zone (MOA, 2013). Sharks are found inshore and offshore.

Guyana's marine finfish community exemplifies the ecological connectivity between the mangroves, estuaries, and offshore zones because many fish species are dependent on different habitats at specific life stages, or occur in more than one habitat type. Several species that occur in the inshore and offshore zones as adults are dependent on coastal mangroves as juveniles, particularly the drums, croakers, and snappers. The catfishes occur in the mangroves, estuaries, and oceanic waters as adults. Some other species including the snooks and tarpon may occur occasionally in the ocean but are specifically adapted to completing their entire life cycles in mangrove-lined estuaries (MOA, 2013).

5.2.5 Seabirds

Guyana's avifauna population is highly diverse, especially within the mangrove and wetland areas. The canopy of coastal and riverine mangroves provides a habitat for many species of avifauna. The most recent inventory of bird species in Guyana was completed in 2009, and listed 814 species as occurring in the country. More than 90 of those species are known to occur in coastal or oceanic habitats (Braun et al., 2007). Coastal bird populations consist of ibises, egrets, herons, gulls and other seashore species. Oceanic species such as frigatebirds and albatrosses spend most of their time at sea and are less common along the coast.

Migratory seabirds also occur in Guyana on a seasonal basis. Guyana's coastal mangroves are noted for being wintering grounds for migratory birds including austral and Nearctic migratory species. Austral migrants breed in temperate South America during the summer, but spend the remainder of the year in the tropics. Nearctic migrants migrate in the other direction, breeding in North America during summer and overwintering in tropical South America. Both groups spend winter in Guyana, which creates a peak in migratory waterbird abundance in Guyana from early October to late March.

As described in Section 5.3.6, the Guyanese government considers ecotourism to be a potential growth sector for the nation's economy. Bird watching is a key attraction for ecotourists, and Guyana is currently investing to develop birding-based tourism. The government has developed a birding marketing strategy, and Guyana is now recognised as a prime birding destination. The Guyana Tourism Authority is seeking to further promote this activity by attending events such as the British Bird watching Fair. (GMTIC, 2014). Seabirds are concentrated along the coast where transportation, accommodations, and other infrastructure necessary to support tourists is currently most developed. Although travel into the interior may become more frequent in the future, tours focusing on seabirds in the coastal mangroves and beaches will play a key role in the expansion of Guyana's tourism industry over the short term due to their proximity to Georgetown and the relative ease with which coastal bird watching locations can be accessed.

5.2.6 Benthic Resources

Benthic biological resources offshore Guyana are poorly studied, but do not include the matrix of shallow coral reefs and seagrass meadows that are characteristic of coastal tropical Atlantic environments elsewhere. The highly turbid conditions offshore Guyana do not permit the growth of warm water corals, which rely on symbiotic photosynthetic algae for nourishment. Two cold-water coral species (*Madrepora oculata* and *Solenosmilia variabilis*) are known to occur offshore Guyana. Both species occur in a wide range of depths; *M. oculata* is known from 55-1,950 m and *S. variabilis* is known from 220-2,165 m. The locations and the extent of deepwater corals offshore Guyana has not been published (Freiwald et al., 2004).

Like shallow, warm-water corals, many cold water corals construct reefs that support highly diverse invertebrate and fish fauna (NOAA, 2014). Both *Madrepora oculata* and *Solenosmilia variabilis* are technically considered reef-building corals but M. oculata is particularly fragile and does not often form deepwater reefs. It more frequently occurs as a commensal species living within or on reefs that were originally constructed by more robust species such as *S. variabilis*.

Several species of bentho-pelagic shrimp occur in Guyanese waters, including the Atlantic Seabob (*Xiphopenaeus kroyeri*), the Southern Brown Shrimp (*Penaeus subtilis*), and the Southern White Shrimp (*Penaeus schmitti*). The Red-spotted Shrimp (*Penaeus brasiliensis*), and the Southern Pink Shrimp (*P. notialis*) are found in deeper waters (EPA, 2010). These species are free swimming but are often found at or near the bottom.

5.2.7 Marine Reptiles

Five sea turtle species are found in the wider Caribbean, all of which occur in Guyanese waters. Four of these species: green turtle (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and Olive ridley turtle (*Lepidochelys olivacea*) nest on Guyana's beaches. Loggerhead turtles (*Caretta caretta*) also occur offshore Guyana but rarely come ashore. The primary nesting site for all these species is Shell Beach, located on the northwestern coast of Guyana. The exact location of secondary nesting sites changes due to coastal erosion which creates and destroys nesting areas continuously, but they are generally distributed along the northwest coast between the Pomeroon and the Waini river estuaries. Leatherback turtles are the most common species on the nesting beaches, while nesting green and hawksbill turtles are less common. Olive Ridley turtle populations have declined in recent times, but remain stable.

According to the Center for Rural Empowerment and the Environment (CREE), the primary nesting season for the leatherback, green, hawksbill, and olive ridley turtles in Guyana (Shell Beach) occurs during the cover of darkness from March to August (CREE, 2014). Large populations of the green and leatherback turtles are located in the Guianas (Suriname and French Guiana), while smaller nesting areas are located from northwestern Guyana (Shell Beach) to Venezuela and into the Caribbean Sea (which includes the Netherland, Lesser, and Greater Antilles); the Gulf of Mexico (Central America); and Atlantic Ocean (the Bahamas; and the southern coast of the United States) (Piniak, 2011).

The hawksbill turtles' range is primarily in the Caribbean Sea with small nesting areas in the Guianas and in eastern Brazil. The olive-ridley turtles primarily nest along the French Guiana coast with small nesting areas along the northeastern coast of Venezuela to the Suriname and in eastern Brazil (Piniak, 2011).

The primary threats to sea turtles are poaching of eggs and adults, intentional and accidental fishing, and habitat disturbance and degradation due to marine pollution, coastal zone development, shore erosion, lighting and debris. Population monitoring and conservation activities are limited, primarily due to the logistical challenges associated with the remoteness of primary nesting sites.

5.2.8 Marine Mammals

The equatorial waters of Guyana are home to several species of marine mammals. There have been no comprehensive studies on marine mammals offshore Guyana, but regional studies and bycatch reports provide some insight into the composition and distribution of the marine mammal community in the vicinity of the Project.

The 2007 Global Bycatch Assessment of Long-lived Species (Project GloBAL)'s Country Profile of Guyana contains a list of marine mammals whose distributions overlap with Guyana's Exclusive Economic Zone (EEZ). These species are listed in Table 5.4. The IWC's Scientific Committee's (SC) Draft Report on Small Cetaceans of the Wider Caribbean (IWC/SC 2006) cites information from French Guiana and Venezuela and provides secondary information on Guyana's marine mammals.

Bottlenose dolphins are incidentally captured in both gillnet and trawl fisheries in these countries. Tucuxi or grey dolphin (Sotalia fluviatilis) are known to suffer incidental capture in gillnets and seines throughout their range which includes the Guianas (French Guiana, Suriname and Guyana).

A survey conducted by Rueben Charles in 2002[3] of 125 Guyanese captains of trawlers, drift seine and red snapper fishing vessels found that these vessels usually encountered Boto (*Inia geoffrensis*), Spotted Dolphin (*Stenella spp*.), Longmouth dolphin or Common Dolphin (*Delphinus delphi*), Tucuxi (*Sotalia fluviatilis*), Spinner Dolphin (*Stenella longirostrus*), and Bottlenose Dolphin (*Tursiops truncates*). More recently, in September 2009, a 36ft whale beached at Almond Beach in the North West District.

An opportunistic visual survey of cetaceans performed offshore Suriname in 2012 provides further data on marine mammal distribution offshore of the Guianas. The survey documented twelve species of cetaceans, including sperm whales (*Physeter macrocephalus*), Bryde's whale (*Balaenoptera brydei*), false killer whales (*Pseudorca crassidens*), melon-headed whales (*Peponocephala electra*), rough-toothed dolphin (*Steno bredanensis*), long-beaked common dolphin (*Delphinus capensis*), Fraser's dolphin (*Lagenodelphis hosei*), pantropical spotted dolphin (*Stenella attenuate*) spinner dolphin (*Stenella longirostris*), Atlantic spotted dolphin (*Stenella frontalis*), common bottlenose dolphin (*Tursiops truncatus*), and short-finned pilot whale (*Globicephala macrorhynchus*) (Boer, 2013).

The data from the 2012 Suriname survey strongly suggest that toothed whales (including dolphins, porpoises, pilot whales, and sperm whales) are more common offshore of Suriname than the baleen whales (including Bryde's and sei whales). The species with the highest abundance index was the melon-headed whale, while the lowest was the Bryde's whale. The most frequently sighted species was the spinner dolphin, and the least frequently sighted was the sei whale (Boer, 2012). The highest number of strandings reported were for sperm whales, and the lowest number were for sei whales (Boer, 2012). The 2012 Suriname study was conducted at similar depths and distances offshore as the Sorubim and Liza Areas of Interest, so such species could occupy similar ranges within the Project lead areas as well.

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[3] Unpublished survey on the occurrence of bottlenose dolphins in Guyana waters conducted by Rueben Charles in 2002.

Table 5.4 Marine Mammals with Ranges that include Waters Offshore Guyana

Common name	Scientific name
Sei whale	*Balaenoptera borealis*
Bryde's whale	*Balaenoptera brydei*
Blue whale	*Balaenoptera musculus*
Fin whale	*Balaenoptera physalu*
Short beaked common dolphin	*Delphinus delphis*
Minke whale	*Balaenoptera acutorostrata*
North Atlantic right whale	*Eubalaena glacialis*
Pygmy killer whale	*Feresa attenuate*
Short-finned pilot whale	*Globicephala macrorhynchus*
Rissos dolphin	*Grampus griseus*
Pygmy sperm whale	*Kogia breviceps*
Dwarf sperm whale	*Kogia simus*
Frasers dolphin	*Lagenodelphis hosei*
Humpback whale	*Megaptera novaeangliae*
Blainvilles beaked whale	*Mesoplodon densirostris*
Gervais beaked whale	*Mesoplodon europaeus*
Trues beaked whale	*Mesoplodon mirus*
Melon-headed whale	*Peponocephala electra*
Sperm whale	*Physeter macrocephalus*
False killer whale	*Pseudorca crassidens*
Tucuxi	*Sotalia fluviatilis*
Pantropical spotted dolphin	*Stenella attenuate*
Clymene dolphin	*Stenella clymene*
Striped dolphin	*Stenella coeruleoalba*
Rough-toothed dolphin	*Steno bredanensis*
West Indian manatee	*Trichechus manatus*

5.2.9 Special Status Species

The International Union for Conservation of Nature (IUCN) maintains the IUCN Red List, which provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated to determine the relative risk of extinction (IUCN, 2014). The IUCN Red List is globally recognized as a source of information on the conservation status of specific species. There are 290 species known to occur in the coastal and marine habitats in Guyana on the IUCN Red List. Eighty-eight of these marine and coastal species have been ranked Near Threatened or higher, or Data Deficient. These species are listed in Appendix 1.

According to the IUCN's classification scheme, these species currently face a credible threat of extinction, are expected to face such risks soon, or cannot be objectively assessed with the currently available data. Most of the listed species that could be potentially affected by the Project (64 of these species are finfish. They include highly migratory species such as tunas and sharks, bentho-pelagic species like groupers, and demersal species including the skates and rays. As noted in Section 5.3.2, many of these listed finfish species are also targeted by the Guyanese commercial fishing industry. The remaining IUCN-listed marine and coastal species in Appendix 1 is comprised of sea turtles, marine mammals, and crustaceans.

5.2.10 Protected Areas

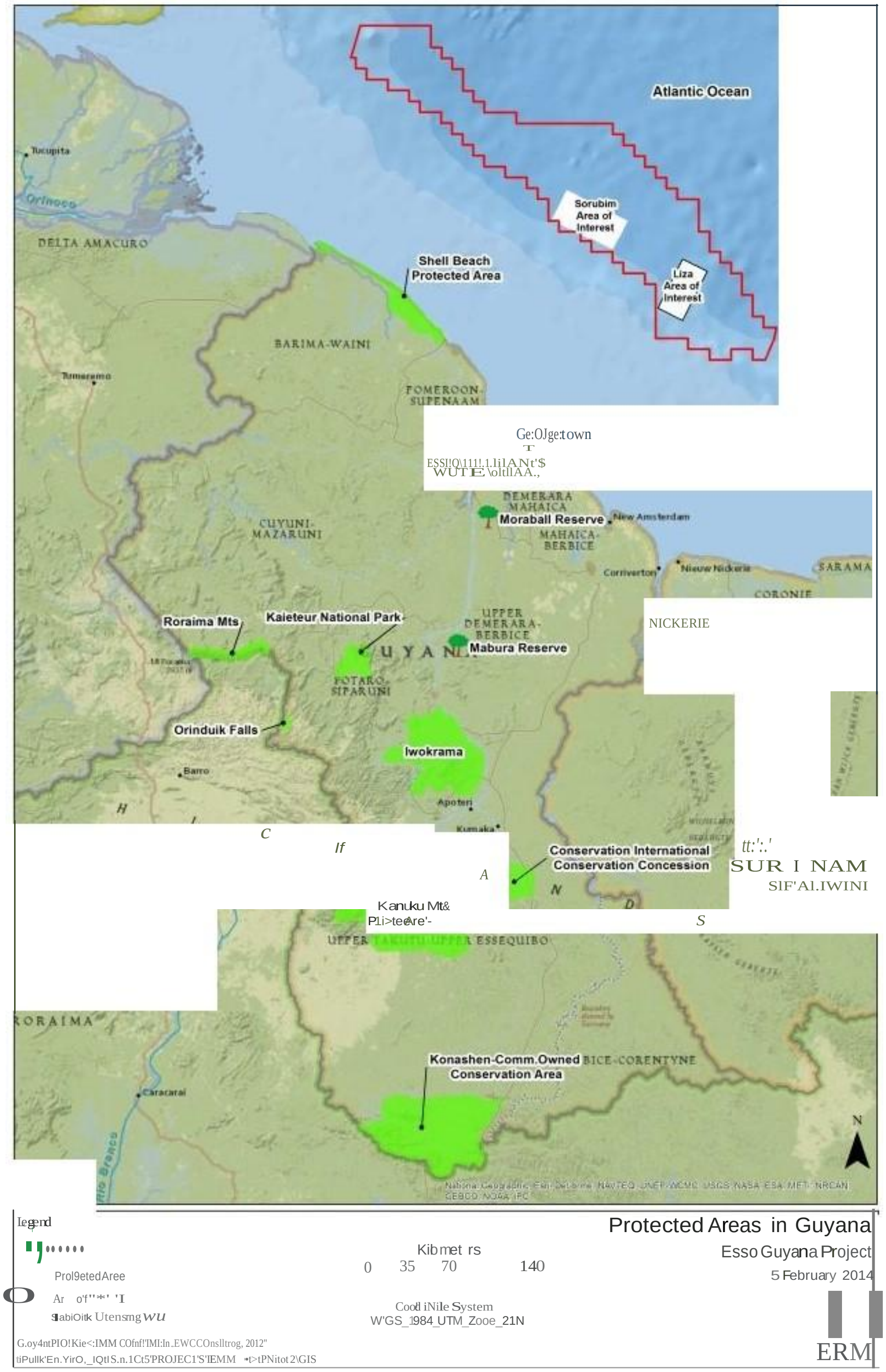
In 2011, Guyana enacted protected areas legislation which established a Protected Areas Commission to oversee and manage protected areas. The legislation also established Shell Beach and the Kanuku Mountains as Guyana's newest nationally protected areas, which increased the total number of protected areas in Guyana to six and increased the total land area protected to approximately 1.8 million hectares or about nine percent of Guyana's land area, as summarized in Table 5.5. Figure 5.6 illustrates the locations of Guyana's protected areas.

