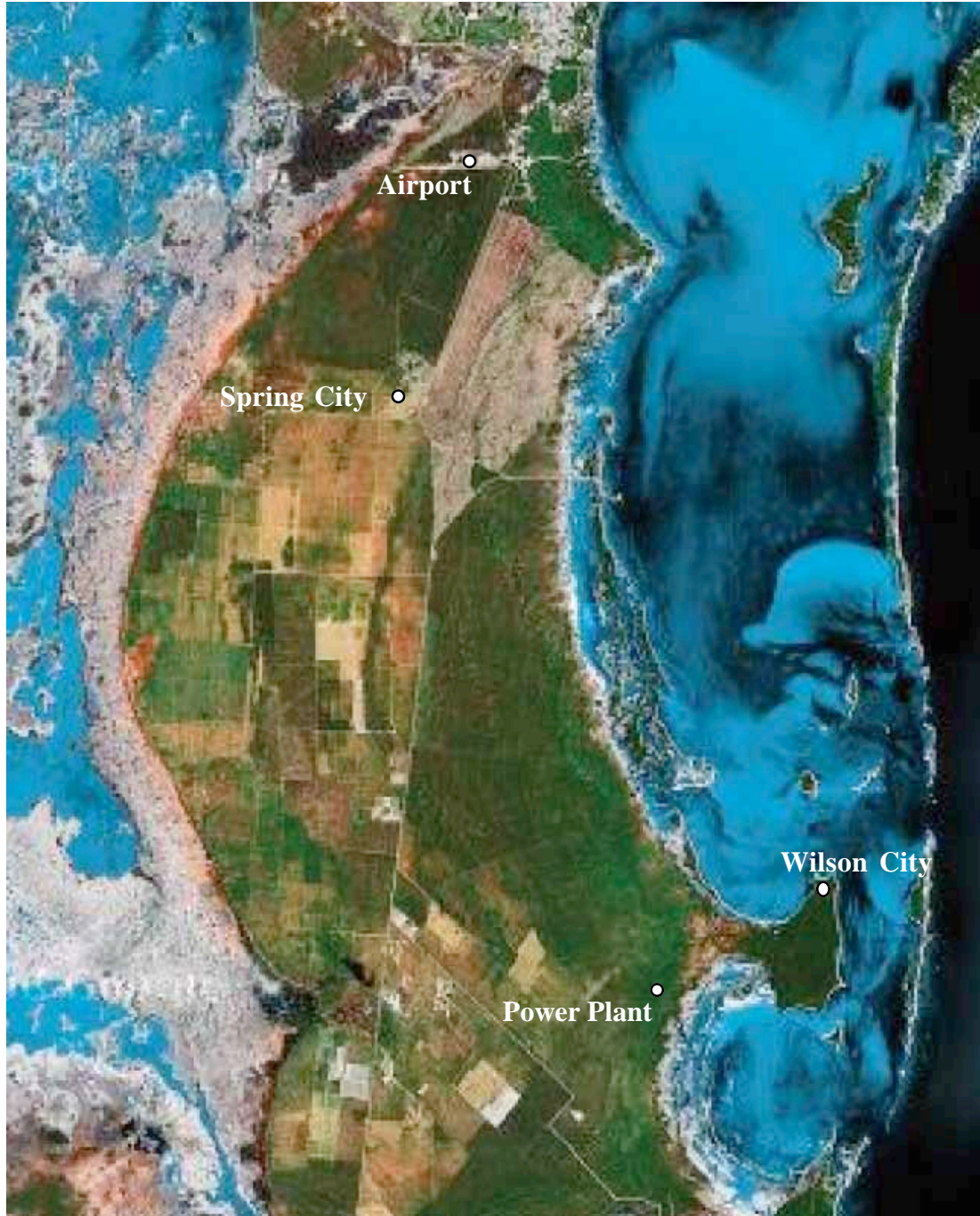


Bahamas Islands Services



**Environmental  
Impact Assessment  
Report**

**BEC Expansion  
New Power Plant  
Wilson City  
Abaco, Bahamas**

**Bahamas Electricity  
Corporation  
Blue Hill and Tucker  
Roads  
Nassau, Bahamas**

**KES No. 127-08-001**

**October 2008**

Environmental Impact Assessment  
Report

Wilson City Power Plant  
Abaco, Bahamas

Prepared for

Bahamas Electricity Corporation  
Blue Hill and Tucker Road  
Nassau, Bahamas

KES No. 127-08-001

Prepared by:

KES Environmental Services, Inc.  
1712 Clydesdale Drive  
Loxahatchee, Florida 33470

email: kes\_inc@yahoo.com  
Phone: (954) 792-4268

---

Crystal Robbins  
Environmental Engineer

---

Michael Duvall PG, REP.  
Senior Consultant

Date: October 20, 2008

# TABLE OF CONTENTS

Page 1 of 7

Section	Page
EXECUTIVE SUMMARY	ES-1
ES.1 PROPOSED PROJECT	ES-1
ES.2 AREA OF INFLUENCE	ES-2
ES.3 ENVIRONMENTAL IMPACTS	ES-2
ES.4 AGENCY CONSULTATION & PUBLIC INVOLVEMENT	ES-2
ES.5 ENVIRONMENTAL MANAGEMENT PLAN	ES-3
ES.6 ENVIRONMENTAL ACCEPTABILITY OF PROJECT	ES-3
ES.7 UNAVOIDABLE NEGATIVE IMPACTS TO PROJECT BENEFITS	ES-4
ES.8 CONSEQUENCES OF NON-PROJECT IMPLEMENTATION	ES-4
1.0 INTRODUCTION	1-1
1.1 BACKGROUND	1-1
1.2 OBJECTIVES	1-1
1.3 PROPOSED PROJECT	1-2
1.4 EIA METHODOLOGY	1-2
1.4.1 Property Inspection	1-3
1.4.2 Literature Review	1-3
1.4.3 Agency / Public Involvement	1-3
1.5 NEW CONSTRUCTION AND EIA REQUIREMENTS	1-3
2.0 REGULATORY OVERVIEW	2-1
2.1 REGULATORY FRAMEWORK	2-1
2.1.1 The Environmental Health Act	2-4
2.1.2 Certificate of Approval	2-4
2.1.3 The Conservation and Protection of the Physical Environ. Act	2-4
2.1.4 Declaration of Protected Tress Order	2-5
2.1.5 The Wild Birds and Plant Protection Acts	2-5
2.1.6 The Fisheries Resources Act	2-5
2.1.7 Antiquities, Monuments and Museum Act	2-5
2.1.8 The Public Works Acts	2-6
2.1.9 Acquisition of Land Act	2-6
2.1.10 The Bahamas National Trust Act	2-6
2.1.11 Proposed and Applicable Regulations	2-7
2.2 BEST COMMISSION	2-7
2.3 DEPT. OF ENVIRONMENTAL HEALTH SERVICES	2-8
2.4 OTHER GOVERNMENT AGENCIES	2-8
2.5 THE BAHAMAS NATIONAL TRUST	2-9
2.6 PERMIT APPLICATION AND REVIEW	2-9