Table 5.5 Protected Areas in Guyana

Protected Area	Approximate Size (ha)
Kaieteur National Park	63,000
Iwokrama Forest,	371,00
Konashen (Community Owned Conservation Area)	625,000
Moraballi Forest Reserve	11,000
Kanuku Mountains	611,000
Shell Beach Nature Reserve	200,000

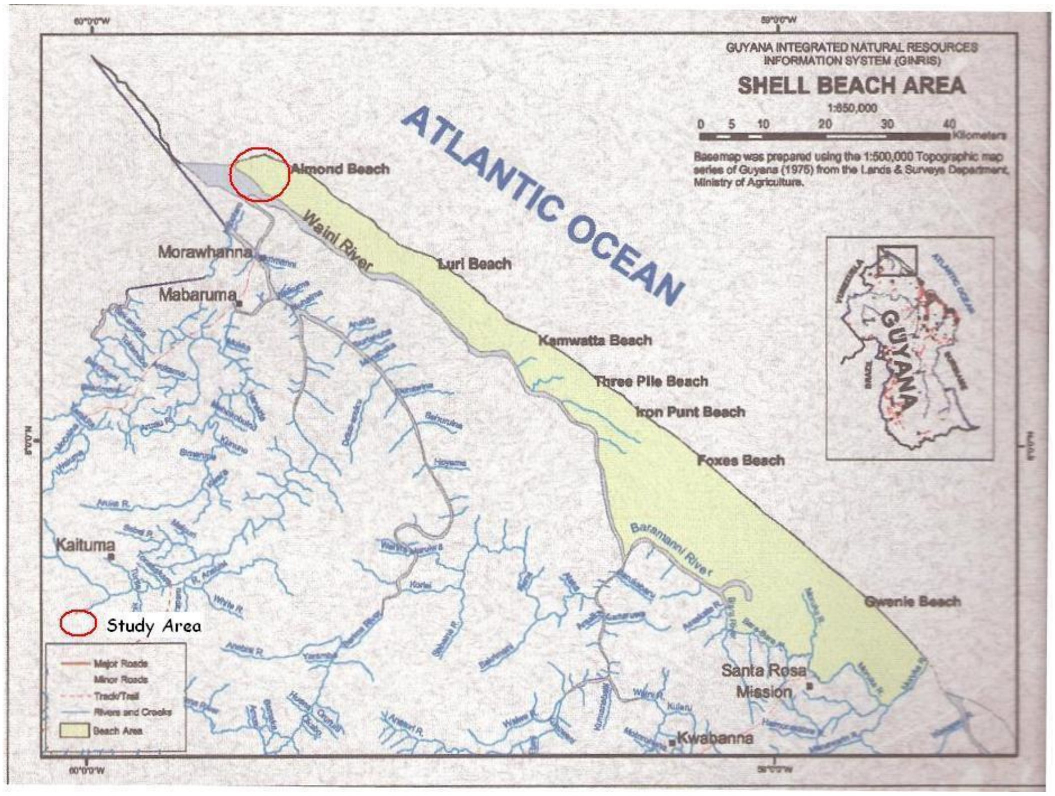
Shell Beach is the only protected area on Guyana's coast. Figure 5.7 provides a detailed map of Shell Beach and the surrounding area. It is located in northwestern Guyana and extends for almost 140km between the Waini, Baramani, and Moruka Rivers and the Atlantic Ocean. Shell Beach is a dynamic area and its landscape constantly changes due to the competing effects of erosion and accretion along the shorefront. Seventy percent of the area is forested; the rest is made up of mostly swamp (28.8%), and sandy beaches (1.2%). Shell Beach supports numerous plant species including coconut trees, papaya trees, and palm (GMTCS, 2011; Bovell, 2011).

Figure 5.6 Protected Areas of Guyana



Source: Guyana Protected Areas Conunissi.on, EMC Consulting, 2012.

Figure 5.7 Shell Beach Protected Area



Source: Guyana Marine Turtle Conservation Society Information Package EMC Consulting, 2012

There are currently no designated marine protected areas in Guyana. However, the ecology of the coastal zone and Shell Beach are inextricably connected to the coastal marine ecosystem. The Shell Beach Protected Area includes riparian area along the coast, but does not extend into the Atlantic Ocean. The vegetation within the coastal zone area of Guyana is comprised of lowland swamp forests, palm savannas, and the largest stretch of mangrove forests in the country. The vegetative community has changed little in recent history apart from limited clearing to accommodate a few dispersed encampments and farmsteads. The rivers bordering the protected area discharge nutrients through the protected area's mudflats and mangroves. These high nutrient levels contribute to the productivity of the marine ecosystem. Fish, prawns, and crabs from the nearshore marine area use the mangrove covered coastlines as nursery habitat.

Shell Beach is best known as a marine turtle nesting site. The composition of the substrate at Shell Beach, its geographical location and the low anthropogenic impact makes it an ideal nesting site for sea turtles. Most nesting beaches in Guyana are used by only one or two species of sea turtle but four species of sea turtle (Leatherback, Hawksbill, Olive Ridley, and Green Turtle) found in Guyana nest at Shell Beach (Pritchard, 2001). In addition to the sea turtles there are also at least four other species of turtles present within the protected area including the yellow-foot tortoise (*Geochelone denticulate*), scorpion mud turtle (*Kinosternon scorpioides*), giant river turtle (*Podocnemis expansa*) and mata mata (*Chelus fimbriata*).

The Shell Beach protected area also supports rich bird and mammal communities. In 2004, a Rapid Biodiversity Assessment of Shell Beach documented 170 species of birds (one of the richest populations in all of Guyana, including well known species such as scarlet ibis, roseate spoonbill, and Caribbean Flamingos). Parrots are also very abundant in the area. Orange-winged Amazon parrots were historically extremely abundant and are commercially collected for the wildlife trade in the area, and several species of macaws are common in the riparian forests. Twenty species of mammals including such charismatic megafuana as howler monkeys, jaguars, and manatees are known to inhabit the Shell Beach area and surrounding coastal region (Prince et al., 2004, Kalamandeen et al. 2005).

The area near Shell Beach has been inhabited for 10,000 years by Amerindian groups from the Warao, Carib, and Arawak tribes (Charles et al, 2004). Most of the current indigenous residents of the Shell Beach area are concentrated in a community known as Almond Beach, near the northern end of the Protected Area. Other communities included within the boundary of the protected area as delineated in 2011 include Father's Beach and Assakata. The remainder of the Protected Area is sparsely populated, if at all.

Indigenous communities have historically used Shell Beach area for subsistence fishing, crabbing, trapping, farming, logging, and palm harvesting. They also historically engaged in sea turtle trapping and harvesting of sea turtle eggs. While these activities have declined in recent years as emphasis on conservation and sustainability has increased illegal catching of turtles may still occur (Charles et al, 2004).

Unfortunately, today many of these indigenous communities are suffering from poverty resulting in overexploitation of some of the key organisms they rely on in the area. Increasing activity in proximity to Shell Beach has the potential to disrupt the ecosystem in various ways and do additional harm. In 1997, a fire caused by human activity extensively damaged an area of mangroves (Pritchard, 2001). Throughout the past few decades there have also been various industrial proposals for Shell Beach. There have been proposals to extract shell material from the beaches as feedstock for fertilizer production, as well as a plan for a luxury tourist outpost by Tower Hotel (Charles et al, 2004). Amerindian communities in the area have also expressed interest in developing ecotourism as well (Charles et al., 2004).

5.3 SOCIOECONOMIC RESOURCES

5.3.1 Demographics

Guyana is divided administratively into ten regions. Six of the regions are located in the north of the country along the coast, and the remaining four comprise the interior portion of the country. With the exception of the East Berbice-Corentyne region which spans the entire eastern border of the country with Suriname from the Atlantic Coast to Brazil, the coastal regions tend to be smaller than the interior regions. Figure 5.8 illustrates Guyana's national borders, the regional boundaries within the country, and the most prominent towns.

Regional Population Distribution

Most of the country's population is located in the six coastal regions and according to the 2002 national census nearly half of the country's population lives in the Demerara-Mahaica region, which includes the capital city of Georgetown. The second-most populous region is East Berbice-Corentyne. The third-most populous region is Essequibo Islands-West Demerara, located west of Georgetown. All three of these regions are coastal, and when these regions are added to the populations of Barima-Waini, Pomeroon-Supenaam, and Mahaica-Berbice the population of Guyana's six coastal regions accounts for 88% of the nation's total population (BSG, 2007). Table 5.6 summarizes the distribution of population within the ten regions in 2002, the last year for which complete census data is available.

Figure 5.8 Guyana's Regions and Major Towns

Legend

- Georgetown
- Major Town
- Area of Interest
- Region Boundary
- Stabroek Licensing Area

Kilometers

0 35 70 140

Coordinate System: WGS_1964_UTM_Zone_21N

Guyana's Regions and Major Towns

Esso Guyana Project

17 February 2014

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Table 5.6 Regional Distribution of Guyana's Population

Region	Population	Percent of Guyana's Total Population
Guyana	751,223	100.00%
Barima-Waini	24,275	3.2%
Cuyuni-Mazaruni	17,597	2.3%
Essequibo Islands - West Demerara	103,061	13.7%
Demerara-Mahaica	310,320	41.3%
East Berbice - Corentyne	123,695	16.5%
Mahaica - Berbice	52,428	7.0%
Potaro - Siparuni	10,095	1.3%
Pomeroon - Supenaam	49,253	6.6%
Upper Takutu - Upper Essequibo	19,387	2.6%
Upper Demerara - Berbice	41,112	5.5%

Source: BSG, 2007.

Major Cities and Towns

Georgetown is the capital of Guyana and its largest city, and is located in the Demerara-Mahaica regon. The 2002 National Census reported a population of 134,497, which accounts for more than 40% of the entire population of the Demerara-Mahaica region. Linden, located in the Upper Demerara - Berbice region, is the second most populous city in the country but it is much smaller than Georgetown and unlike Georgetown it is located approximately 90 km inland. The combined population of the six largest towns in the country together account for less than 15% of Guyana's total population, underscoring the fact that with the exception of Georgetown, Guyana is largely a rural country.

Table 5.7 Populations of Major Towns in Guyana

City/Town	Population	Region	Percent of Regional Population	Percent of Guyana's Total Population
Georgetown	134,497	Demerara-Mahaica	43.3%	17.9%
Linden	29,298	Upper Demerara - Berbice	71.3%	3.9%
New Amsterdam	17,033	East Berbice-Corentyne	13.8%	2.3%
Anna Regina	12,391	Pomeroon - Supenaam	25.2%	1.6%
Corriverton	11,494	East Berbice-Corentyne	9.3%	1.5%
Bartica	7,423	Cuyuni-Mazaruni	42.1%	0.9%

Ethnic Composition

Guyana is populated primarily by people of Indian and African descent. People identified as Eastern Indian (to differentiate them from Amerindian) and African descent accounted for over 70% of the total population of the country in 2002. People of mixed ethnic descent and of Amerindian descent are the next two most common ethnic groups in Guyana. These four ethnic groups constitute over 90% of the total Guyanese population.

The distribution of most ethnic groups within Guyana follows the distribution of the national population as a whole; i.e.; most ethnic groups are concentrated near the coast. The Amerindians are unique among the ethnic groups in being concentrated in the interior. No more than 25% of any other ethnic group lived in the interior in 2002, but in that year over 50% of Guyana's Amerindian population lived in the interior (BSG, 2007). The negative impacts of mining and logging activities have had a disproportionate effect on Amerindian communities because these activities impacts have historically occurred primarily in the interior. Table 5.8 summarizes the distribution of the primary ethnic groups in Guyana by region.

Table 5.8 Regional Distribution of Guyana's Population by Ethnic Group

Regions	African/ Black	Amerindian	Chinese	Eastern Indian	Mixed	Portuguese	White
Guyana	30.21	9.14	0.19	43.45	16.73	0.2	0.06
Barima-Waini	0.07	2.01	0	0.05	1.09	0	0
Cuyuni-Mazaruni	0.88	1.07	0.01	3.14	1.45	0.01	0
Demerara-Mahaica	2.91	0.28	0.02	8.98	1.51	0.01	0
East Berbice - Corentyne	17.21	0.7	0.11	15.51	7.59	0.14	0.04
Essequibo Islands - West Demerara	2.27	0.14	0.01	4.03	0.53	0	0
Mahaica - Berbice	3.47	0.27	0.03	11.31	1.38	0.01	0.01
Potaro - Siparuni	0.27	0.98	0	0.21	0.88	0	0
Pomeroon - Supenaam	0.09	1.02	0	0.03	0.19	0.01	0
Upper Demerara - Berbice	0.03	2.3	0	0.01	0.23	0	0
Upper Takutu - Upper Essequibo	3.01	0.39	0.01	0.17	1.89	0.01	0

5.3.2 *Regional Employment Patterns*

Guyana's National Bureau of Statistics tracks regional employment data by sector rather than by industry. The 2002 employment data is categorized into three sectors-agriculture, manufacturing, and the service industry. Table 5.9 summarizes the 2002 regional employment data by sector.

Table 5.9 Employment by Sector and Region

Regions	Agriculture	Manufacturing	Services	Total
Guyana	51,091 (22.1%)	56,371 (24.4%)	123,391 (53.4%)	230,854
Barima-Waini	2,197 (39.9%)	1,374 (25.0%)	1,934 (35.1%)	5,504
Cuyuni-Mazaruni	1,539 (27.3%)	1,904 (33.8%)	2,189 (38.9%)	5,632
Demerara-Mahaica	9,850 (9.4%)	26,062 (25.0%)	68,517 (65.6%)	104,429
East Berbice - Corentyne	13,076 (37.6%)	6.843 (19.7%)	14,829 (42.7%)	34,748
Essequibo Islands - West Demerara	8,921 (27.1%)	7,878 (23.9%)	16,114 (49.0%)	32,913
Mahaica - Berbice	5,060 (37.4%)	3.052 (22.6%)	5,402 (40.0%)	13,514
a Potaro - Siparuni	812 (28.9%)	1,370 (48.8%)	627 (22.3%)	2,809
Pomeroon - Supenaam	3,707 (27,0%)	3,513 (25.6%)	6,499 (47.4%)	13,719
Upper Demerara - Berbice	1,973 (16.5%)	3,901 (32.6%)	6,085 (50.9%)	11,960
Upper Takutu - Upper Essequibo	3,957 (70.3%)	474 (8.4%)	1,195 (21.2%)	5,626

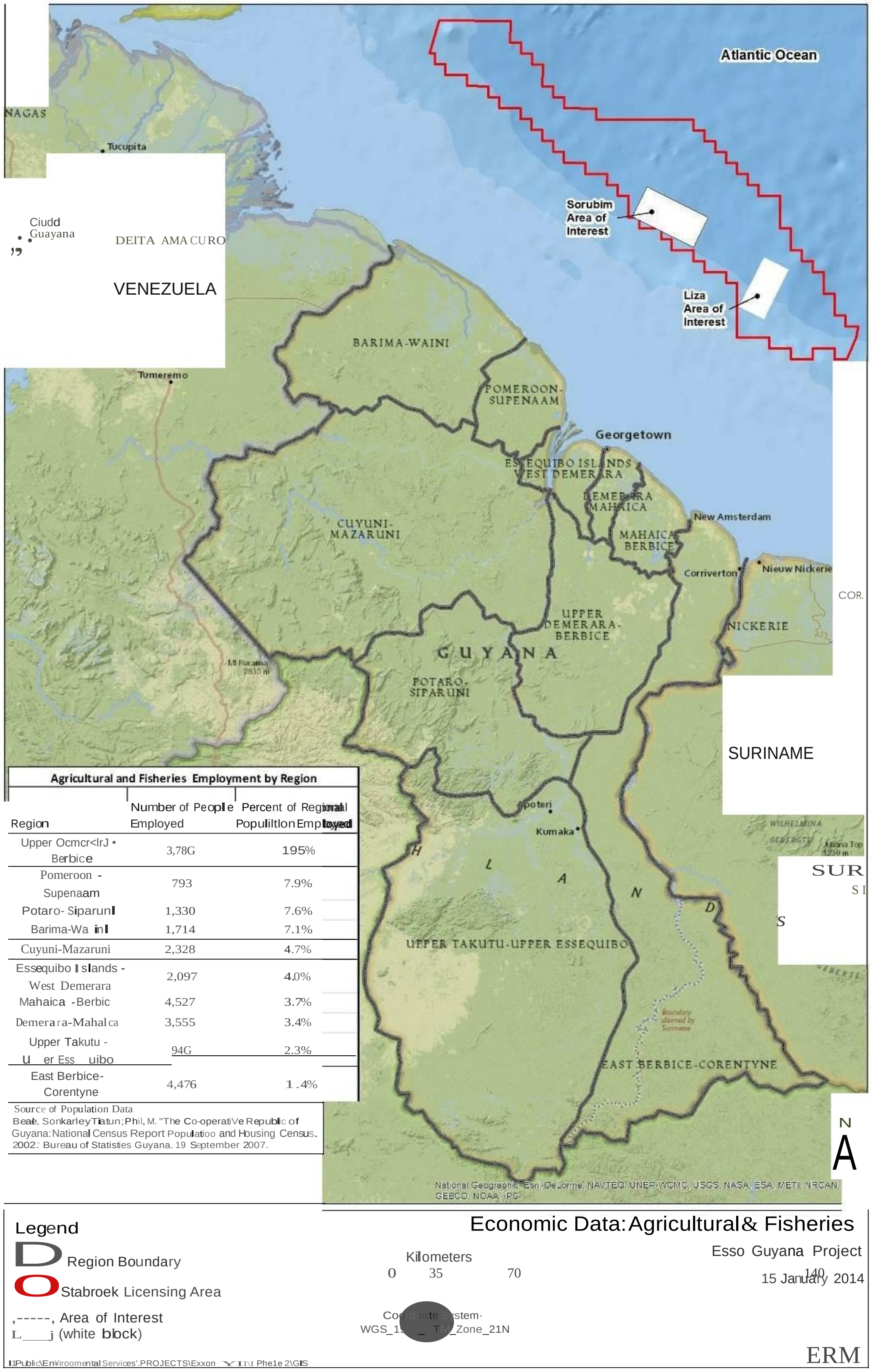
The regional employment data in Table 5.9 indicate pronounced differences in the distribution of agricultural and non-agricultural employment as a function of population. The services sector constitutes the largest percentage of overall employment in coastal regions where most of the country's population is concentrated. The regions with the top five service sector employment rates (Demerara-Mahaica, Essequibo Islands-West Demerara, Pomeroon-Supenaam, East Berbice-Corentyne, and Mahaica-Berbice) contain over 85% of Guyana's total population. Consequently the services sector accounts for more jobs than the agricultural and manufacturing sectors combined in the national economy.

Agriculture and related occupations, which require large expanses of open land and low-cost transportation to markets, is concentrated in Upper Takatu-Upper Essequibo and Barima-Waini, both of which have relatively low populations. Upper Takatu-Upper Essequibo is known as a beef producing region, and much of the beef produced there is sold to nearby Brazil because transportation to domestic but more distant population centers in the north of Guyana can be prohibitively expensive (Reece, 2012). Barima-Waini is a center of the timber industry (Reece, 2012).

Fisheries and Aquaculture

Fisheries are of critical importance to Guyana's economy, especially to the local economies of the coastal regions. The industry is thought to supply work to an estimated 10,600 people with more than 7,000 more employed in related industries (MOA, 2013), although it is difficult to determine the exact number employed in fisheries because the government tracks fishery and agriculture employment together as a single category and manages fisheries as a division of the Ministry of Agriculture. Figure 5.8 illustrates employment in the fishing and agriculture sector as a percentage of population within each region. There are four main types of marine fisheries in Guyana (MOA, 2013) that can be defined by the species targeted, gear types used, and the depth of water where the fishery takes place. Table 5.10 summarizes the characteristics of these fisheries.

Figure 5.8. *Regional Employment in the Fishing and Agriculture Sector*



Agricultural and Fisheries Employment by Region

Region	Number of People Employed	Percent of Regional Population Employed
Upper Ocmcr<lrJ • Berbice	3,78G	195%
Pomeroon - Supenaam	793	7.9%
Potaro- Siparunl	1,330	7.6%
Barima-Wa inl	1,714	7.1%
Cuyuni-Mazaruni	2,328	4.7%
Essequibo Islands - West Demerara	2,097	4.0%
Mahaica -Berbic	4,527	3.7%
Demerara-Mahalca	3,555	3.4%
Upper Takutu - U er Ess uibo	94G	2.3%
East Berbice-Corentyne	4,476	1.4%

Source of Population Data
Beale, Sonkarley Tiatun; Phil, M. "The Co-operative Republic of Guyana: National Census Report Population and Housing Census. 2002." Bureau of Statistics Guyana. 19 September 2007.

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Table 5.10 Primary Characteristics of Marine Fisheries in Guyana

Type of fishery	Species	Gear	Depth
Industrial	Seabob and prawns	Trawls	0-20 fathoms
Semi-industrial	Red snapper and vermillion snapper	Fish traps and lines	Edge of continental shelf
Artisanal	Mixed finfish and shrimp	Gillnets, seines, and others	0-10 fathoms
Shark	Various	Trawls, gillnets, and hook and line	Throughout the continental shelf waters

The industrial seabob and prawn fisheries are the most organized and heavily managed fisheries in Guyana. There is a formal stock assessment process for the seabob fishery, although no stock assessment process for prawns in Guyana. The seabob fishery produces higher yields than the prawn fishery and the seabob population is generally considered to be in better condition than the prawn population (MOA, 2013). The seabob fishery landed more tonnes (approximately 19,433) than any other fishery in Guyana in 2012 (MOA, 2012).

Industrial fishing operators are represented by two types of trade organizations in Guyana. The Guyana Association of Trawler Owners & Seafood Processors (GATO&SP) was established in 1999 to promote the interests of the industry and to facilitate cooperative relationships among its members at a national level. The membership is comprised of trawling vessel owners and seafood processors (PSC, 2014) and interfaces directly with regulators on matters of interest to its members. At the regional level, the industrial fishery is organized into cooperatives. There were six cooperatives active in 2013. Cuyuni-Mazaruni and Mahaica-Berbice each had two active cooperatives while Demerara-Mahaica and East Berbice-Corentyne each had one.

The semi-industrial fishery is not as organized as the seabob and prawn fishery, and there is no formalized stock assessment process for the snappers that the semi-industrial fleet targets. The semi-industrial fishery produces much smaller yields than the industrial fishery. In 2011 the semi-industrial fishery landed 1,126 tonnes. The artisanal fishery is similarly unorganized, with only about a third of the estimated 1234 vessels participating in the fishery having been licensed. The artisanal fishery landed an estimated 16,300 tonnes of mixed finfish in 2012. The shark fishery is also poorly monitored, but the MOA estimates that it produced 1.05 tonnes of landings in 2012 (MOA, 2013).

In addition to the fisheries described above, subsistence fishing also occurs throughout the coastal regions of the country, in the nearshore marine environment, estuaries, and rivers. Unlike the fisheries described above and in Table 5.8, the catch is consumed personally by either the fisherman, his family, and/or friends/associates the subsistence fishery in subsistence fishing, and sustenance is the prime motivating factor rather than profit. Subsistence fishing tends to be influenced by the season, and often occurs during "off" periods for agricultural and other activities (Maison, 2007). Small flat bottomed vessels and cast nets, seines, or handlines are the primary gears used in the subsistence fishery. Subsistence fishing is essentially a non-commercial activity so it is not effectively regulated and no landings data are available.

5.3.3 *Cultural and Archaeological Resources*

The literature reviewed for this profile did not reveal a detailed listing of shipwrecks offshore Guyana. However, a website claiming to be the world's largest online shipwreck database reports as many as 501 sites in the coastal waters reaching from Trinidad to Cayenne, French Guiana. Within Guyana's EEZ, most of the wrecks documented are located along the eastern coast from Georgetown to the Surinamese border, and occur within 30 km of the coast (Wreck Site, 2012).

In March 2012, the cargo ship MT Chrisanne V sank off the coast, near the mouth of the Pomeroon River and in 2009, an American company called Sub Sea Research claimed to have discovered a shipwreck 40 miles off the coast of Guyana, in 800 feet of water. The ship is reported to have cargo on board worth billions of dollars, but this claim has not been validated (ABC News Australia, 2012).

Georgetown and the surrounding region are known for historic buildings, which date to the late eighteenth century through the mid-nineteenth century when Guyana was a first a Dutch colony and later an English colony (National Trust of Guyana, 2009). Historic buildings from this period include the Staboek Market, Fort Zeelandia, St. George's Cathedral, Parliament, the Red House, the State House, City Hall, The High Court, St. Andrew's Kirk, Church of the Sacred Heart, and the Georgetown Light House. Other historic features include several monuments and museums. Several of these buildings been nominated as UNESCO World Heritage Sites including Fort Zeelandia, St. George's Cathedral, and City Hall, but none of the nominations have been formally accepted to date (UNESCO, 2014).

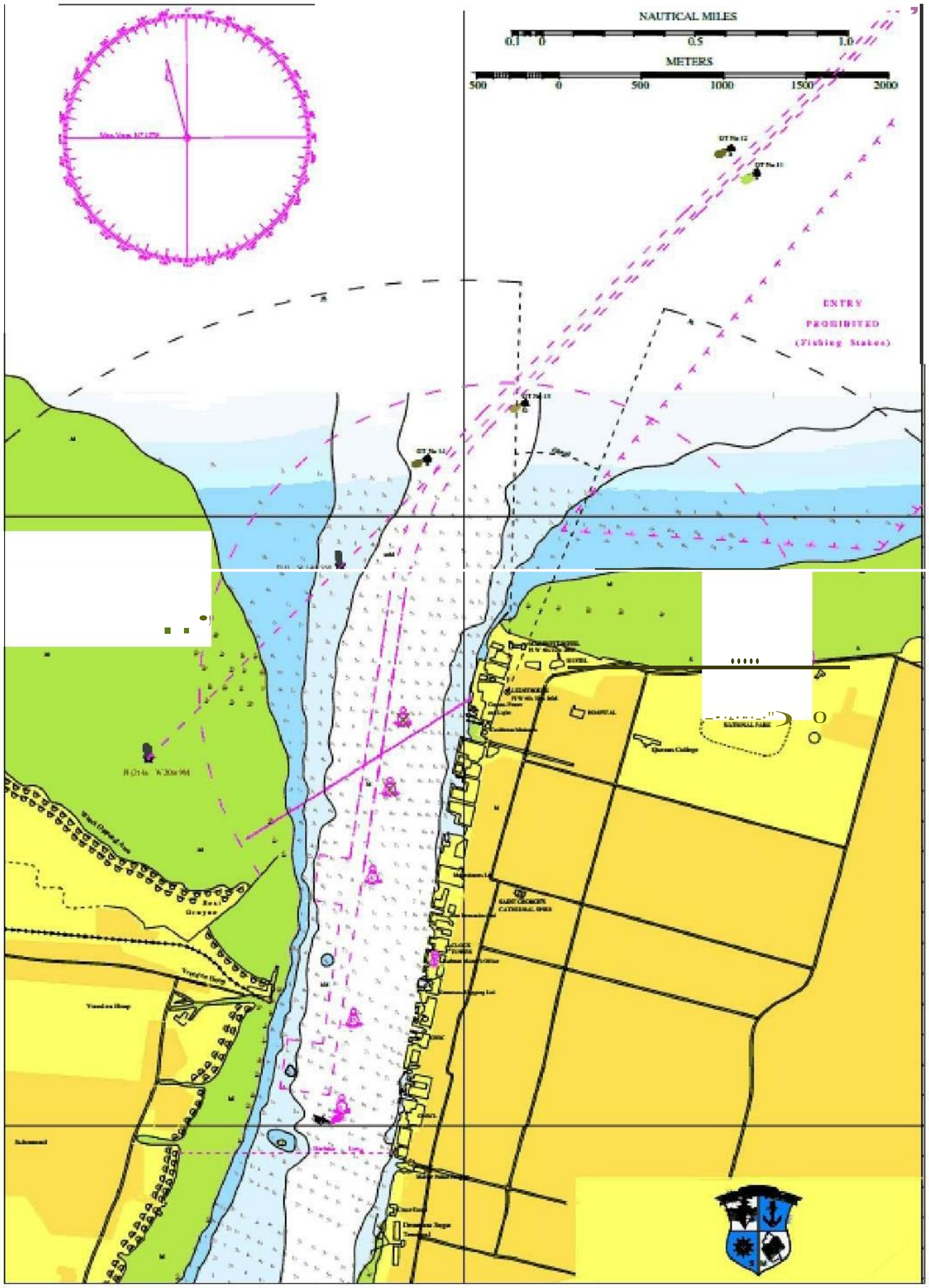
5.3.4 *Navigation and Marine Infrastructure*

A shipping channel is maintained on the lower Demerara River for the use of private, commercial, and military vessels. Superintendent of Surveys of the Habour Master Department indicates that ship draft is presently 4.5 meters at low water for supply boats in the Demerara River. Dredging is presently being conducted by the MARAD to obtain this year's target of 5.5 meters at Low water.

The Port of Georgetown, which is equipped with over 40 separate wharves, and the country's 1,000km of navigable river waterways provide easy access to most centers of economic activity. There are also several existing portside facilities (docks) along the mouth of the Demerara River near Georgetown that can be used as staging areas or storage yards, however they are congested and space is limited. Smaller ports can also be found at New Amsterdam on the Demerara River. Figures 5.9 and 5.10 illustrate the channels in the vicinity of Georgetown Harbour and Berbice, respectively.

Shipping routes between various ports along coastal South America and the Caribbean region do exist although they have not been provided to date. Pilotage services are available through the Stabroek Harbour Master, and the department has the capacity to handle the piloting needs for the Project. No formal piloting arrangement exists for the Berbice River. The department can, however, on request facilitate the piloting needs of the company within the Berbice River. For such cases, the department would hire boats and provide the pilot. The Stabroek Harbour Master has advised EEPGL that the Jamaican and Trinidadian vessels' shipping lanes may intercept the exploration block. Further consultation will be required to determine the appropriate course of action to address such potential conflicts. The Transport and Habours Department is responsible for the management of the national ferry service. The department has four ferry vessels, three operational in the Essequibo River and one in the Berbice River.