# TABLE OF CONTENTS

Page 2 of 7

Section		Page
3.0	PROPOSED PROJECT	3-1
3.1	OVERVIEW	3-1
3.2	BAHAMAS ELECTRICITY CORPORATION	3-2
	3.2.1 Abacos Power Needs	3-2
3.3	SITE LOCATION	3-3
3.4	SITE PREPARATION	3-4
	3.4.1 Pipeline Corridor (Wilson City Road)	3-4
	3.4.2 Wilson City Docks	3-5
3.5	MAJOR PROJECT COMPONENTS	3-5
	3.5.1 Storage Tanks	3-6
	3.5.2 Bund Wall Containment	3-7
	3.5.3 Power Block	3-8
3.6	DIRECT COOLING WATER	3-8
3.7	REVIEW OF ALTERNATIVES	3-10
	3.7.1 Proposed Power Plant Site	3-10
	3.7.2 Review of Renewable Energy Alternatives	3-12
	3.7.3 Fuel Choice	3-14
	3.7.4 Cooling Alternatives	3-15
4.0	ENVIRONMENTAL SETTING	4-1
4.1	PHYSICAL ENVIRONMENT	4-1
	4.1.1 Climate	4-2
	4.1.1.1 <u>Winds and Storms</u>	4-3
	4.1.1.2 <u>Temperature</u>	4-3
	4.1.1.3 <u>Precipitation</u>	4-4
	4.1.2 Topography	4-4
	4.1.2.1 <u>Soils</u>	4-5
	4.1.3 Geology	4-5
	4.1.4 Air Quality	4-6
	4.1.5 Noise	4-7
	4.1.6 Water Quality	4-8
	4.1.6.1 <u>Hydrogeology</u>	4-8

# TABLE OF CONTENTS

Page 3 of 7

Section	Page
4.1.6.2 <u>Island Aquifers</u>	4-9
4.1.6.3 <u>Groundwater Sources</u>	4-9
4.1.6.4 <u>Water Use and Distribution</u>	4-11
4.2 NATURAL ENVIRONMENT	4-11
4.2.1 Terrestrial Ecosystems	4-11
4.2.1.1 <u>Fauna</u>	4-11
4.2.1.2 <u>Flora</u>	4-13
4.2.1.3 <u>Pine Forests</u>	4-13
4.2.2 Aquatic Ecosystems	4-15
4.2.2.1 <u>Marine Platform</u>	4-15
4.2.2.2 <u>Reefs</u>	4-15
4.2.2.3 <u>Coastal Environment</u>	4-16
4.2.2.4 <u>Wetlands</u>	4-18
4.2.3 Protected Habitat	4-19
4.2.3.1 <u>Walkers Cay National Park</u>	4-19
4.2.3.2 <u>Black Sound Cay National Reserve</u>	4-19
4.2.3.3 <u>Fowl Cay National Reserve</u>	4-20
4.2.3.4 <u>Tilloo Cay National Reserve</u>	4-20
4.2.3.5 <u>Pelican Cays Land and Sea Park</u>	4-20
4.2.3.6 <u>Abaco National Park</u>	4-20
4.3 EXISTING SITE CONDITIONS	4-22
4.3.1 Inspection Methodology	4-22
4.3.2 Site Reconnaissance	4-22
4.3.2.1 <u>Wilson City Road</u>	4-22
4.3.2.2 <u>Power Plant Site</u>	4-23
4.3.2.3 <u>Wilson City Dock</u>	4-23
4.3.3 Aerial Photographic Review	4-24
4.3.4 Environmental Review	4-24
4.3.4.1 <u>Geology</u>	4-24
4.3.4.2 <u>Soil</u>	4-25
4.3.4.3 <u>Flora</u>	4-25
4.3.4.4 <u>Wetlands</u>	4-26
4.3.4.5 <u>Fauna</u>	4-26
4.3.4.6 <u>Ecological Review</u>	4-26
4.3.4.7 <u>Site Conditions Summary</u>	4-28

# TABLE OF CONTENTS

Page 4 of 7

Section		Page
4.4	SOCIO ECONOMIC ASPECTS	4-29
4.4.1	Land Use	4-29
4.4.2	Population	4-32
4.4.3	Economy	4-32
4.4.4	Abaco Economy	4-34
4.4.5	Non-Government Organizations	4-34
5.0	ANTICIPATED ENVIRONMENTAL IMPACTS	5-1
5-1	IMPACTS DURING CONSTRUCTION	5-1
5.1.1	Erosion/Sedimentation Impacts	5-1
5.1.2	Water Quality Impacts	5-3
5.1.2.1	<u>Impacts to the Sea</u>	5-3
5.1.2.2	<u>Impacts to Groundwater</u>	5-4
5.1.3	Air Quality Impacts	5-8
5.1.3.1	<u>Emission Control Measures</u>	5-9
5.1.3.2	<u>Potential Impacts and Monitoring Programs</u>	5-10
5.1.4	Noise Impacts	5-10
5.1.5	Solid and Hazardous Waste Impacts	5-12
5.1.6	Fire Risks	5-12
5.1.7	Hurricane Risks	5-13
5.2	ECOLOGICAL IMPACTS	5-14
5.2.1	Terrestrial Systems	5-14
5.2.2	Faunal Systems	5-14
5.2.3	Aquatic Systems	5-15
5.2.3.1	<u>Wetland Impacts</u>	5-15
5.2.3.2	<u>Coastal Impacts</u>	5-15
5.2.4	Protected Habitats	5-15
5.3	IMPACTS ON HUMAN POPULATIONS	5-16
5.3.1	Land Use Impacts	5-16
5.3.2	Visual and Aesthetic Impacts	5-16
5.3.3	Impacts on Neighborhoods and Communities	5-16
5.3.4	Relocation Impacts	5-17
5.3.5	Traffic Impacts	5-17