Figure 5.9 Shipping Channel in the Demerara River



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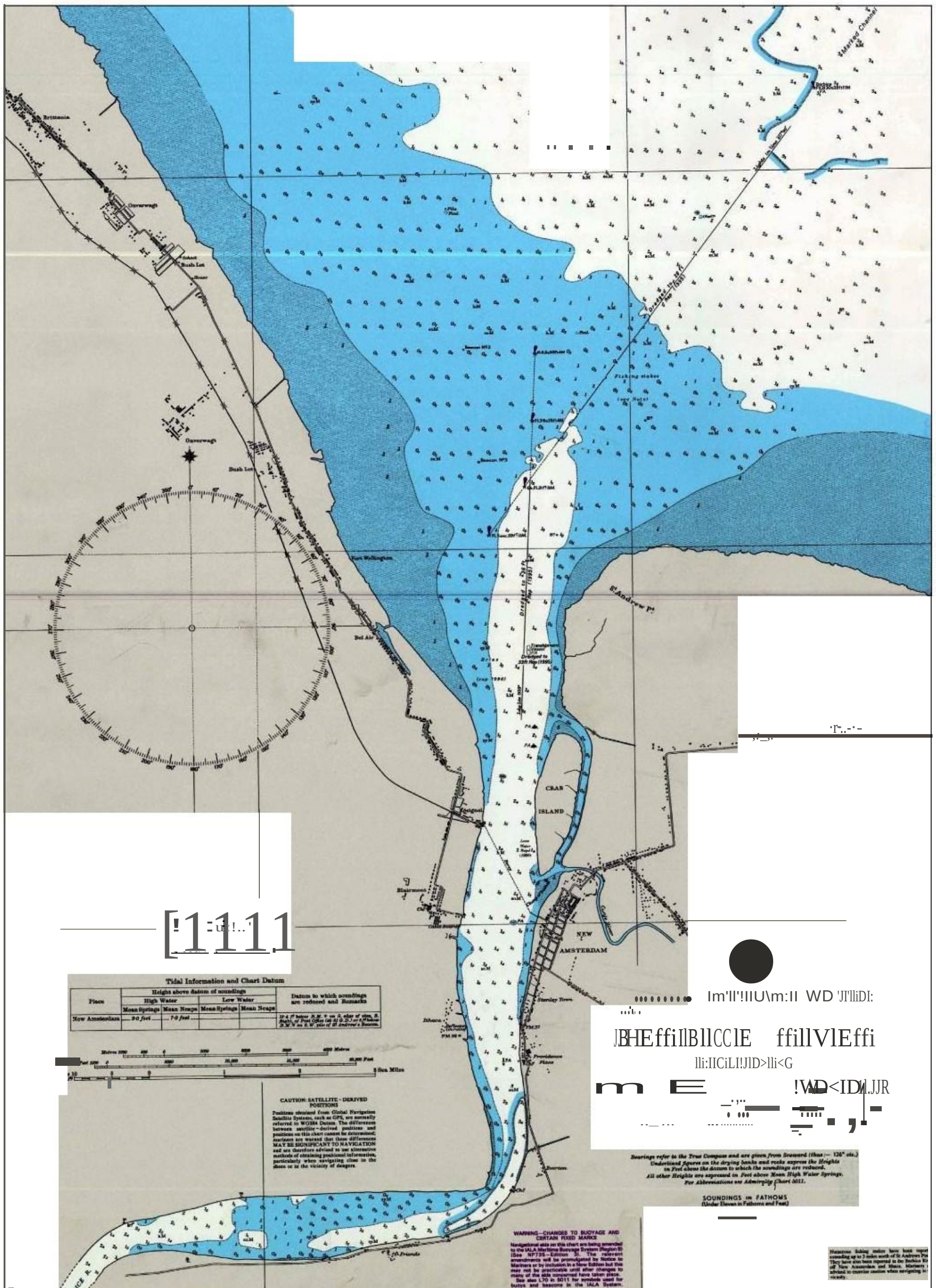
Navigational Chart of Guyana:
Showing Georgetown Harbour
Esso Guyana Project
15 January 2014

Figure 5.10 Entrance to the Berbice River



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Navigational Chart of Guyana: Entrance to the Berbice River

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5.3.5 *Land Transportation*

Land based transportation infrastructure in Guyana is comprised of road and rail service, although automobiles have replaced trains as the preferred mode of transport across the country. The national road network consists of a few primary routes connecting the major towns across the coast and selected communities in the interior. Various smaller roads, many of which are unpaved connect communities across the interior. The Project would not require overland transport outside of Georgetown and/or Berbice, so the remainder of this section focuses on the local transportation conditions in those towns.

Georgetown has a compact network of streets at its center that is typical of a small city. Several factors negatively affect traffic conditions within the city. Speeding, reckless and aggressive driving, and driving under the influence of alcohol frequently contribute to traffic accidents in Georgetown. Road conditions vary widely and can be poor. Traffic signage is often ignored (OSAC, 2013). Many intersections are not signal controlled, and where signals do exist they are frequently out of service. Many different types of vehicles including cars, large commercial vehicles, mini-buses, horse drawn carts, bicycles, mopeds, scooters, and motorcycles all share the same travel lanes and traffic congestion occurs frequently. Driving at night poses additional concerns due to poor street lighting and road conditions, drivers not lowering high beam lights, livestock, and pedestrians congregating by the roadside (OSAC, 2013). Many of the same conditions that affect road transportation in Georgetown, including variable traffic and infrastructure conditions, driver behavior and ability, and mix of vehicles using the roads also affect road transportation conditions in Berbice.

Traffic congestion is a chronic problem in Georgetown, and the East Bank Demerara Road which is the major arterial road connecting much of the Georgetown Port area to the rest of Georgetown is particularly susceptible to congestion due to backups at the Demerara Harbour Bridge. Daily retraction of the bridge for a period of about one hour causes severe road traffic congestion at both ends of the bridge, as well as delays and inconvenience to ocean going vessels. Traffic congestion does not present as significant a challenge in Berbice as it does in Georgetown due to its smaller population, but can occur.

5.3.6 *Tourism and Recreation*

Most tourism activity and infrastructure in Guyana is located along the coast, although in recent years tours into the interior have increased in popularity. Hotels and other forms of accommodation may be found in most of the major coastal cities and towns including Georgetown, Linden, Berbice, and Bartica, although most of the hotels are located in Georgetown. Five of the six major resorts in the country are located on the coast as well. Most of the major outfitters offering tours into the interior also operate from offices in Georgetown.

Tourist attractions in Georgetown and surrounding areas

Most of the major tourist attractions in Guyana such as museums, zoos, parks, public gardens, etc. are located in Georgetown. Georgetown and the surrounding areas are known for their many historic buildings, which date to the late eighteenth century through the mid-nineteenth century when Guyana was a first a Dutch colony and later an English colony (National Trust of Guyana, 2009). Historic buildings from this period include the Staboek Market, Fort Zeelandia, St. George's Cathedral, Parliament, the Red House, the State House, City Hall, The High Court, St. Andrew's Kirk, Church of the Sacred Heart, and the Georgetown Light House. Other historic features include several monuments and museums. Several of these buildings been nominated as UNESCO World Heritage Sites including the Fort Zeelandia, St. George's Cathedral, and City Hall, but none of the nominations have been formally accepted to date (UNESCO, 2014). Guided tours of Georgetown's historic buildings and sites are available.

Guided tours of such attractions as the Essequibo River, the El Dorado Rum Factory, and the Georgetown City Center are also available in Georgetown.

Ecotourism

Guyana's National Development Strategy identifies ecotourism and adventure tourism as growth sectors of the national economy (NDP, 1997). It describes Guyana as being uniquely suited for development as an ecotourism destination because ecotourism is the fastest growing segment of the tourism industry, the diversity of Guyana's natural heritage, and Guyana's unique status as the only English-speaking nation in the Amazon Basin and South America in general.

6.0 ASSESSMENT OF POTENTIAL IMPACTS

6.1 PHYSICAL RESOURCES

6.1.1 Coastal Oceanography and Bathymetry

Drilling up to two exploration wells in the Stabroek Block would have no significant effect on the oceanographic conditions or bathymetry of the offshore environment. The regional currents, waves, tides, and other physical attributes of the ocean would not be altered by the Project. The presence of the rig and the support vessels in the water column will create turbulence in water moving past them, which would cause temporary and extremely localized disturbances in the natural current patterns, but these effects would dissipate within a few hundred meters of the rig and would cease entirely after the rig is removed and the wells are capped.

The process of drilling the well will produce cuttings, which EEPGL currently proposes to discharge from the rig into the ocean after treatment to remove any hazardous fluids to acceptable discharge thresholds. The physical presence of the rig and support vessels would have no effect on bathymetry, but accumulation of cuttings discharged from the rig on the seafloor in the vicinity of the well would have the effect of raising the seafloor slightly in the affected area. Cuttings discharges have not been modelled to date, but the range of these effects would likely be similar to effects on currents (i.e., within a few hundred to a few thousand meters of the rig).

The shorebase will have no effect on oceanography or bathymetry. It will be located on land within an established industrial area either within the existing Georgetown Port, or within another facility on the Berbice River that is currently being purpose-built to support offshore oil and gas exploration activities. Regardless of the location that is ultimately selected no planned upgrades are currently expected.

The magnitude of the effects on currents and bathymetry described above will be *small*, due mainly to the small size of the impact zone. The sensitivity/vulnerability/importance of the local current patterns and bathymetry is *low*. Therefore the potential impacts of the project on oceanography and bathymetry are considered *negligible*.

6.1.2 *Marine Water Quality*

Potential impacts on marine water quality will be similar to those potential impacts on oceanography. Depending on the type and final rig selected, anchoring of the rig to the seafloor could be required. If so, such actions would temporarily disturb the sediment in the immediate vicinity of the rig. During the drilling operations, discharges from the drill rig will also temporarily alter the physical properties of the seawater within a small mixing zone around the rig. Plugging and abandonment of wells and the removal of the rig at the end of the project will again disturb the seafloor temporarily, causing minor suspension of sediment in the immediate vicinity of the rig and anchor points.

Utilization of an existing shorebase facility should have a minimal effect on marine water quality. The shorebase will include hardscape areas, but these will be located within the established boundaries of developed areas within the Georgetown Port or another facility on the Berbice River. Runoff from the shorebase will be managed by the owner/operator appropriately to prevent localized degradation of water quality. Secondary containment will be furnished for the storage of bulk fuels, drilling fluids and muds being kept at the shorebase pending transfer to the rig. Further details on the possible siting a temporary drilling mud plant at the shorebase facility will be provided to the EPA for the permitting and approval of these local operations, if used.

The purpose of the mud plant would be to provide raw material storage, batch mixing and testing of fluid products needed to support drilling operations for bulk transport to the rig offshore. Further discussion of the housekeeping and dust control procedures to be used when storing and handling bulk materials including barite, calcium carbonate, soda ash or sodium bicarbonate, lime, cement and other common drilling additives has been provided in Section 6.1.4

The anticipated effects on marine water quality from installation and operation of the rig and shorebase (i.e.; turbidity at the anchor points and planned discharges as well as material storage, handling and transfer) will be restricted to the immediate vicinity of the rig and shorebase and would be temporary in nature. The magnitude of these effects should be *negligible*. Local water quality will be sensitive to temporary changes, but the importance of such localized and temporary water quality changes in the open ocean is *low*.

EEPGL is undertaking coastal sensitivity mapping and spill modelling analyses as well as preparing a Project-specific OSRP to ensure an effective response in the very unlikely event that an unintended release of hydrocarbons occurs. Computer-based spill trajectory models will be run to predict the potential path that released materials would be most likely to take if they enter the environment, based on a number of factors. For offshore spills, key factors, or inputs, to the modeling include the quantity of material released, the type of material and its characteristics (e.g. density), historic seasonal wind and current patterns, water depth, etc. The modeling is an important component in oil spill response planning to help ensure that the necessary resources are in place to protect the environment in the event of an accidental release. Sections 2.6 and 2.7 describe some of the measures that will be employed to reduce the risk of such an unplanned event.

A preliminary assessment of the predominant winds, waves and currents off the coast of Guyana indicate that should such an unlikely event occur from either of the Areas of Interest located approximately 170-180+ km offshore, the resulting hydrocarbons released would likely follow the Guiana Current in a northwesterly direction parallel to the South American coastline into the Caribbean Sea. Surface currents may range from 10 cm/s to 216 cm/s, but mostly between 41 cm/s to 123 cm/s. These currents are highest in April and May months, and lowest in September.

It is less likely that hydrocarbons released from the Areas of Interest would contact the coast of South American, but winds in the Project area are typically from the east and northeast, which could cause a shearing force to be imparted on the surface of the slick in conflict with the northwest Guiana Current and therefore influence the final trajectory of hydrocarbons to move further southward toward land. Spreading of the slick across the water surface and variations in the Guiana Currents may also cause hydrocarbons to contact the land rather than simply travelling parallel to the shoreline, but due to the distance of the well site to the coast, the hydrocarbons would have been somewhat weathered before reaching land even if they travel south toward the coast rather than toward the Caribbean Sea.

The impact rating methodology described in Section 4.3.4 incorporates likelihood into the magnitude rating. Due to the precautionary measures listed in Sections 2.6 and 2.7, the likelihood of a major unplanned release of hydrocarbons is expected to be *negligible*.

However, considering the biodiversity values of coastal Guyana described in Section 5.2, importance of ecotourism and fishing to the national economy as described in Section 5.3, biological and socioeconomic receptors would be highly sensitive to a release, therefore the current anticipated impacts of the project on marine water quality are considered *minor* pending a final assessment of the potential impact rating for an unanticipated release of hydrocarbons will not be confirmed until EEPGL has completed the preparation of a regional coastal sensitivity map and modelling of spill scenarios.

This analysis will identify the physical, biological, and socioeconomic resources that are most vulnerable to impacts from the specific types of spill events that could occur during a project of this type and the measures to be taken to reduce such potential impacts. Regardless of how low the probability of such an event to occur, EEPGL is preparing an OSRP that will adequately and effectively outline the response for such an unanticipated release and how EEPGL would mobilize both its own resources, those of its oil spill response contractor as well as notifying Guyana's government to mobilize their resources.

The lead agency for oil spill response in Guyana is the Maritime Administration Department (MARAD) of the Ministry of Public Works and Communication. Maritime responsibilities are handled by several departments and ministries, though the Coast Guard, under the auspices of MARAD, enforces all maritime regulations and is the primary response organization in any marine pollution indecent in navigable waters. In addition, the Guyana Defence Force and the Fire Service also assume some operational responsibility for pollution response.

The OSRP will clearly delineate the responsibilities of each entity that would take part in a response. The coastal sensitivity mapping, modelling analysis, and OSRP are being conducted parallel to the SEA process. EEPGL will share the coastal sensitivity map and results of the modelling analysis with government stakeholders when they are available, and will consult directly with the Guyanese government stakeholders to develop the OSRP.

6.1.3 *Coastal and Marine Geology and Stratigraphy*

The well(s) will disturb the shallow marine sedimentary layers and underlying geology within the well annuli, and accumulations of discharged cuttings will cause additional accumulations in the immediately surrounding area(s). The cuttings will remain in the marine environment once discharged, but as described in Section 5.1.3 the marine sediments offshore Guyana are highly dynamic, so the cuttings would be expected to dissipate away from the well site rapidly over time. Therefore the impact of the cuttings on marine stratigraphy will be very *minor*.

The project will have no effect on coastal geologic resources. The shorebase and utilization of local office space and residential housing /accommodations are the only element of the project that will be located on the coast and operation of the shorebase will have no effect on the underlying geography of the site, regardless of the final location selected. The magnitude of the project's effects on marine geology and stratigraphy will be *small*. The sensitivity/vulnerability/importance of the local marine geology and sediment patterns is *low*, so the combined rating of potential impacts on coastal and marine geology and stratigraphy is *negligible*.

6.1.4 *Air Quality*

The shorebase and marine components of the project will both have localized impacts on air quality. The primary effects of the shorebase activities on air quality will be those emissions from combustion sources (e.g.; nitrogen dioxides (NOx), sulfur dioxide (SO2), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter) and dust[4]. Small generators , power equipment, cranes and other mobile combustion sources used onsite will generate small amounts of air emissions. The batch preparation of drilling fluids, muds and cement at the shorebase and associated transfer of such materials and goods to the support vessels serving the drill rig as well as wastes from the rig and vessels have the potential to generate dust. Appropriate measures will be put in place to reduce the amount of dust generated at the shorebase. These include watering unpaved areas and roads, storage of materials in

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[4] Although dust is also particulate matter, dust is included separately here to differentiate between microscopic particulate combustion products and larger-grained products from the physical breakdown of granular materials.

sealed containers, and proper maintenance and operation of the mud plant.

Air quality impacts associated with the drilling operation in the offshore environment will be limited to combustion emissions associated with operation of power equipment on the drill rig and support vessels. The constituents of the offshore combustions emissions will likely be similar to the constituents identified above for the shorebase, although the volume and duration of combustion products generated will be greater offshore. There will also be combustion emissions associated with the transit of vessels between the shorebase and the well site(s).

The magnitude of potential impacts in both locations is expected to be *small*. Activities offshore may produce more air pollutants than the shorebase but there are no sensitive receptors offshore and the pollutants would dissipate before reaching the coast, so the sensitivity and importance of air quality in the immediate vicinity of the shorebase (regardless of whether it is located in Georgetown or Berbice) is more important than at the well site(s) due to the proximity of both potential shorebase sites to populated areas. In recognition of this sensitivity, the sensitivity/vulnerability/importance of air quality impacts is rated as *medium*. The overall rating of potential impacts on air quality is *minor.*

6.1.5 Natural Hazards

As described in Section 5.1.5, the most significant natural hazard risks in the coastal and offshore environments that could be affected by the Project are floods and drought. None of the Project components will substantially affect susceptibility to these hazards nor impact the protection of the coastal plain. None of the activities that will occur offshore at the well site(s) will affect the rate at which floods or droughts occur or their impacts on affected populations, particularly within the coastal plain. Likewise, establishment and operation of the shorebase will not affect the incidence or impacts of floods or droughts in the surrounding areas. The magnitude of the effects on natural hazard risks described above will be *negligible*, due mainly to the small size of the impact zone. The sensitivity/vulnerability/importance of the natural hazard risks to the local population is *low*. Therefore the potential impacts of the project on natural hazard risks are considered *negligible*.

6.2 BIOLOGICAL RESOURCES

6.2.1 Coastal and Marine Habitats

Most of the planned project activities will have insignificant effects on coastal and marine habitats. Drilling the well(s) will cause extremely localized physical disturbance of the bottom habitat at the well site, and resuspension/resettlement of sediment during setup of the drill rig will affect a small area of down current from the well sites(s). The extent of the area that will be potentially affected by re-settlement of sediment is unknown because it depends on several variables including the density and quantity of sediment disturbed and the velocity of any bottom currents that may occur at the time when the sediment is disturbed. Nevertheless, the sediment that is re-suspended will have the same biophysical properties as the seafloor surrounding the well site, re-settlement will be a short-lived, temporary occurrence, and most of the suspended sediment is expected to re-settle in the general vicinity of the rig. As described in Section 6.1.1, cuttings discharges have not been modelled to date, but the range of these effects would likely be similar to effects on currents (i.e., within a few hundred to a few thousand meters of the rig).

The magnitude of the effects on marine habitat described above will be *small*, due mainly to the small size of the impact zone relative to the size of the deep shelf ecosystem in which is will occur. Cold water corals are known to occur offshore Guyana, and are known to be sensitive to physical damage due to their slow growth rates and fragility of their calcium carbonate exoskeleton. Offshore drilling and production activities are considered a potential threat to cold water corals (e.g. from physical disturbance, release of chemicals and discharge of drill cuttings and cement). Although it is currently unknown whether they occur within the zone that would be potentially affected by the sediment and/or cuttings plumes generated by the rig, if they do occur in the area they will be highly sensitive to accumulations of sediment and/or cuttings.

Taking into account the high sensitivity and vulnerability of these corals, their importance to deepwater marine biodiversity, and the uncertainty surrounding their distribution in the immediate vicinity of the well(s), the sensitivity/vulnerability/importance component of the impact rating is *medium*. Therefore the potential impacts of the project on marine habitat are considered *minor*. Upon completion of the coast sensitivity mapping and oil spill modelling efforts described in Section 6.2.1 the potential impact rating for an unanticipated release of hydrocarbons to reach coastal and marine habitats will be reassessed.

Establishment and operation of the shorebase will have little to no impact on coastal habitat. It will be located entirely within an existing industrial facility within the Georgetown Port or another facility dedicated to support of offshore oil and gas facilities located on the Berbice River. The Georgetown Port is an existing facility and the Berbice River facility is currently being built to accommodate another offshore exploration project, so regardless of the location that is ultimately chosen for the Stabroek project's shorebase, it will not drive additional habitat impacts. The magnitude of the shorebase's effects on marine habitat will be *small* and the sensitivity/vulnerability/importance of the effects will be *low*, so the potential impacts of the project on coastal habitat are considered *negligible*.

6.2.2 Mangroves

The Project is not expected to directly affect any mangroves. Drilling and associated activities in the marine environment will take place over 100 km offshore from the nearest mangrove, and the shorebase will occupy land that has already been developed or is currently being developed as industrial zones.

The main risk to mangroves associated with the Project is related to the potential for an unintended release of hydrocarbons. As described in Section 6.1.2 an unplanned release of hydrocarbons to the marine environment is very unlikely, but possible. Sections 2.6 and 2.7 describe the measures that will be put in place to reduce this risk and Section 6.1.2 summarizes the numerous organizations that would respond to a release event. Given these measures and the location of the well site(s), the magnitude of the impacts of a release on mangroves expected to be *negligible*. Mangroves are important providers of a number of ecological services upon which fish, wildlife and humans depend and they depend on a delicate balance of hydrologic conditions and sediment/water quality to thrive, so their sensitivity/vulnerability/importance is *high*. Therefore the potential impacts of the project on coastal habitat are considered *negligible*.

6.2.3 Mud Banks

The Project is not expected to directly affect mud banks along coastal Guyana. Drilling and associated activities in the marine environment will take place over 100 km offshore, and the shorebase will occupy land that has already been developed or is currently being developed as industrial zones.

The main risk to mud banks associated with the Project is related to the potential for an unintended release of hydrocarbons. Mudbanks are of critical ecological importance as feeding zones for birds, nursery areas for fish, and habitat for a variety of invertebrates so the sensitivity/vulnerability/importance of these resources is *high* but the likelihood of a release reaching these areas is very small, so the magnitude of this impact is considered *negligible*. Sections 2.6 and 2.7 describe the measures that will be put in place to reduce this risk and Section 6.1.2 summarizes the numerous organizations that would respond to a release event. Given these measures and the location of the well site(s), the overall rating of potential impacts on mud banks is *negligible*.

6.2.4 Marine Finfish

As described in Section 5.2.3, the Project's footprint spans multiple fish communities. The well site(s) will be located in an area inhabited by demersal and pelagic marine fishes, while the shorebase will be located in an area inhabited by estuarine species. The shorebase will have virtually no impacts on finfish because it will not change the water quality or physical habitat conditions in the Demerara or Berbice River estuaries. Activities at the well site will have a slightly greater impact on finfish.

Setting up the rig, drilling the well(s), conducting the VSP, plugging and abandonment of the well(s), and de-mobilizing from the well site(s) will cause visual, auditory, and physical impacts to the marine environment, and will likely cause sensitive species to avoid the immediate area surrounding the rig until activities at the well site(s) are concluded. All these potential impacts will be localized and temporary. The impact of the VSP will have a slightly larger auditory footprint than the well setup, and could affect hearing specialist species[5] and those species with well developed swim bladders[6] more than others in the immediate vicinity, but the available literature suggests that the VSP would have little or no lasting effects on finfish (URS, 2009; LGL, 2006). These effects may be offset to some degree by the rig's propensity to provide habitat for

[5] Hearing specialists are species that have developed heightened sensitivities to sounds in a specific frequency range. This adaptation occurs in some species to facilitate feeding or social behavior. Hearing specialists are distinguished from hearing generalists, which hear equally well across a wider range of frequencies, but do not possess the acuity of the specialists within their specific frequency range.

[6] Caged exposure tests have determined that species with large swim bladders or other highly vascularized, low density organs or structures tend to be more susceptible to acute acoustic injury than species that lack these features when exposed to such sources within a few meters.

structure-oriented species, but the effect of providing additional habitat for these species will also be temporary.

If an unintended release were to occur the magnitude of impacts on finfish would be much greater, and would range from lethal, to sublethal, to displacement. Given the spatial limitations and temporary impacts of the most likely impacts of the project and the small likelihood of a hydrocarbon release, the magnitude of impacts on marine finfish will be *small*. As a group marine finfishes have a moderate sensitivity to the types of sensory and physical impacts that will occur during drilling operations. They are much more sensitive to impacts from a hydrocarbon release, but many would vacate the area in the event of a release. Therefore marine finfish are considered *moderately* sensitive/vulnerable to impacts from the Project. The overall rating of potential impacts on marine finfish is *minor*.

6.2.5 Seabirds

The Project's impacts on seabirds will be similar to its impacts on finfish. The shorebase will have minimal impacts on birds because of its small footprint and general lack of impact on seabird habitat. Some secretive species may avoid the area around the rig while drilling operations are underway, but the presence of the rig and support vessels is also likely to attract more tolerant seabird species, which will use them to perch and loaf. Seabirds can be attracted to oil rigs by a combination of night lighting, food, and other visual cues (Baird, 1990; Weise et al., 2001) and this attraction can render them more susceptible to certain hazards including impacts with the rig structure, oiling, and incineration by flares (Weise et al., 2001).

Using rigs as a resting place provides energetic benefits to the birds, and to the extent that the rigs concentrate food, such as small baitfish, they may in some cases provide nutritional benefits as well. These positive effects must be weighed with the potential negative effects of being injured or killed by collisions with the rig, flaring, or becoming oiled. The magnitude of both the positive and negative effects of the Project on seabirds will be *small* due to the short duration of the drilling campaign. The sensitivity of the seabird population is *medium*, considering that rigs attract seabirds and that they experience both positive and negative effects as a result of that attraction. The overall rating of potential impacts on seabirds is *minor*.

6.2.6 *Benthic Resources*

As described in previous sections, setup and operation of the rig will temporarily disturb a small area within the footprint of the rig supports and the drill apparatus. Benthos that is unable to avoid these components will be injured or killed, but this effect will only occur within the immediate footprint of the rig and is expected to affect a relatively small number of organisms. Deposition of sediment and cuttings will affect a somewhat larger area, but the impacts of sediment and cuttings deposition on benthos will be less severe.

As described in Section 5.1 through 5.3, the seafloor within the Areas of Interest continually receives inputs of sediment via the North Brazil Current as well as from upslope areas to the south. It is a dynamic system, and the benthos in this area are adapted to continual deposition of sediment through the water column; however the benthic community is the only biological community that will unavoidably come into physical contact with the drilling apparatus. Should an unintended release from the well occur, the benthic community would also be in the closest proximity to the hydrocarbons being released. The shorebase will have virtually no impact on benthos because it will be located on land. The magnitude of the Project's impacts on benthos will be *small*, and the sensitivity/vulnerability/importance of these potential impacts will be *medium*, therefore the overall impact on benthos will be *minor.*

6.2.7 *Marine Reptiles*

The shorebase will have virtually no impacts on marine reptiles because it will be located in a riverine area where marine reptiles do not occur. Marine reptiles are transients within the Sorubim and Liza Areas of Interest, so they may encounter the rig or the support vessels but would not be expected to be negatively impacted by their presence unless they collided with a support vessel transiting between the rig and the shorebase. This event would likely have significant impacts on the individual turtle but would not have a significant impact on the regional population.

The most significant albeit unlikely potential impact of the Project on marine reptiles would be an unintended release of hydrocarbons. As described above, the possibility of an unintended release of hydrocarbons exists, but is remote. Various safeguards will be put in place to reduce the risk that a release could occur, but if a release were to occur, the impact on sea turtles could be very significant especially if it reached the nesting beaches on Guyana's coast. The magnitude of low level of impacts that would occur under normal conditions would be *negligible* and the likelihood of a hydrocarbon release reaching the nesting beaches is also very small, but considering the regional importance of Guyana's nesting beaches if a spill were to reach the nesting beaches the impacts could potentially last for multiple migratory seasons and affect populations distributed across the Caribbean region. The scale and duration of the potential impacts of a hydrocarbon release are uniquely higher for marine reptiles than for other marine biota. Therefore the overall magnitude of potential impacts on marine reptiles is considered *medium*.

The overall sensitivity/vulnerability/importance of impacts on marine reptiles related to an unintended hydrocarbon release are more difficult to assess because they are dependent on several factors, many of which vary among species and according to seasonality and the specific spill scenario under consideration. These factors include:

- The chemical composition and concentration of the hydrocarbon and any other chemicals used during the response;
- The dose received and duration of exposure;
- The route of exposure (inhaled, ingested, absorbed, or external); and
- The biomedical risk factors of the animal (age, sex, reproductive stage, and health status). For turtles this will include differing impacts and vulnerabilities at the different life stages such as eggs, post-hatchlings, juveniles and adults (NOAA, undated).

The effects on sea turtles of encountering hydrocarbons range widely depending on the specific scenario. Death can occur from numerous complications, but sublethal effects such as skin and eye irritation, respiratory complications, gastrointestinal injury or irritation, burns to mucous membranes of eyes and mouth, and increased susceptibility to infection can also occur (NOAA, undated).

The presence of the Shell Beach nesting area, which is a large reproductive aggregation of regional significance to several species is unique to sea turtles, and does not occur among the other taxonomic groups considered in the impact assessment. Considering the relatively innocuous nature of the most likely effects and the potentially damaging effects of a hydrocarbon release together, the overall sensitivity/vulnerability/importance of potential impacts on marine reptiles is considered *medium*. Therefore the Projects potential impact on marine reptiles are collectively rated as *moderate* pending completion of the oil spill modelling and coastal sensitivity mapping.

6.2.8 Marine Mammals

The shorebase will have very few if any potential impacts on marine mammals because they generally do not occur in the vicinity of either site that is currently under consideration for the shorebase. The likelihood of a collision event with a supply or support vessel would also be extremely rare due to the operating speeds of the vessels, and typical marine navigation best practices to be employed. EEPGL will have a marine mammal observer on board the vessel during the performance of the VSP.

In the very unlikely event of an unintended release of hydrocarbons, marine mammals would be expected to generally avoid the affected area, but prior oil spills have demonstrated that complete avoidance does not always occur, particularly in cases of large spills (NOAA, undated). Marine mammals as a group would be less susceptible to large-scale mortality under a spill scenario than sea turtles because they do not have reproductive aggregations in the area equivalent to the sea turtles at Shell Beach, and although some whales raise their calves in the Caribbean and tropical North Atlantic region, marine mammal calves would be better able to swim away from the affected area than a neonatal sea turtle.

Seismic surveys are suspected of having a range of effects on marine mammals including annoyance/harassment, interference with echolocation and communication, and potential injury. Although there is general consensus that seismic surveys have the potential to negatively affect marine mammals and it can be difficult to predict or quantify specific impacts, there is a growing amount of empirical evidence being gathered that shows no injury from seismic surveys.

Specific behavioral observations of marine mammals exposed to seismic stimuli are typically variable and some findings are contradictory. Where feeding, orientation, hazard avoidance, migration or social behaviour are altered, it is possible that populations could be adversely affected but the biological significance of these effects has not been measured (Gordon et al., 2004). The magnitude of Project-related impacts on marine mammals is therefore considered *negligible*. The magnitude of these potential impacts is generally understood to be highly dependent on the proximity of the animal to the source and the duration of the exposure, which of which can be reduced through adaptive measures such as pre-acquisition visual surveys of the Project area, stationing observers during data acquisition, and using "soft starts".

The most significant potential risk of Project-related impacts on marine mammals would be associated with the performance of the planned VSP after drilling is complete. The most likely effects of the VSP would include temporary displacement and/or interference with communication and navigation. No documented cases of a VSP causing injury to a marine mammal have been confirmed. Due to marine mammals' tendency to travel in groups, the potential for impacts on multiple individuals could exist. Considering the very short duration of such a survey, the magnitude of the potential impact on marine mammals by this activity is expected to be *low*.