# TABLE OF CONTENTS

Page 5 of 7

Section	Page
5.3.6 Economic Impacts	5-17
5.3.6.1 <u>Construction Employment</u>	5-17
5.3.6.2 <u>Housing Impacts</u>	5-18
5.3.6.3 <u>Public Facilities and Services</u>	5-18
5.3.7 Cultural Resources Impacts	5-18
5.4 IMPACTS DURING OPERATION	5-19
5.4.1 Air Quality Impacts	5-19
5.4.2 Acid Precipitation	5-23
5.4.3 Ecological Impacts	5-24
5.4.3.1 <u>Faunal Impacts</u>	5-24
5.4.3.2 <u>Flora Impacts</u>	5-24
5.4.3.3 <u>Wetlands</u>	5-25
5.4.3.4 <u>Protected Habitat</u>	5-25
5.4.3.5 <u>Marine Ecology</u>	5-25
5.4.3.6 <u>Landscaping</u>	5-26
5.4.4 Supply and Discharge of Water	5-26
5.4.4.1 <u>Groundwater Modeling</u>	5-27
5.4.4.2 <u>Groundwater Injection Concerns</u>	5-27
5.4.5 Solid Waste Management	5-28
5.4.6 Noise and Vibration Impacts	5-30
5.4.7 Soil and Groundwater Contamination	5-32
5.4.7.1 <u>Fuel Management</u>	5-32
5.4.7.2 <u>Impacts to Surface Water During Fuel Transfer</u>	5-33
5.4.7.3 <u>Impacts to Ground/Surface</u>	5-33
5.4.7.4 <u>Impacts to the Subsurface</u>	5-34
5.4.7.5 <u>Direct Groundwater Impacts</u>	5-34
5.4.7.6 <u>Site Drainage Systems</u>	5-35
5.4.7.7 <u>Operational Mitigation</u>	5-36
5.4.8 Societal Impacts During Operations	5-36
5.4.8.1 <u>Land Use</u>	5-36
5.4.8.2 <u>Visual and Aesthetics</u>	5-36
5.4.8.3 <u>Neighborhood and Communities</u>	5-37
5.4.8.4 <u>Relocation Impacts</u>	5-37
5.4.8.5 <u>Traffic Impacts</u>	5-37
5.4.8.6 <u>Economic Impacts</u>	5-38
5.4.8.7 <u>Cultural Resources Impacts</u>	5-39

# TABLE OF CONTENTS

Page 6 of 7

Section		Page
5.5	CONSEQUENCES OF NON-PROJECT IMPLEMENTATION	5-39
6.0	HISTORICAL ENVIRONMENTAL PERFORMANCE	6-1
6.1	HISTORICAL CONTEXT	6-1
6.2	HISTORICAL ENVIRONMENTAL REPORTS	6-3
6.3	ANNUAL REVIEW CONCERNS	6-3
	6.3.1 Air Emissions	6-3
	6.3.2 Surface Water Discharges	6-4
	6.3.3 Soil/Ground/Land Impacts	6-5
	6.3.4 Groundwater Impacts	6-5
	6.3.5 Noise Emissions	6-6
	6.3.6 General House Keeping	6-6
6-4	OPINION	6-7
7.0	ENVIRONMENTAL MANAGEMENT SYSTEM	7-1
7.1	ENVIRONMENTAL MANAGEMENT PLAN	7-1
	7.1.1 Fuel Management	7-2
	7.1.2 Management of Lubricating Oil	7-2
	7.1.3 Emissions Monitoring	7-2
	7.1.4 Ambient Air Quality Monitoring	7-3
	7.1.5 Water Management	7-3
	7.1.6 Maintenance	7-4
	7.1.7 Contaminated Land	7-5
7.2	ENVIRONMENTAL MONITORING PLAN	7-5
	7.2.1 Parameters to be Monitored	7-5
	7.2.1.1 <u>Atmospheric Emissions</u>	7-6
	7.2.1.2 <u>Ambient Air Quality</u>	7-6
	7.2.1.3 <u>Noise</u>	7-7
	7.2.1.4 <u>Water Quality and Discharge</u>	7-7
	7.2.1.5 <u>Socio-Economic Monitoring</u>	7-8
	7.2.1.6 <u>Public Complaint Procedure</u>	7-9
	7.2.1.7 <u>Ecological Monitoring</u>	7-10
	7.2.1.8 <u>Reporting Procedures</u>	7-10
7.3	RESOURCES, IMPLEMENTATION AND TRAINING	7-11
	7.3.1 Resources	7-11

# TABLE OF CONTENTS

Page 7 of 7

Section		Page
	7.3.2 Implementation	7-12
	7.3.3 Training	7-12
8.0	ENVIRONMENTAL ACCEPTABILITY OF PROJECT	8-1
8-1	FRIENDS OF THE ENVIRONMENT	8-2
8-2	COMPLIANCE WITH APPLICABLE STANDARDS	8-5
8-3	COMPARE UNAVOIDABLE IMPACTS TO BENEFITS	8-6
	8.3.1 Land Use	8-6
	8.3.2 Geology	8-6
	8.3.3 Water Quality	8-7
	8.3.4 Biological Resources	8-8
	8.3.5 Air Quality	8-8
	8.3.6 Aesthetics	8-9
9.0	PUBLIC CONSULTATION	9-1
10.0	REFERENCES	10-1
APPENDICES		
A	BEST Pre-approval Letter and Project Team Qualifications Summary	
B	Project Photographs	
C	Copy of FRIENDS Correspondence	
D	MAN B&W Noise Model Inputs	
E	Elements of BEC EMS	
F	Draft SPCC Plan	
G	BMP Plan	

## LIST OF FIGURES

### SECTION 1.0

- 1-1 Regional Location Map
- 1-2 Site Vicinity Map
- 1-3 Topographic Map

### SECTION 3.0

- 3-1 Site Survey
- 3-2 Power Plant Pipeline Route
- 3-3 Template Site Plan

### SECTION 4.0

- 4-1 Overview of the Bahama Banks Map
- 4-2 Regional Mean Temperature Map
- 4-3 Regional Precipitation Map
- 4-4 Schematic Section of an Island Aquifer
- 4-5 Water Resources Location Map
- 4-6 Idealized Section Showing Coral Zonation on a Reef
- 4-7 Abacos National Parks Location Map
- 4-8 Aerial view of proposed Power Plant Site (1)
- 4-9 Aerial view of proposed Power Plant Site (2)
- 4-10 Aerial view of proposed Fuel Dock

### SECTION 5.0

- 5-1 Closest Potentially Sensitive Receptor Map
- 5-2 Pelican Cays Land and Sea Park Location Map

### SECTION 8.0

- 8-1 Access Routes to Wilson City Dock

## LIST OF TABLES

### SECTION 4.0

- 4-1 Facies Composition and Distribution in the Bahama Banks
- 4-2 Bahamas Hurricane and Tropical Storm Frequency 1871-1987
- 4-3 Geologic Time Scale
- 4-4 Stratigraphic Model for Bahamas Geology
- 4-5 List of Birds observed in the vicinity of Marsh Harbour
- 4-6 Summary of Marinas in the Abacos
- Glossary of Geological Terms

### SECTION 5.0

- 5-1 Saffir Simpson Hurricane Intensity Scale

### SECTION 8.0

- 8-1 Impacts Determinations Summary

## **EXECUTIVE SUMMARY**

### **ES.1 PROPOSED PROJECT**

The proposed power plant site is to be located on 25-acres of currently vacant, undeveloped, pine-covered Crown Land with an additional 75 acres available for future expansion. The power plant site will be located on the southern side of Wilson City Road (aka Abaco Farm Road). The proposed power plant will include the powerhouse, within which will be installed 4 x 12 Megawatt (MW) engines fueled by Heavy Fuel Oil (Bunker C). The proposed facilities will almost double the nominal generating capacity from the installed capacity at Marsh Harbour. A fuel pipeline is also proposed which will run from the power plant northeast along the Wilson Road extension, and then southeast away from the Wilson City ruins to terminate at the coast. A docking pier is anticipated, located perpendicular to the coast, to access deep water. The dock area will house pumping facilities to receive waterborne fuel shipments to service the plant. When the need for additional power generation capacity was confirmed, and prior to selection of the Wilson City plant site, BEC reviewed a number of siting options including the expansion of the existing Marsh Harbour Power Plant facility and a proposed site at Snake Cay. Based upon limited space and the close proximity of a residential community, the Marsh Harbour site was subsequently eliminated from further consideration. The selection of the Snake Cay site had additional value based upon its remote location, and the availability of water borne access for fuel and materials. However, based upon eco-sensitivity and land use concerns, Snake Cay was deemed unsuitable for BEC.

### **ES.2 AREA OF INFLUENCE**

The proposed power plant is approximately fourteen (14) miles south of Marsh Harbour, the largest settlement on the island, and seven (7.0) miles south of Spring City, a settlement whose presence is rooted in the former pulpwood and sugar industries. Marsh Harbour Airport is located between the site and Marsh Harbour. The subject site is located in a predominantly pine forest area of the island, with pine covered Crown Lands in cardinal locations of the property. The ruins of Wilson City, northeast of the site, are a settlement or lumber camp which was the first of its kind in Abaco. Most of the

remnants of the town / camp were removed by the 1920s. There are currently no developments within a three mile-radius of the proposed power plant project.

### **ES.3 ENVIRONMENTAL IMPACTS**

Loss of 25-acres of pine forest habitat is an unavoidable consequence of the proposed project. Potential impacts to flora and fauna will be limited to site development activities. No protected wildlife was observed, although the Bahama Parrot is commonly found in the pinewoods of Abaco. In the event nesting birds are encountered, work would be instructed to stop; otherwise any encountered birds, since they are mobile, would likely relocate to undisturbed areas of the forest. Caribbean pine removal will be conducted only with permit approval. The potential for ecological impact, if fuel and other chemicals are improperly managed during facility operations, are a potential for concern. However this concern is mitigated if the operation of the facility is conducted in strict accordance with BEC operations and procedures guidelines, as outlined in their Environmental Management System (EMS) procedures. These procedures include operational activities, fuel delivery and storage, fuel inventory, general waste disposal, site housekeeping, control of chemicals and environmental incident reporting. Implementation of the EMS during operation of the power plant and associated facilities will ensure that degradation of the island's ecosystem does not occur as a result of inadvertent or inappropriate operational practices.

### **ES.4 AGENCY CONSULTATION AND PUBLIC INVOLVEMENT**

During the building permit application and EIA review process at the Town Planning Committee meeting, should the Committee deem it necessary and if there is strong public objection to the project, representatives or members of the general public may be invited to voice their views or objections. Due notice is also taken of any comments made by NGO's such as Friends of the Environment (FRIENDS). With respect to FRIENDS, there is a concern with regard to potential impacts to Sea of Abaco ecology, and specifically to the Pelican Cays Land and Sea Park during the operation of the power plant. While this is an important consideration in the power generation dialogue, finding the balance between the power generation needs of the Abacos and the need to be

ecologically and environmentally responsible are not mutually exclusive and are clearly acknowledged by BEC. The importance for reliable and inexpensive electricity, which provides the basis for Abaco's continued and improving standard of living for all of its citizens, should not be marginalized on the basis of the “no development” alternative. In addition, the use of alternative fuels has not yet developed to the utility scale, although active investigation into viable alternative technologies continues.

#### **ES.5 ENVIRONMENTAL MANAGEMENT PLAN**

The environmental management plan (EMP) will be used to ensure that the Wilson City power station is operated with minimum environmental impact. In order to accomplish this objective, the environmental management systems include an Environmental Management Plan, Environmental Monitoring Plan, and Resources Implementation and Training Program. The EMP will serve as a guideline for the minimum requirements of the detailed procedure to be developed and will be updated and revised as needed throughout the construction and operation phases of the Project. Monitoring of certain parameters during both the construction and operational phases of the power station is essential to ensure that impacts are fully evaluated and that necessary mitigation measures are applied. This is necessary to demonstrate compliance with any current and future standards. Monitoring will apply to the following: atmospheric emissions, ambient air quality, noise, water quality and discharges, socio-economic monitoring, public complaints procedures and ecological monitoring. Implementation of the EMP will be the responsibility of the Environmental Health & Safety Manager who will be coordinating and arranging the collection and reporting of the results of all emissions, ambient air quality, noise and water quality monitoring. Full-time monitoring will be required both during the construction phase and operations phase of the project.