Taking into consideration the wider range of potential impacts that could occur as a result of increased marine vessel traffic and the unlikely occurrence of an unintended release the overall sensitivity/vulnerability/importance of impacts on marine mammals is rated as *medium*, and an overall rating of Project-related potential impacts on marine mammals is *moderate*.

6.2.9 *Special Status Species*

Project-related impacts on special status species can be considered a subset of the biological resource impacts discussed in Sections 6.3 through 6.8 above; however potential impacts on special status species require special consideration because these species are assumed to have a diminished capacity to recover due to their conservation status. The four Critically Endangered species in Appendix 1 (Atlantic goliath grouper, daggernose shark, Caribbean electric ray, and largetooth sawfish) are all finfishes, as are four of the Endangered species (Nassau grouper, squat-headed hammerhead, scalloped hammerhead, and Atlantic bluefin tuna). All have been listed as Critically Endangered or Endangered due to a combination of fishing mortality (both as target species or bycatch), habitat loss, slow maturation rates, and low fecundity, although habitat loss is a much less important driver than fishing-related mortality in the status of the Endangered category than in the Critically Endangered species (IUCN, 2014).

All of the Critically Endangered species are estuarine and nearshore species, so the Project will not directly affect habitat for these species. The Endangered finfishes are distributed more offshore so they will have the potential to encounter the rig and support vessels, but the Project will not alter habitat conditions for these species. The Project will not affect fishing-related mortality rates for any finfish species. The Project will not affect any of the underlying causes for these species' declines across their ranges, so the magnitude of Project-related potential impacts on Critically Endangered species and Endangered finfishes will be small. There is no direct nexus between the primary factors in these species' declines so their overall sensitivity/vulnerability/importance to the Project is rated as low and the overall effect of the Project on these species will be *negligible*.

Two non-fish species, green turtles and giant otters, are also listed as Endangered in Appendix 1. Potential impacts on green turtles are considered *moderate* as discussed in Section 6.2.6. Giant otters are endangered due to a combination of the legacy effects of historically widespread hunting and present-day destruction of riparian tropical forests, especially along large interior rivers (IUCN, 2014). The Project will not affect giant otters' habitat, nor will it affect the species' capacity to recover from legacy impacts. Therefore the magnitude of Project-related impacts on giant river otters will be *small* and their sensitivity to Project-related impacts will be low, so the overall effect of the Project on giant river otters will be *negligible*.

Vulnerable species include a mix of elasmobranchs (sharks and their relatives), marine mammals, finfishes, and the leatherback turtle. The Near-Threatened category is comprised entirely of finfishes and almost entirely of elasmobranchs. The elasmobranchs and finfishes in both categories are mostly listed due to overfishing, slow maturation rates, and low fecundity. Overfishing is the primary factor implicated in the status of the Near-Threatened bony fishes (groupers and tunas). Numerous factors including habitat loss have been implicated in declines of tarpon and leatherback turtles. The Project will be located within offshore habitat for several of these species and adjacent to inshore habitat for tarpon, but will not alter the value of the habitat or the capacity of these habitats to support these species. The overall effect of the Project on these species will be *negligible,* with the exception of potential impacts on leatherback turtles which are considered *moderate* as discussed in Section 6.2.7, and on marine mammals as discussed in Section 6.2.8.

The Data-Deficient category is the largest group of species in Appendix 1. This group is similar to the other groups in that it consists mostly of fishes that are listed due to a combination of suspected overfishing and habitat loss. This group also includes some whales which have been listed due to naturally low population levels, legacy impacts from historical hunting and habitat conversion. It is difficult to assess the magnitude and sensitivity/vulnerability/importance of impacts on this group because it includes so many species and the threats to these species are diverse. These limitations notwithstanding, unlike the other IUCN listing categories, Data-Deficient species are not assumed to be in need of conservation action; they are listed because sufficient information does not exist to determine whether a need exists. Further, most Data-Deficient species listed in Appendix 1 are listed primarily due to factors that are unrelated to the Project.

6.2.10 *Protected Areas*

Shell Beach is the only one of Guyana's protected areas that would be potentially exposed to impacts from the Project. Shell Beach's sensitivity to Project-related impacts derives from the sensitivity of its biodiversity, which would be highly sensitive in general to releases of hydrocarbons. The key threat to Shell Beach's biodiversity is a potential unintended release of hydrocarbons. As discussed in Section 6.2.6, sea turtle nesting habitat is one of Shell Beach's most important biodiversity-related attributes. Although the potential impacts of expected Project-related activities will be minimal and Shell Beach would not be highly sensitive to the Project under normal conditions, Shell Beach would be highly sensitive to a hydrocarbon release and if hydrocarbons were to reach Shell Beach.

The low likelihood of such a release reaching Shell Beach is related to several factors described in Section 6.1.2, including the very small likelihood of a significant release occurring, the tendency of ocean currents to carry hydrocarbons toward the Caribbean Sea rather than the Guyanese coast, and the magnitude and duration of the wind shear or current deviations that would be necessary to re-direct hydrocarbons across more than 160 km of ocean to the coast. If a large amount of hydrocarbons reached Shell Beach the ecological effects could be far reaching and long-lasting, but the likelihood of a release reaching Shell Beach is very *small*. Therefore the magnitude of potential impacts related to an unintended release of hydrocarbons reaching Shell Beach is considered *negligible* and the Projects' impacts on protected areas are collectively rated as *minor*.

6.3 SOCIOECONOMIC AND CULTURAL RESOURCES

6.3.1 Demographics

The Project will have very little effect on demographics, primarily because most of the Project-related activities and infrastructure will occur offshore. Workers will be accommodated on the rig and support vessels, and will not come ashore except to re-supply the rig from the shorebase. The Project may provide a modicum of employment for a small number of local workers, but this work will be short term and will last only for the length of the Project. The Project will not require or encourage the relocation of large numbers of people within Guyana, nor will it promote influxes of foreign workers into the labor force. Employment opportunities and use of goods and services that arise from the Project are expected to be limited to the Georgetown and/or Berbice areas and will not influence the economy or labor force elsewhere in the country. The magnitude of the Project's potential impacts on demographic patterns is *low*, and the sensitivity/vulnerability of the demographic composition of the affected communities is *negligible*. Therefore the overall impact of the Project on demographics will be *negligible*.

6.3.2 *Regional Employment Patterns*

The Project will have little if any impact on regional employment patterns. As described above, the employment opportunities and use of goods and services that arise from the Project will not influence the economy or labor force elsewhere in the country outside the immediate vicinity of Georgetown or Berbice, and the Project will not encourage migrants to move to these areas in search of work. The magnitude of the Project's effects on labor markets throughout Guyana in general will be *small*, and the sensitivity/vulnerability of the national labor market to these effects is *low*, so the overall impact on regional employment patterns will be *negligible*.

The Project's impacts on fisheries will be limited to potential interference/displacement of fishermen from their preferred fishing locations. This could occur if the rig spuds in a popular fishing area, but the likelihood of spudding in an area of intense fishing effort is remote because of the considerable distance a fishing vessel would have to travel to reach the Areas of Interest from the coast.

Although the 2012 Marine Fisheries Management Plan states that fishing for snapper and grouper can occur as far offshore as the continental slope, the plan also states that most fishing activity takes place inshore of that point (MOA, 2013). The Stabroek PPLA is located further offshore near the continental slope, so most interactions between the Project and fishermen will be limited to encounters with the support vessels transiting between the rig and shorebase. These will be chance encounters but these should not affect fishing activities. The magnitude of effects on fishing will be *small* and the sensitivity/vulnerability of the fishing industry to these effects is *low*, so the overall impact on fishing will be *negligible*.

6.3.3 *Cultural and Archaeological Resources*

The Project will have no impacts on the historical character of the various cultural landmarks in Georgetown. Though it is reasonable to assume a shipwreck could be located in or near the vicinity of any potential offshore exploration drilling activities, performance of the geotechnical survey, shallow hazard evaluation and site clearance for the Areas of Interest will confirm whether a shipwreck or other cultural/archaeological resource is present in the vicinity of the Project. Baseline surveys performed prior to initiating activities are generally able to identify the presence of a shipwreck and allow for the feature to be avoided. Under this scenario, impacts on cultural/archaeological resources will be minimal, however the possibility for a resource to go unnoticed does exist.

A chance find could potentially occur prior to the start of drilling. Under this scenario, appropriate action would be taken to address the potential magnitude of the impact as well as the vulnerability of the resource. EEPGL understands that the National Trust is developing a chance find procedure for projects of this type, and will work with the National Trust to implement the procedure as appropriate if and when it is developed. Therefore the overall magnitude of potential impacts on cultural/archaeological resources is considered *small*, and the sensitivity/vulnerability of cultural/archaeological resources is *low*, yielding an overall rating of *negligible*.

6.3.4 *Navigation and Marine Infrastructure*

Project related potential impacts on navigation and marine transport are expected to be similar to potential impacts on fishing. Other marine vessels will likely encounter the support vessel and may pass by the rig. The Stabroek Harbour Master has advised EEPGL that the Jamaican and Trinidadian vessels shipping lanes may intersect the exploration block, but EEPGL expects to be able to locate the rig such that it does not impede shipping traffic. There is no reason to assume that the Project will impede shipping traffic either within the harbour or offshore. The magnitude of impacts on navigation and marine transport are expected to be *small*, but the sensitivity/vulnerability of shipping to such impediments will be *moderate*, especially if conflicts with ships transiting to Jamaica and Trinidad prove unavoidable. Therefore the overall rating of potential impacts on navigation will be *minor*.

The marine infrastructure available in Guyana (navigation aids, pier/port/quayside space, etc.) is generally sufficient to execute the Project. Some small improvements by owner may be made to make the shorebase fit for purpose. These small investments will have a *positive* but *minor* effect on Guyana's marine infrastructure.

6.3.5 *Land Transportation Infrastructure*

The only component of the Project that could potentially affect land transportation infrastructure is the transportation of materials and supplies between offsite pipe yards or storage/warehousing facilities areas and the shorebase. This impact would only have the potential to occur if offsite storage facilities are required as described in Section 2.10, and it is currently unknown whether the Project will require such facilities.

If offsite storage/warehousing facilities are required, materials would be transported between the offsite facilities and the shorebase by road. The scenario with the highest likelihood of potential impacts on existing land transportation capacity involves a shorebase located in Georgetown with an offsite storage/warehousing component. The likelihood of these impacts is difficult to ascertain at this point, but they would have a relatively small footprint and a short duration, so the magnitude of these impacts is considered *medium*. The sensitivity/vulnerability/importance of the impact would be *low* if the shorebase were located in Berbice due to the smaller amounts of existing road traffic there compared to Georgetown.

If the shorebase were located in Georgetown the sensitivity / vulnerability /importance of the impact would be higher because of the higher traffic volumes and existing traffic issues in the vicinity of the Demerara Habour bridge, which is in close proximity to the port. The shorebase logistics plan will take into consideration the local traffic conditions and patterns. Due to low sensitivity/vulnerability/ importance of the impact if the shorebase is located in Berbice and the availability of operational alternatives to reduce the inherently higher vulnerability associated with a shorebase in Georgetown, the overall sensitivity/vulnerability/importance of impacts on land transportation is considered *low*, and the overall impact rating is considered *minor.*

6.3.6 Tourism and Recreation

The bulk of the Project-related activities will occur offshore, where they will not affect existing tourism operations. Activities at the shorebase will occur within an industrial zone that would not be expected to attract tourists. Therefore the magnitude of impacts on tourism and recreation will be *small*, the sensitivity/vulnerability of tourism and recreation to the Project-related potential impacts will be *low*, and the overall rating of these impacts is *negligible*.

7.0 CUMULATIVE IMPACT ASSESSMENT

A cumulative impact arises as a result the synergies between Project-related potential impacts and impacts from other activities. Cumulative impacts can result from minor, but collectively substantial actions undertaken over time. The cumulative impact assessment process identifies cumulative impacts to which the Project may contribute. The approach for assessing cumulative impacts is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

The cumulative impact assessment for this SEA included three major tasks:

- Determining the scope of the cumulative analysis, including relevant resources, geographic extent, and time frame;
- Conducting the cumulative effects analysis; and
- Determining the cumulative impacts on relevant resources.

7.1 SCOPE OF THE CUMULATIVE IMPACT ANALYSIS

7.1.1 Identification of Relevant Resources

Resources identified for consideration in the cumulative impacts analysis were those that would be impacted by the Project. If the Project-related potential impacts on a resource were rated minor or higher, the resource was identified as potentially eligible for the cumulative impact analysis. Table 7-1 provides a summary of the decision-making process conducted to identify the resources that were potentially eligible for the cumulative impacts assessment based on the Project's anticipated impacts.

Table 7.1 Consideration of Resources for Cumulative Impacts Analysis

Resource	Impact Rating	Potentially eligible for Cumulative Impact Analysis
Coastal Oceanography and Bathymetry	Negligible	No
Marine Water Quality	Minor	No
Coastal and Marine Geology and Stratigraphy	Negligible	No
Air Quality	Minor	Yes
Natural Hazards	Negligible	No
Coastal and Marine Habitats	Minor	Yes
Mangroves	Negligible	No
Mud Banks	Negligible	No
Marine Finfish	Minor	Yes
Seabirds	Minor	Yes
Benthic Resources	Minor	Yes
Marine Reptiles	Moderate	Yes
Marine Mammals	Moderate	Yes
Special Status Species	Negligible	No
Protected Areas	Minor	No
Demographics	Negligible	No
Fisheries and Aquaculture	Negligible	No
Cultural and Archaeological Resources	Negligible	No
Navigation and Marine Infrastructure	Minor/Positive	Yes
Land Transportation	Minor	Yes
Tourism and Recreation	Negligible	No

Impacts from the Project alone are not sufficient to create cumulative impacts; there must be synergies between Project-related impacts and impacts of one or more other activities on a resource for cumulative impacts to occur.

In consultation with Guyanese government stakeholders, EEPGL has identified two activities with the potential for synergistic effects with the Project. The first activity is the replacement of the Demerara Harbour Bridge. In October 2013, the Ministry of Public Works released a feasibility study which determined the existing bridge had exceeded its useful life, contributed to severe road traffic congestion at both ends of the bridge (including along the East Bank Road near the Georgetown Port), and impedes shipping traffic in the Demerara Harbour. The study evaluated eight options for replacement of the Demerara Harbour Bridge. In February 2014 the Ministry of Public Works announced that although a final location for the new bridge had not been selected, Kurupukari Crossing on the Upper Essequibo River was a likely location for the new bridge (Guyana Chronicle Online, 2014).

The second activity with the potential to contribute to cumulative impacts with the Project is when and if Anadarko renews the completion of a seismic survey campaign in the Roraima block that they initiated in late 2013. That survey was interrupted due to a border dispute between Venezuela and Guyana. The geographic scale of the offshore survey area and the extent to which the survey will require support from the coastal facilities is currently unknown, but the data acquisition component of the survey would be confined to the Roraima Block.

7.1.2 Geographical Extent of Analysis

The geographic area of concern for a cumulative impacts analysis is typically defined by the extent of the influence of the Project and its alternatives. The extent of the Project's influence on the relevant resources for this cumulative impacts analysis includes the Sorubim and Liza Areas of Interest, the shorebase on the Demerara Harbour or the lower Berbice River, and the route that would be traversed by the support vessels between the shorebase and the Areas of Interest.

7.1.3 Time Frame for Analysis

In order to assess the influence of a Project, a cumulative impact analyses should consider past, present, and reasonably foreseeable future conditions. The impacts of past activities have been considered in the analysis of this SEA in establishing the current conditions against which the Project is compared. Potential impacts of concurrent and future actions are considered in this section of the SEA.