#### **ES.6 ENVIRONMENTAL ACCEPTABILITY OF THE PROJECT**

It is the intention of the project through both construction and operations phases to be in compliance with the environmental laws and regulations of the Bahamas. BEC acknowledges its responsibility as a steward of the ecological well being of the Abacos. In this regard, little or no impacts are anticipated with respect to marine life in the

vicinity of the Wilson City dock through the construction phase of the project. During the operations phase, potential impacts are mitigated through the use of state of the art fueling hoses employed during fuel transfer. This system has been used throughout the world and is a proven design with little or no potential for significant fuel loss. The Bahamas Maritime Authority also requires a responsible officer to be present for specific tasks such as a liquid transfer, ensuring correct valve operation prior to transfer. In addition, no impacts are anticipated as a consequence of the operations of the main power plant facility based upon its distance (2 miles) from the coast.

### **ES.7 UNAVOIDABLE NEGATIVE IMPACTS TO PROJECT BENEFITS**

BEC, through its mandate, has determined the need for additional power generating capacity for the Abacos, to support its continued economic growth and to serve the needs of all its consumers. The impact of the construction and operation of the facility is of concern with respect to continued maintenance of biodiversity of the island and the need to operate and build a facility in an environmentally and ecologically beneficial manner without causing irreparable harm to the ecosystem. The selection of the project site was settled upon when it was determined that the space for the proposed plant and for future expansions was not available at the existing Marsh Harbour site. The unavoidable loss of 25-acres of upland pine forest is more than compensated for by the minimization of potential impacts to vicinity receptors. In addition, the construction of the pipeline mitigates potential traffic accidents associated with what would be necessarily high frequency overland fuel transfer from the government dock at Marsh Harbour. Finally, the “no-development” alternative has a potentially more significant impact on the economy of the Abacos, and the tourism sector in particular.

### **ES.8 CONSEQUENCES OF NON-PROJECT IMPLEMENTATION**

The installed capacity at Marsh Harbour is insufficient to meet current and near future demand for power in Abaco. Without additional capacity, the need for load shedding becomes likely in order to maintain a balance between demand and generation capacity. Therefore, the proposed project is designed to meet the current and future needs providing reliable additional electricity generation capacity. Alternatively, without the

additional capacity offered by this project, greater reliance would be placed upon the use of small diesel generator sets for residential, commercial and industrial purposes. These typically burn premium fuels such as high-speed diesel, whilst their energy efficiency and inherent emissions means that their environmental performance may compare unfavorably with larger scale generation. The Bahamas government relies heavily on tourism and hence the security of power supply for hotel and other tourism and recreational facilities is highly significant. Any load shedding in this sector will have a corresponding effect upon tourism with the economy suffering as a result. Therefore, non-project implementation is not considered to be a viable option from the point of view of sustainable development and hence the proposed project should proceed.

## **1.0 INTRODUCTION**

### **1.1 BACKGROUND**

The proposed power plant site, at Wilson City, is approximately fourteen (14) miles south of Marsh Harbour, the largest settlement on Abaco. Due to current demands within Abaco, expansion of the existing power generating facilities is considered necessary to meet the demands of all consumers on the island. The island is experiencing tremendous economic growth due to various development projects; as a result, the proposed power plant is required in order to fulfill the demands of tourism, domestic consumers and general economic growth. However, within the Commonwealth of the Bahamas, a full environmental impact assessment (EIA) is required for all proposed new developments, extensions or major modifications to existing developments. It is in this regard that KES Environmental Services (KES) is providing professional environmental consulting services. A team of environmental professionals utilizing such skills that included geology, ecology, environmental engineering, coastal engineering, sociology and project management conducted the EIA between July and October 2008, subsequent to BEST and BEC approval. The same consulting team approved for the no-longer viable Snake Cay site was used on the subject site. A copy of the BEST pre-approval letter and summary project team qualifications are provided in Appendix A.

### **1.2 OBJECTIVES**

The EIA scope of work is designed to visually identify and record any obvious existing environmental conditions that might be detrimentally impacted as a result of the proposed construction project. It is the intention of this EIA to review the scope of the proposed construction project and evaluate the environmental consequences of this action. This review would consider indigenous fauna, flora, marine life, micro ecology, geology and other concerns in the immediate vicinity of the site. The specific objectives of the EIA are to identify the potential environmental impacts associated with the project, allowing the selection of appropriate measures for their mitigation. Furthermore, the review included an assessment of BEC's past and present operations in order to identify and evaluate the current environmental aspects and impacts associated with system activities and to

provide guidance for environmentally sound management of the power sector in order to avoid a situation where deterioration in environmental quality is a consequence of growth of the power sector.

### **1.3 PROPOSED PROJECT**

The proposed power plant site will be located on 25-acres of currently vacant, undeveloped, pine-covered Crown Land with an additional 75 acres viable for future expansion. The power plant site will be located on the southern side of Wilson City Road (aka Abaco Farm Road). The proposed power plant will include the powerhouse within which will be installed 4 x 12 Megawatt (MW) engines fueled by Heavy Fuel Oil (Bunker C). The proposed facilities will almost double the nominal generating capacity from the installed capacity at Marsh Harbour. A fuel pipeline is also proposed which will run from the power plant northeast along the Wilson Road extension, and then southeast away from the ruins to terminate at the coast. A docking pier is anticipated to be located perpendicular to the coast to access deep water. The dock area will house pumping facilities to receive waterborne fuel shipments to service the plant. The design and build project has been awarded to MAN B&W who propose to construct, from the ground up, a state-of-the-art power generating facility which will take into account the environmental protection needs of the Bahamas in general and Great Abaco in particular. The location of Great Abaco in relation to the other Bahama Islands and the southeast coast of Florida is shown in Figure 1-1, a regional location map. The Abacos lie at the northern end of the group of islands and cays that form the Bahamas. The subject site is located on the eastern side of Abaco, south of Marsh Harbour and Marsh Harbour Airport. Figure 1-2 is a site vicinity map locating the subject site and Figure 1-3 is a topographic map illustrating the project area.