7.1.4 *Resource specific Cumulative Impact Assessment*

This section contains a summary of the cumulative impacts that would likely result from the synergistic effects of the Project and the other relevant activities on each of the resources included in the analysis as identified in Table 7.1.

Air Quality

The Project will have *minor*, temporary air quality impacts in both the onshore and offshore environments. These potential impacts will have no lasting effects on the air quality in the vicinity of either the well(s), the shorebase, or the route between the coast and the well site(s). Replacement of the Georgetown Harbour Bridge would have similar impacts on air quality as operation of the shorebase although on a larger scale and over a longer period. Synergistic effects between the two Projects would only occur if they were to occur at the same time and sensitive receptors were exposed to pollutants from both the Projects at the same time. This is unlikely given that the start date for construction of the bridge has not been announced and the most likely location of the new bridge is not near either potential location for the shorebase, and the start date for seismic acquisition in the Roraima Block is uncertain. Therefore, cumulative impacts on air quality are considered *negligible*.

Marine Finfish

The Project will have *minor* impacts on marine finfish. The potential exists for synergistic impacts on individuals or species, mostly because marine finfishes often migrate over long distance and often us different habitats at different life stages. For example, pelagic species such as sharks, tunas, or jacks could be exposed to noise from multiple marine sources over a large area or region as well as in proximity to the planned VSP component of this Project. Such activities do not necessarily have to overlap in time to generate synergies between their impacts. Demersal species like the snappers which use coastal areas as nursery habitat and offshore benthic areas to forage as adults could experience multiple impacts on nursery and adult habitat from the various activities in this analysis, although the Project's contribution to these impacts would be minimal due to the extremely small physical impact footprint. Therefore cumulative potential impacts on marine finfish are considered *minor*.

Seabirds

The same factors that determine cumulative impacts on finfish also affect the potential for cumulative impacts on seabirds. Seabirds are highly migratory and move from inshore to offshore environments readily, so they could be potentially impacted by multiple projects located both onshore and offshore. A seabird affected by one project has the potential to be impacted by additional projects occurring at a later time and across a broad spatial distribution depending on the season and their migratory patterns. Seabirds are less likely to be impacted by EEPGL activities onshore than offshore based on the location of the planned wells and small temporary shorebase operations. Therefore cumulative potential impacts on seabirds by Project activities are considered *minor.*

Benthic Resources

Benthic resources (e.g.; crabs, shrimps, worms, corals, bivalves, etc.) do not generally undertake large migrations through the open ocean, so it is highly unlikely that they will be exposed to impacts of more than one project. Therefore cumulative potential impacts on benthic resources are considered *negligible*.

Marine Reptiles

The same factors that determine cumulative potential impacts on finfish and seabirds also affect the potential for cumulative impacts on marine reptiles. They are migratory and long lived, so they could encounter and be potentially affected by multiple projects/activities however sea turtles are not attracted to offshore structure as some fish species and birds are, they aren't found within the Demerara River where the impacts from the bridge project will occur, and they aren't as sensitive to seismic impacts as marine mammals. There are very few potential synergies between the impacts of the Projects/activities included in this analysis on sea turtles except for vessel collisions and unintended hydrocarbon releases, and both of these are rare events. Therefore cumulative potential impacts on marine reptiles are considered *negligible.*

Marine Mammals

The same factors that determine cumulative impacts on finfish, reptiles, and seabirds also affect the potential for cumulative impacts on marine mammals. Marine mammals are highly migratory so they could encounter different Projects easily. They are particularly susceptible to collisions with vessels and seismic impacts, which the Project and the Roraima seismic survey both include. Like finfish and seabirds, whales affected by one project has the potential to be impacted by another project at a later time, and mammals that are not directly affected by the Project or the other activities may also be impacted by food-chain related cumulative impacts on fishes. Therefore cumulative potential impacts on seabirds are considered *minor.*

Navigation and Marine Infrastructure

The Project has the potential for *minor* impacts on marine navigation and infrastructure, as would continuation of the Roraima seismic survey. It is impossible to determine whether the two projects would affect the same shipping routes because the footprint of the Roraima survey is not known at this time, but due to the separation between the two areas (minimum 60 km between the Sorubim Area of Interest and the Roraima Block), any synergistic effects are likely to be minimal. The bridge replacement project may cause congestion within the Demerara River during the replacement but is intended to improve marine traffic flow over the long term, so the net impact of the analysed projects/activities is considered *negligible*.

8.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1 INTRODUCTION

This section of the SEA summarizes the mitigation measures that are recommended to manage the impacts of the Project. Each of the avoidance, minimization, and mitigation measures described in this section is recommended to address a specific Project-related impact described in Section 6.0 of the SEA. These impacts are summarized in Table 7.1. The table is designed to aid and facilitate the decision makers and public in general when reviewing the SEA, and to feed into EEPGL's OIMS Framework.

8.2 AVOIDANCE, MINIMIZATION AND MITIGATION MEASURES

- Treat wastewater to primary and secondary levels for drilling rig and standby/support vessels, respectively. Oil and grease will be removed and the wastewater tested per MARPOL requirements to ensure compliance with an oil in water content of <15 ppm. All waste management systems such as sewage treatment and oil prevention will be certified to international standards;
- Use of Water Based Muds (WBM) and low-toxicity OGP Group 3 NADF as well as utilization of solids control and cuttings dryer systems to treat cuttings prior to discharge to the marine environment;
- Only well-maintained shorebase cranes and construction equipment will be used, which will be inspected and serviced regularly by the shorebase owner/operator. Sources of combustion equipment in intermittent use will be shut down (or throttled down to a minimum);
- Relevant authorities will be informed of the Project and period of drilling activities including notices to Mariners;
- The rig will be provided with navigation warning devices and an exclusion zone will be maintained around the rig. Notices will be issued/posted to alert mariners of the installation/drilling activities;
- Non-hazardous and hazardous wastes will be collected, segregated and stored onboard separately in appropriately labelled and capped containers, where required for hazardous wastes;
- Those wastes not treated and discharged on the drill rig (e.g. food waste and drill cuttings will be discharged on the drill rig) will be transferred to port for treatment and disposal. The need for alternative waste disposal options for any waste would be determined on a case-by-case basis and consider the life cycle operational, safety, resource and environmental risk factors;
- Support vessels will be employed to maintain an exclusion zone around the rig to reduce the risk of vessel collision;

- Completion of the detailed well planning, design and control provisions outlined in Sections 2.6-2.7 including rig acceptance, comprehensive inspection, and BOP installation and testing;
- EEPGL and the drilling contractor will develop emergency response plans (covering oil spill incidents) that will be implemented onboard all vessels and the drill rig;
- EEPGL will run computer-based spill trajectory models to simulate the most likely spill scenarios from a project of this type to identify the areas that could be potentially affected by a spill event, the available lead time to mobilize a response in the field, and magnitude of such an event;
- Preparation of a coastal sensitivity map to identify the physical, biological, and socioeconomic resources that are most vulnerable to impacts from spill events;
- Development of an OSRP in consultation with Guyanese government stakeholders that provides a tiered response process to be followed in case of an unintended release, and establishes the responsibilities of each entity that would take part in a response;
  - Spill Response Plans will be developed and implemented for the shorebase and offshore activities to ensure the capability to respond appropriately to a hydrocarbon or chemical spill at sea or onshore;
  - Performance of a tabletop drill and emergency response exercise with demonstration of field equipment;
  - Training of support vessel crews and procurement of appropriate equipment for a Tier I or 2 level responses will be maintained;
- Completion of a proprietary Geotechnical Site Investigation and Environmental Baseline Survey (EBS) for the planned lead well site areas;
- Conduct hydrodynamic modelling of cuttings discharges;
- Furnish specific information on air emissions when rig design information becomes available;
- Maintain active watches for marine mammal and reptiles on rig during the performance of the VSP;
- Implementation of a stakeholder engagement plan, that includes a grievance mechanism process for stakeholders including local fishing interests (e.g.; artisanal/subsistence fishermen, fishing cooperatives, and trawler association). This process will direct community members on how to engage EEPGL regarding any issues, concerns or grievances during the project. A variety of communication methods may be employed such as face to face meetings, electronic mail communications, or printed notices displayed in prominent locations in local communities;

- Observation of standard local navigation procedures in and around the Georgetown Harbor, Demerara River, and/or Berbice River, as well as best shipkeeping and navigation practices while at sea shall be implemented. This includes Notice to Mariners, Trawlers Association and Co-ops at the start and conclusion of operations ;
- Development of a shorebase logistics plan to reduce potential conflicts with local road traffic when transporting goods to/from the shorebase and pipeyard;
- While minimal hiring is expected, contracts will specify required local content language. Specific hiring policies to support use of local labor and services;
- Cultural heritage chance find process will be employed. Implementation of chance find procedures under development by the National Trust.

8.3 SUMMARY

The impact rating methodology described in Section 3.0 provides a consistent, rigorous system for rating potential impacts. This rating system was applied to generate the ratings listed in Section 6.0.

In summary, detailed analysis of the expected impacts according to the methodology described in Section 6.0 indicates that the proposed project is not expected to result in any major environmental or social risks. Most of the identified impacts in Section 6.0 are expected to be *negligible* or *minor*. Application of the recommended mitigation measures listed in Sections 7.2 is expected to ensure that these impacts do not exceed these rating levels (see Table 8.1).

The most significant potential impacts associated with the Project would be the effect of an unintended hydrocarbon release on marine reptiles and their nesting habitat on Shell Beach, but the likelihood of this occurring is extremely remote. Modelling of release scenarios to determine the actual risk to coastal communities including Shell Beach and the appropriate measures to manage such risks to acceptable levels are currently being undertaken as the final well locations and design are completed. The coastal sensitivity mapping, spill modelling, and OSRP that are currently being developed in parallel with the SEA will enable EEPGL to fully manage these risks.

Table 8.1 Summary of Environmental and Social Risk Rating

Resource	Expected Impact
Coastal Oceanography and Bathymetry	Negligible
Marine Water Quality	Minor
Coastal and Marine Geology and Stratigraphy	Negligible
Air Quality	Minor
Natural Hazards	Negligible
Coastal and Marine Habitats	Negligible/Minor
Mangroves	Negligible
Mud Banks	Negligible
Marine Finfish	Minor
Seabirds	Minor
Benthic Resources	Minor
Marine Reptiles	Moderate *
Marine Mammals	Moderate *
Special Status Species	Negligible/Minor
Protected Areas	Minor
Demographics	Negligible
Fisheries and Aquaculture	Negligible
Cultural and Archaeological Resources	Minor
Navigation and Marine Infrastructure	Minor
Tourism and Recreation	Negligible
Marine Infrastructure	Positive

* Based on abnormal situation such as an unplanned release and not as any part of normal operations.

9.0 REFERENCES

ABC News Australia, “Salvagers discover treasure-laden shipwreck,” January 30, 2009. Available at: http://www.abc.net.au/news/2009-01-30/salvagers-discover-treasure-laden-shipwreck/278446, last accessed 1 October 2012.

Anthony, Edward J.; Gardel, Antoine; Gratiot, Nicolas; Proisy, Christophe; Allison, Mead A.; Dolique, Franck; and Fromard, Francois. “The Amazon-influenced muddy coast of South America: A review of mud-bank-shoreline interactions.” Elsevier: Earth Science Reviews. Vol. 103, issues 3-4 (December 2010): 99-121.

Baird, P.H., 1990. Concentrations of seabirds at oil-drilling rigs. The Condor 92: 768-771.

De Boer, M.N. 2013. Preliminary report to cetaceans and marine turtles observed in Suriname. Working paper submitted to the Workshop on Transboundary Management of Marine Mammals under the Mamacocosea Project, Paramaribo, Suriname, 18-20 March 2013.

Bovell, Owen, 2011. Guyana Mangrove Nursery Manual. Guyana Mangrove Restoration Project. Available at http://www.gcca.eu/sites/default/files/catherine.paul/guyana_mangrove_nursery_manual_2011.pdf

Braun, M. J., D. W. Finch, M. B. Robbins and B. K. Schmidt. 2007. A Field Checklist of the Birds of Guyana, 2nd Ed. Smithsonian Institution, Washington, D.C.

BSG, 2007. Bureau of Statistics Guyana. Population and Housing Census 2002. National Census Report. http://www.statisticsguyana.gov.gy/census.html.

Caribbean Regional Fisheries Mechanism: Guyana country summary. Available at: http://caricom-fisheries.com/members/guyana.asp, last accessed 1 October 2012.

Charles, Reuben; Bynoe, Mark; Wishart, Jennifer; Cheong, Martin. (2004). Shell Beach Protected Area Situation Analysis. GMTCS publication.

Center for Rural Empowerment and the Environment (CREE), 2014. Available at http://www.conservationforpeople.org/.

CGX, 2014. Available at http://www.cgxenergy.com/Home.aspx.

CGX, 2013. History. http://www.cgxenergy.com/About-Us/History.aspx.

CGX, 2009. Strategic Environmental Assessment for Offshore Exploration Drilling Corentyne License Area, Guyana. CGX Resources Inc. June 2009.

CGX, 2008. Guyana: On the Brink of Success? Upstream Insight: Latin America. Prepared by Wood Mackenzie. November 2008. http://www.cgxenergy.com/cmsAssets/docs/analysts/Wood%20Mackenzie/WoodMacKenzie-Nov08.pdf.

Charlier, 2001. Review of environmental considerations in management of the Brazil-Guianas shrimp and groundfish fisheries. FAO Fisheries Report 651:37-57. http://www.fao.org/docrep/003/y1715e/y1715e05.htm#bm5..4.19.4.

Cold Water Coral Reefs, Out of sight – no longer out of mind. UNEP-WCMC, 2004. Available at: http://assets.wwf.org.uk/downloads/coldwatercoral.pdf

De Master, D.J., and R.H. Pope, 1996. Nutrient dynamics in Amazon shelf waters: results from AMASSEDS. Cont.Shelf Res.16 (3): 263-289.

Ekau, W. and Knoppers, B.A. (2003). A review and redefinition of the Large Marine Ecosystems of Brazil, p.355-372.Eisma, D. and H.W. van der Marel. 1971. Marine Muds along the Guyana Coast and their Origin from the Amazon Basin. Netherlands Institute for Sea Research, Texel. Contr. Mineral. And Petrol. 31, 321-334. http://link.springer.com/article/10.1007/BF00371152#page-2.

EM-DAT, 2010. EM-DAT: The OFDA/CRED International Disaster Database, www.emdat.be - Université catholique de Louvain - Brussels – Belgium.

EMC Consulting Offshore Fisheries internal document, 2012.

Engstrom, Mark and Lim, Burton. Smithsonian National Museum of Natural History. Checklist of the Mammals of Guyana. Accessed February 2014, http://botany.si.edu/bdg/guymammals.html.

Environmental Protection Agency, Guyana Fourth National Report to the Convention on Biological Diversity, 2010. Available at: http://www.cbd.int/doc/world/gy/gy-nr-04-en.pdf.

EPA, 2012. About Us. http://www.epaguyana.org/index.php/aboutus.

FAO, 2005. Fishery Country Profile: The Republic of Guyana. Available at: http://www.fao.org/fi/oldsite/FCP/en/GUY/profile.htm.

FAO, 2013. Legal Office of the Food and Agriculture Organization of the United Nations (FAOLEX). Laws of Guyana: Environmental Protection Act. http://faolex.fao.org/docs/pdf/guy39200.pdf.