### **1.4 EIA METHODOLOGY**

The process, procedures and methodologies used in acquiring information and recording data for this EIA have been prepared in accordance with the generally accepted environmental policies and guidelines of The Inter-American Development Bank (IDB) and World Bank for development and/or improvement projects, subject to the

environmental impact assessment process, as well as the model outline proposed by the Bahamas Environmental Science & Technology (BEST) commission.

#### **1.4.1 Property Inspection**

An onsite inspection of the proposed power plant site, linear facility (Wilson City Road) and proposed docking facility was made to note the environmental setting of the property and record any activities at, or near, the site which could be impacted as a result of the proposed action. Photographs were taken during the inspection. Environmental professionals having a degree and/or certification in one of the following disciplines made observations during this inspection: ecology, hydrology, geology, engineering, chemistry, environmental regulation, land use and/or biology.

#### **1.4.2 Literature Review**

A review of reasonably obtainable literature was conducted from sources that may include appropriate governmental agencies, universities and public records to document areas of potential environmental concern. The various elements subject to review include geology, soil, fauna, flora, the aquatic biotic environment, beach environment and other natural features.

#### **1.4.3 Agency/Public Involvement**

Persons familiar with the site and/or conditions and settings similar to the site may provide additional background information. Interviews with such knowledgeable persons or stakeholders may reveal areas subject to specific environmental concern not readily found in the literature.

### **1.5 NEW CONSTRUCTION AND EIA REQUIREMENTS**

As previously indicated, an EIA is required for all proposed new developments, extensions or major modifications to existing developments. For all development of new facilities or extensions to existing facilities, a building permit is required. Application for a building permit and a copy of the EIA report is submitted to the Department of Building Control for registration and payment of the license application fee. The permit application and EIA report are also sent to BEST for review.

## 2.0 REGULATORY OVERVIEW

### 2.1 REGULATORY FRAMEWORK

The Commonwealth of The Bahamas has established a comprehensive institutional and legal framework for environmental protection and natural resources management. Three key organizations, The Bahamas Environmental, Scientific and Technological Commission (BEST), the Department of Environmental Health Services (DEHS) and The Bahamas National Trust (BNT), together with specific governmental resource management agencies, provide the institutional direction for environmental protection and management. Environmental protection is supported by a number of laws and regulations that control activities in the physical and biological environment. Recent modifications to long-established natural resources laws, and new laws and regulations dealing with the physical environment, have enhanced the existing legal framework. Additional laws are currently under development to update the existing legal structure. Summarized below are the legal, regulatory and administrative frameworks governing environmental protection and natural resources management.

There are a number of statutes that relate to environmental planning and protection in The Bahamas. These Acts are summarized as follows:

- ***Archipelagic Waters & Maritime Jurisdiction Act 1993 (No. 37 of 1993)***  
This Act establishes the boundaries of the archipelagic waters that come under the jurisdiction of The Bahamas as prescribed under the Law of the Sea Convention. The Bahamas thus has authority over these waters, the seabed and the resources found therein.
- ***Fisheries Resources (Jurisdiction & Conservation) Act 1977 (Ch. 225)***  
This Act establishes the Exclusive Fishery Zone (EFZ). It reflects concern with respect to conservation and management of the marine environment and its resources. It also recognizes traditional fishing rights and provides for the declaration of protected marine areas and regulation of the fishing industry.
- ***Merchant Shipping (Oil Pollution) Act 1976 (Ch. 253)***  
This Act provides for the proper registration of ships, the control, regulation and orderly development of merchant shipping in The Bahamas, proper qualification of seamen and regulation of employment conditions for seamen. These provisions

advocate ship safety and competency which prevent shipping accidents that can be detrimental to the marine environment as well as result in human casualties.

- ***Conservation and Protection of the Physical Landscape of The Bahamas Act 1997 (No. 12 of 1997)***  
This Act prohibits all significant excavation, landfill operation, quarry mining or mining of physical natural resources (such as sand) without permission of the Director of Physical Planning. The Act also gives the Director the authority to request an Environmental Impact Assessment (EIA) for any excavation or land reclamation activities. It provides for the protection of trees that are rare and of historical significance and imposes stiff penalties for violators of this law.
- ***Town Planning Act 1961 (Ch. 236)***  
This Act provides the Department of Physical Planning with the authority to grant permits for building construction, zone residential areas, determine building specifications and restore buildings.
- ***Local Government Act 1996 (No. 5 of 1996)***  
This Act divides the Family Islands into 23 districts, each administered by a District Council. With this Act, much authority has devolved from Central Government to the District Councils. The Council and their respective Town Committees are responsible for town planning, licensing and administering budgets. They are also mandated to create open spaces for community use, including recreational parks and to provide community services, such as water, health care, sanitation, and waste collection and disposal.
- ***Bahamas National Trust Act 1959 (Ch. 355)***  
This Act establishes The Bahamas National Trust as the entity that advises the Government on areas for preservation and conservation. It gives the Trust the power to create by-laws to be in effect in the protected areas it establishes. These areas are of environmental, historical and/or cultural importance.
- ***Wild Animals (Protection) Act 1968 (Ch. 229)***  
This Act prevents the taking, capture or export of any wild animal without the permission of the Minister of Agriculture & Fisheries. These animals include wild horses, the hutia and iguanas.
- ***Wild Birds Protection Act 1952 (Ch. 230)***  
This Act provides for the protection of wild birds. The Act lists several species including the White-Crowned Pigeon, Whistling Duck and Yellow-Crowned Night Heron.
- ***Agriculture & Fisheries Act 1963 (Ch. 223)***  
This Act provides for the protection of plants by Ministerial declaration of protected areas. Within these areas, persons are prohibited from uprooting or destroying any plant species.

- ***Plant Protection Act 1916 (Ch. 231)***  
This Act is primarily concerned with controlling diseases related to importation of infected plants.
- ***Coast Protection Act 1968 (Ch. 190)***  
This Act serves to regulate construction or alteration of the coastline for the purpose of the protection of land. It also provides for protection against encroachment and erosion by the sea.
- ***Continental Shelf Act 1970 (Ch. 5)***  
This Act provides for the protection, exploration and exploitation of the continental shelf. It gives The Bahamas Government sovereignty over the continental shelf.
- ***Antiquities, Monuments and Museum Act 1998 (No. 5 of 1998)***  
This Act provides for the preservation, conservation and restoration of historical, paleontological and archaeological resources.
- ***Port Authorities Act 1962 (Ch. 247)***  
This Act provides for the regulation and control of ports, harbours and navigational aids throughout The Bahamas as well as pilots and pilotage. It also regulates dredging activities for harbours and ports. The Act prevents dumping of ship ballast water in Bahamian harbours. This can prevent the introduction of exotic species and pollution of waters.
- ***Environmental Health Services Act 1987 (No. 4 of 1987; Ch. 217)***  
This Act promotes conservation and maintenance of the environment and also addresses the control of contaminants and pollutants that may adversely affect the environment and human health. The Act also outlines regulations with respect to water supplies, solid and liquid waste, beaches, seaports, harbours and marinas.
- ***Water and Sewerage Corporation Act 1976 (Ch. 184)***  
This Act establishes the Corporation. Functions of this organization include the application of appropriate standards and techniques for investigation, use, control, protection, management and administration of water. The Corporation is also mandated to oversee waste disposal, water treatment, water quality and disposal quality.
- ***Private Roads and Subdivision Act 1961 (Ch. 237)***  
This Act enables the Department of Physical Planning to regulate road construction and subdivision development.
- ***CITES Act 2005***  
This Act enables implementation of the Convention on International Trade in Endangered Species at the national level.

Additional details of a few of the previously referenced Acts follows:

### **2.1.1 The Environmental Health Act**

The Environmental Health Act, Chapter 217, and the Environmental Health Regulations (1998), promote the conservation and maintenance of the environment in the interest of public health. The Minister of Health is responsible for regulating, monitoring, and controlling the actual and likely contamination or pollution of the environment from any source, for ensuring compliance with all relevant regulations and for setting out minimum standards for a clean and healthy environment. The Minister is assisted by the Director of Environmental Health Services and staff, and is advised by an Environmental Health Board.

### **2.1.2 Certificate of Approval**

A Certificate of Approval from the Director of Environmental Health Services must be obtained by anyone who intends to construct, alter, extend or replace any plant, structure, equipment, apparatus, mechanism or thing that may emit or discharge, or from which may be emitted or discharged, a contaminant or pollutant into any part of the environment.

### **2.1.3 The Conservation and Protection of the Physical Environment of the Bahamas Act**

The Conservation and Protection of the Physical Environment of the Bahamas Act, No 12 (1997) is administered through the Department of Physical Planning in the Office of the Prime Minister and controls the physical landscape to prevent environmental degradation, flooding and removal of hills; excavation in the form of land removal, quarrying, mining, or harvesting sand or rock; filling lands, wetlands, drainage basins or ponds; digging or removing sand from beaches and sand dunes; any work that will affect the coastlines; and harvesting or removing protected trees. Permits must be obtained from the Director of Physical Planning for any of these activities. Severe penalties, fines and imprisonment

can be imposed for violations of the Act. The Quarrying and Mining Zones Order (1997) provides additional control over land removal.

#### **2.1.4 Conservation and Protection of the Physical Environment Of the Bahamas Act and the Declaration of Protected Trees Order**

Certain species of hardwood trees, rare trees, and trees of remarkable growth or historical significance are protected under the Conservation and Protection of the Physical Environment of the Bahamas Act and the Declaration of Protected Trees Order (1997). A license to harvest any protected trees is required. Before any excavation or construction begins, a qualified person to identify potentially protected trees would inspect the area. Currently, ten tree species are protected by the Order.

#### **2.1.5 The Wild Birds and Plant Protection Acts**

The Wild Birds Protection Act (1987) protects birds and bird eggs during closed seasons. Protection of the bird habitats is not addressed by this Act. The Plant Protection Act (1987) relates to plant disease and controls importation of plants to prevent outbreaks of exotic disease and establishment of unwanted species.

#### **2.1.6 The Fisheries Resources Act**

The Fisheries Resources Act, Chapter 225, amended as No. 38 in 1993, provides for conservation of the fisheries resources of the Bahamas. It establishes an exclusive fisheries zone and regulates harvesting of fisheries resources within the zone. The Minister of Agriculture and Fisheries may declare any area within the zone, as well as the land adjacent to it, a protected area for the purposes of the Act. Department of Fisheries officers enforce the regulations. Permission must be granted to fish within an exclusive fisheries zone, and permission may include conditions necessary or expedient to conserve and manage the resource.

#### **2.1.7 Antiquities, Monuments and Museum Act**

Areas or structures of cultural, anthropological, archeological, paleontological or historical significance are regulated under the Antiquities, Monuments and Museum Act

(1998) and Regulations (1999). Discovery of a cultural or historical feature must be reported to the Minister and measures are required to preserve its integrity. A permit must be obtained to excavate, carry on building or other work, plant or fell trees, and deposit earth or refuse on, in or near a monument, or demolish, remove, obstruct, deface, or interfere with a monument.

### **2.1.8 The Public Works Act**

The Public Works Act, Chapter 21, while providing for construction, management and development of public works, buildings and roads, also provides that the Minister of Works can make rules to regulate the use, obstruction, alteration, encroachment upon or damage to any government property.

### **2.1.9 Acquisition of Land Act**

Land to be acquired for a specific building or construction by Government must meet the requirements of the Acquisition of Land Act (1913) and its regulations (1987). Whenever land in any locality is likely to be needed for any public purpose, a notification to that effect must be published in the Gazette, the official government publication. A public notice is also required to be displayed at a convenient place in the respective district to show what land is needed and where. After notification, a 30-day public response period is observed. The Government may acquire, by private purchase agreement or through compulsory purchase, the selected land. In the event that a structure is moved, compensation is paid to the owner to cover the expense of moving the house to another site plus payment for any damages incurred.