Freiwald, A., Fosså, J.H., Grehan, A., Koslow, T., Roberts, J.M. 2004. Cold-water Coral Reefs. UNEP-WCMC, Cambridge, UK. http://www.unep-wcmc.org/biodiversity-series-22_103.html

Gafar, John (1998) Growth, Inequality and Poverty in Selected Caribbean and Latin American Countries, with Emphasis on Guyana. Journal of Latin American Studies. Vol 30: (03) pp 591-617GLSC, 2006.

Gaullier. V., L. Loncke, L. Droz, C. Basile, A. Maillard, M. Patriat, W. R. Roest, B. Loubrieu, L. Folens, F. Carol. Slope Instability on the French Guiana Transform Margin from Swath-Bathymetry and 3.5 kHz Echograms. Advances in Natural and Technological Hazards Research. Volume 28, 2010, pp 569-579.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M.P. Simmonds, R. Swift, and D. Thompson. 2004. A Review of the Effects of Seismic Surveys on Marine Mammals. Marine Technology Society Journal. Volume 37, Number 4.

Guyana Lands and Surveys Commission National Focal Point (UNCCD). Guyana National Action Programme to Combat Land Degradation.

GMTCS, (2011) Guyana Marine Turtle Conservation Society: Proposed Shell Beach Delineation Process, Final Report. University of Guyana. Pp.1-41.

GMTIC, 2014. Guyana Ministry of Tourism, Industry, and Commerce. Tourism Department. http://mintic.gov.gy/tourism/tourismsector.html

Guyana Mangrove Restoration Project (GMRP), 2010. National Mangrove Management Action Plan 2010. Available at http://www.mangrovesgy.org/images/stories/Documents/Project%20reports/NATIONAL%20MANGROVE%20MANAGEMENT%20ACTION%20PLAN%20%202010-2012.pdf

GMTCS, 2011. Guyana Marine Turtle Conservation Society. Report on the Proposed Shell Beach Protected Area Delineation Process. Final Report.

Guyana Chronicle Online, 2014. "Guyana's Coastal Zone". Available at: http://www.guyanachronicle.com/site/index.php?option=com_content&view=article&id=3731%3Aguyanas-coastal-zone&Itemid=12

Guyana Chronicle Online: "Plans afoot to relocate old, still serviceable Demerara Harbour Bridge, preferably to a freshwater environment". Available at: http://guyanachronicle.com/plans-afoot-to-relocate-old-still-serviceable-demerara-harbour-bridge-preferably-to-a-freshwater-environment/

Guyanese Online: Shell Beach of Guyana. Available at: http://guyaneseonline.files.wordpress.com/2012/06/shell-beach-of-guyana-by-dmitri-allicock1.pdf.

Gyory, J; A. J. Mariano, and E. H. Ryan. "The Guiana Current." Ocean Surface Currents. (2013). http://oceancurrents.rsmas.miami.edu/atlantic/guiana.html.

Hydromet, 2014. Climate Fact Sheet. http://www.hydromet.gov.gy/climate.html

IRICS, undated. ENSO and North Atlantic Hurricanes. Columbia University's Earth Institute. http://iri.columbia.edu/climate/ENSO/globalimpact/TC/Atlantic/index.html

IUCN 2013. The IUCN Red List of Threatened Species. Version 2013.2. <http://www.iucnredlist.org>.

Luis Felipe et al. Marine biodiversity in French Guiana: Estuarine, coastal, and shelf ecosystems under de influence of Amazonian waters. Gayana (Concepc.) [online]. 2003, vol.67, n.2, pp. 302-326. ISSN 0717-6538. http://dx.doi.org/10.4067/S0717-65382003000200013.

Kalamandeen, Michelle and Phillip DaSilva (2005) A Preliminary Survey of the Herpetofauna of Shell Beach. Biodiversity and Conservation Studies in Guyana: Volume 2.Ilieva, undated. The socioeconomic importance of mangroves in Guyana. Ecosystem services evaluation. Ca'Foscari University of Venice, Italy.

LGL, 2006. Environmental Assessment of Petro-Canada's Vertical Seismic Profiling Program at the Terra Nova Development. http://www.cnlopb.nl.ca/pdfs/tnvsp/tneaa01.pdf

Maison, D.M.A. 2007. Management of Inshore Artisanal Fisheries in Guyana: a Co-Management Approach. Fisheries Department, Ministry of Agriculture Guyana. http://www.unuftp.is/static/fellows/document/dawn07prf.pdf

Minority Rights Group International, World Directory of Minorities and Indigenous Peoples - Guyana: Indigenous peoples, 2008. Available at: http://www.unhcr.org/refworld/docid/49749d16c.html,

MOA, 2013. Guyana Ministry of Agriculture, Fisheries Department. Marine Fisheries Management Plan 2013-2018.

National Trust of Guyana, 2009. History of Georgetown. http://www.nationaltrust.gov.gy/new/index.php?option=com_content&view=article&id=53&Itemid=153

NCS, 2006. Guyana's National Competitiveness Strategy. http://www.competitiveness.org.gy/initiative/ncs-action-plan/sub-sectors/eco-tourism

NDP, 1997. Guyana's National Development Strategy. Chapter 20: Tourism. http://www.sdnp.org.gy/nds/chapter20.html

NDS, 1997. Guyana's National Development Strategy (NDS). http://www.guyana.org/NDS/NDS.htm

Nicholas School of the Environment and Earth Sciences at Duke University, Project Global: Guyana. Available at: http://bycatch.nicholas.duke.edu/Countries/Guyana, last accessed 1 October 2012.Nittrouer, C.A., and D.J. De Master, 1987. Sedimentary processes on the Amazon continental shelf. Pergamon Press, New York.

NOAA, 2008. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration. Currents. http://oceanservice.noaa.gov/education/kits/currents/05currents1.html

NOAA, undated. Impacts of Oil on Marine Mammals and Sea Turtles. http://www.nmfs.noaa.gov/pr/pdfs/health/oil_impacts.pdf

NOAA, 2014. National Marine Fisheries Services. Marine Habitat Protection Program: Deep-Sea Corals. http://www.habitat.noaa.gov/protection/corals/deepseacorals.html

OAS, 2013. http://www.oas.org/juridico/mla/en/guy/en_guy-int-text-const.pdf

OET, 2012. Repsol, Partners Abandon Jaguar-1 Well (Guyana). Offshore Energy Today. http://www.offshoreenergytoday.com/repsol-partners-abandon-jaguar-1-well-guyana/.

Piniak, Wendy E. Dow, and Eckert, Karen L. Sea turtle nesting habitat in the Wider Caribbean Region. Vol. 15: 129-141. (November 2011).

Prince, Waldyke et al (2004) Report on the Rapid Biodiversity Assessment of the proposed Shell Beach Protected Area. GMTCS Publication.

Pritchard, P. (2001) Shell Beach as a Protected Area, Occasional Paper, Georgetown

PSC, 2014. Private Sector Commission: Directory of Sectoral Members. http://psc.org.gy/members/sectoral/

RAC-REMPEITC Caribe: Oil Spill Response Country Profile Guyana. Available at: http://cep.unep.org/racrempeitc/National%20OPRC%20Plans/guyana/Guyana%20Nov2008.pdf/at_download/file

Reece, M. 2012. Regons of Guyana. http://www.guyanagraphic.com/content/regions-guyana

Repsol, 2009. Strategic Environmental Assessment for Offshore Exploration Drilling Georgetown Licence Area, Guyana. Prepared for Repsol YPF, by PMO Global Services in association with EMC Guyana.

Shedlock, K.M and J. G. Tanner, undated. Seismic Hazard Map of the Western Hemisphere. http://www.seismo.ethz.ch/static/GSHAP/americas/amerstext.html

Sherman, K. and G. Hempel. 2009. The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's regional seas. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme. Nairobi, Kenya. 2nd printing.

Stabroek News, 2013. Renewed drilling eyed at well abandoned for safety reasons. Published online August 6, 2012. http://www.stabroeknews.com/2012/news/stories/08/06/renewed-drilling-eyed-at-well-abandoned-for-safety-reasons/

Strømme, T. and G. Sætersdal. 1989. Final Report - Surveys of the Fish Resources in the Shelf Areas between Suriname and Colombia 1988. Prepared by the Institute of Marine Research. Bergen. ftp://ftp.fao.org/docrep/nonfao/fns/x6078e.pdf

UNESCO, 2014. Culture: World Heritage Centre: About World Heritage: The States Parties: Guyana. http://whc.unesco.org/en/statesparties/GY/

UNISDR, 2014. PreventionWeb: Countries and Regions: Guyana. http://www.preventionweb.net/english/countries/americas/guy/

United Nations Environment Program World Conservation Monitoring Center, World Atlas of Seagrasses 2003. Available at: http://archive.org/details/worldatlasofseag03gree.

URS, 2009. Ichthys Gas Field Development Project: Review of Literature on Sound in the Ocean and Effects of Noise on Marine Fauna. http://www.ntepa.nt.gov.au/__data/assets/pdf_file/0008/5786/draft_eis_appendix_15.pdf

Wiese, F.K; W.A Montevecchi; G.K. Davoren; F. Huettmann; A.W. Diamond; and J. Linke. 2001. Seabirds at Risk around Offshore Oil Platforms in the North-west Atlantic. Marine Pollution Bulletin, Volume 42, Issue 12. Pages 1285-1290.

World Wildlife Fund: Guianas, Regional Sea Turtle Conservation Program and Action Plan for The Guianas, 2003. Available at: http://www.widecast.org/Resources/Docs/Reichart_et_al_2003_Guianas_Regional_Program.pdf, last accessed 1 October 2012.

Wreck Site, shipwreck database. Available at: http://www.wrecksite.eu/chart.aspx?ch=250&la=-9&lo=-44&na=&zo=50#&&aj=uC3JC0eI9wS4JJHdiX8Gj1pBsmQJQe6gfEFEW333dRop5mATRamNCBpYB%2bsQiyIImxNah%2bZQQ6Egus%2bTZ47z%2bA%3d%3d

World Wildlife Fund: Guianas, Regional Sea Turtle Conservation Program and Action Plan for The Guianas, 2003. Available at: http://www.widecast.org/Resources/Docs/Reichart_et_al_2003_Guianas_Regional_Program.pdf

Workman, W.G. 2000. Special Report: Geophysics and Geology. Guyana Basin: A new exploration focus. WorldOil Online. Vol. 221 No. 5. http://www.worldoil.com/May-2000-Guyana-basin-A-new-exploration-focus.html

Appendix A
IUCN-Listed Coastal and Marine Species Known From Guyana

Common Name	Scientific Name	Species Status
Spotted Eagle Ray	*Aetobatus narinari*	NT
Common Thresher Shark	*Alopias vulpinus*	VU
Foureyed Flounder	*Ancylopsetta kumperae*	DD
Bryde's Whale	*Balaenoptera edeni*	DD
Blackbelly Skate	*Breviraja nigriventralis*	DD
Semipalmated Sandpiper	*Calidris pusilla*	NT
Blacknose Shark	*Carcharhinus acronotus*	NT
Spinner Shark	*Carcharhinus brevipinna*	NT
Silky Shark	*Carcharhinus falciformis*	NT
Bull Shark	*Carcharhinus leucas*	NT
Blacktip Shark	*Carcharhinus limbatus*	NT
Oceanic Whitetip Shark	*Carcharhinus longimanus*	VU
Dusky Shark	*Carcharhinus obscurus*	VU
Caribbean Reef Shark	*Carcharhinus perezi*	NT
Smalltail Shark	*Carcharhinus porosus*	DD
Night Shark	*Carcharhinus signatus*	VU
Green Turtle	*Chelonia mydas*	EN
Frilled Shark	*Chlamydoselachus anguineus*	NT
Hollowsnout Grenadier	*Coelorinchus caelorhincus*	DD
Hookskate	*Dactylobatus clarkii*	DD
Southern Stingray	*Dasyatis americana*	DD
Sharpsnout Stingray	*Dasyatis geijskesi*	NT
Red hogfish	*Decodon puellaris*	DD
Long-beaked Common Dolphin	*Delphinus capensis*	DD
Sickelfish Grouper	*Dermatolepis inermis*	NT
Leatherback	*Dermochelys coriacea*	VU
Variegated Electric Ray	*Diplobatis pictus*	VU
Malacho	*Elops smithi*	DD
Atlantic Goliath Grouper	*Epinephelus itajara*	CE
Red Grouper	*Epinephelus morio*	NT
Nassau Grouper	*Epinephelus striatus*	EN
	Fenestraja plutonia	DD
Pygmy Killer Whale	*Feresa attenuata*	DD
Tiger Shark	*Galeocerdo cuvier*	NT
Nurse Shark	*Ginglymostoma cirratum*	DD
Short-finned Pilot Whale	*Globicephala macrorhynchus*	DD
	Gymnura altavela	VU
Smooth Butterfly Ray	*Gymnura micrura*	DD
Striped Grunt	*Haemulon striatum*	DD
Bigeyed Sixgill Shark	*Hexanchus nakamurai*	DD
Chupare Stingray	*Himantura schmardae*	DD
	Holothuria arenicola	DD

Common Name	Scientific Name	Species Status
Poey's Grouper	*Hyporthodus flavolimbatus*	VU
Spotted Grouper	*Hyporthodus niveatus*	VU
Daggernose Shark	*Isogomphodon oxyrhynchus*	CE
Shortfin Mako	*Isurus oxyrinchus*	VU
White Marlin	*Kajikia albida*	VU
Pygmy Sperm Whale	*Kogia breviceps*	DD
Dwarf Sperm Whale	*Kogia sima*	DD
Hogfish	*Lachnolaimus maximus*	VU
Olive Ridley	*Lepidochelys olivacea*	VU
Neotropical Otter	*Lontra longicaudis*	DD
Giant Manta Ray	*Manta birostris*	VU
Tarpon	*Megalops atlanticus*	VU
Blainville's Beaked Whale	*Mesoplodon densirostris*	DD
Yellowfin Grouper	*Mycteroperca venenosa*	NT
Bullnose Ray	*Myliobatis freminvillii*	DD
Southern Eagle Ray	*Myliobatis goodei*	DD
Caribbean Electric Ray	*Narcine bancroftii*	CE
Lemon Shark	*Negaprion brevirostris*	NT
Killer Whale	*Orcinus orca*	DD
Caribbean Spiny Lobster)	*Panulirus argus*	DD
Smoothtail Spiny Lobster	*Panulirus laevicauda*	DD
Sperm Whale	*Physeter macrocephalus*	VU
Blue Shark	*Prionace glauca*	NT
Largetooth Sawfish	*Pristis pristis*	CE
False Killer Whale	*Pseudorca crassidens*	DD
Giant Otter	*Pteronura brasiliensis*	EN
Venezuela Skate	*Raja cervigoni*	NT
Whale Shark	*Rhincodon typus*	VU
Southern Guitarfish	*Rhinobatos percellens*	NT
Cownose Ray	*Rhinoptera bonasus*	NT
Brazilian Sharpnose Shark	*Rhizoprionodon lalandii*	DD
Gillbacker Sea Catfish	*Sciades parkeri*	NT
Three-spot Slipper Lobster	*Scyllarides delfosi*	DD
Guiana Dolphin	*Sotalia guianensis*	DD
Scalloped Hammerhead	*Sphyrna lewini*	EN
Scoophead Shark	*Sphyrna media*	DD
Squat-headed Hammerhead Shark	*Sphyrna mokarran*	EN
Smalleye Hammerhead Shark	*Sphyrna tudes*	VU
Roundscale Spearfish	*Tetrapturus georgii*	DD
Albacore Tuna	*Thunnus alalunga*	NT
Yellowfin Tuna	*Thunnus albacares*	NT

Common Name	Scientific Name	Species Status
Bigeye Tuna	*Thunnus obesus*	VU
Atlantic Bluefin Tuna	*Thunnus thynnus*	EN
Great Torpedo Ray	*Torpedo nobiliana*	DD
West Indian Manatee	*Trichechus manatus*	VU