### **2.1.10 The Bahamas National Trust Act**

The Bahamas National Trust Act directs the Bahamas National Trust to promote permanent preservation of lands, buildings, underwater areas of beauty, and areas of natural or historic interest. Additionally, the Act directs the Trust to identify sites for protection, and to administer those areas declared protected. The Trust administers the National Parks of the Bahamas, and it has been the leading organization in the country's conservation efforts.

### **2.1.11 Proposed and Applicable Regulations**

Proposed legislation to increase environmental protection and natural resources management includes the Environmental Planning and Protection Act, the Air Pollution Act, the Revised Fisheries Act and the Ozone Protection Act. Since certain standards are currently being developed, or in the event a standard or regulation is unavailable, other appropriate existing United States Environmental Protection regulations, and World Bank criteria may be cited as a reference in the EIA.

## **2.2 THE BAHAMAS ENVIRONMENT, SCIENCE AND TECHNOLOGY COMMISSION**

The Bahamas Environment, Science and Technology Commission (BEST), the country's environmental agency created in 1994, is responsible for the overall environmental and natural resources management of The Bahamas. The BEST Commission has developed Environmental Impact Assessment (EIA) guidelines and requires an EIA for major development projects. BEST has the primary responsibility for assessment of proposals submitted for development projects. The Commission reviews EIA reports, advises the Government as to the acceptability of projects and recommends amendments when necessary. BEST is developing policy and procedures for environmental management, including coastal zone management. The agency's mandate also includes advising the Bahamas government on the environmental impact of development proposals submitted to the commission for review, conducting site visits for projects under EIA review, serving as the country's focal point and point of contact for all international organizations on environmental, scientific and technological matters, coordinating activities related to international treaties, protocols and agreements to which The Bahamas is or will become a signatory, representing the government in discussions and negotiations with representatives of regional and international organizations and foreign governments on environmental, scientific and technological matters, and serving as a forum to encourage and enhance dialogue and information exchange between government agencies and private sector entities.

BEST's Board is headed by the Ambassador for the Environment and consists of representatives from the following: Senate, Department of Fisheries, Department of Environmental Health Services, Department of Agriculture, Water and Sewerage Corporation, College of The Bahamas, Ministry of Tourism, Ministry of Foreign Affairs, Ministry of Finance, Port Department, Department of Land & Surveys and Bahamas National Trust.

### **2.3 THE DEPARTMENT OF ENVIRONMENTAL HEALTH SERVICES**

The Department of Environmental Health Services (DEHS) is responsible for enforcing public health guidelines and industrial regulation and enforcement. The Department is responsible for solid waste management and oil spill contingency plans. Under the Environmental Health Act of 1987, and the Environmental Health Regulations, the DEHS mandate is to promote and protect public health and ensure conservation and maintenance of the environment. In practice, ensuring conservation and maintenance of the environment has been limited to preventing actions taken in the environment that negatively impact human health, such as pollution. The main role of the DEHS is to regulate, monitor, and control actual and likely contamination and pollution of the environment and establish minimum standards required for a clean, healthy, and pleasing environment. For proposed large projects, the DEHS evaluates the effectiveness of pollution control measures and initiatives to protect the health and safety of workers and the natural environment. DEHS also issues the necessary effluent discharge and emissions permits. DEHS has created a new entity, the Environment Monitoring and Risk Assessment (ERMA) Division, formerly the Public Analyst Laboratory attached to the DEHS, which has the responsibility for environmental monitoring.

### **2.4 OTHER GOVERNMENT AGENCIES**

Other Government agencies with specific environmental responsibilities are:

- The Department of Agriculture who oversees the agricultural provisions of the Agricultural and Fisheries Act 1963. This department works to stimulate and diversify crop production. Its mandate also includes conserving biodiversity and protecting wild flora and fauna.

- The Department of Lands & Surveys is responsible for disposing and leasing Crown Lands, land surveying, reproducing photography and photogrammetry and advising the Government on Land matters. In addition, its mandate includes ensuring that the natural characteristics of Crown Land are complimentary to proposed use. The Forestry Unit manages forest resources.

## **2.5 THE BAHAMAS NATIONAL TRUST**

The Bahamas National Trust is a non-profit organization established through The Bahamas National Trust Act in 1959. It is responsible for establishing and managing national parks and protected areas, historic preservation, public awareness and outreach on environmental issues.

## **2.6 PERMIT APPLICATION AND REVIEW**

The following is an overview of the permit application and review process. Within the Commonwealth of the Bahamas, a full environmental impact assessment is required for all proposed new power plant developments or extensions or major modifications to existing power plants. For all development of new facilities or extensions to existing facilities, standard procedures require that a Building Permit be obtained from the Ministry of Public Works. According to the Town & Planning Act, application for a Building Permit must be accompanied by a copy of the EIA Report and must be submitted to the Department of Building Control for registration and payment of the license application fee. The permit application and EIA Report are also sent to the BEST commission, who is responsible for examining all proposed new developments in order to ensure that all new developments are, from a technological and environmental point of view, in the best interests of the nation. Comments will be sought from government agencies such as the Bahamas National Trust, the Department of Archives and the Ministry of Tourism, as well as non-government organizations (NGOs).

The Department of Building Control then forwards the Building Permit Application and EIA Report to the Department of Town Planning and the Ministry of Health and Environment for their evaluation. The Department of Building Control examines the structural and electrical design of the proposed development to ensure that it meets the required Building and Fire Regulations, including Bahamas Building Code.

Permission is also required for use and storage of volatile substances, for construction of new oil tanks, to ensure that they are correctly banded and hurricane proof, for installation of electrical and plumbing works and for air conditioning and boilers. The Building Permit encompasses all these; in addition, consideration is given to the impact on land use and water resources. Once the Town Planning Committee has reviewed the application, they will take into account the views of the government before finalizing their comments. At the Town Planning Committee meeting, should the Committee deem it necessary and if there is strong public objection to the project, representatives or members of the general public may be invited to voice their views or objections.

Due notice is also taken of any comments made by Non-Government Organizations (NGOs), such as Friends of the Environment, and government agencies such as the Ministry of Tourism, Water & Sewerage Corporation and Bahamas National Trust, together with any potential impacts that they might identify as giving cause for concern.

On submission of the Building Permit Application (and EIA) to the Ministry of Health & Environment, the Department of Environmental Health (DEH) considers the environmental impacts of the proposed development, and the issuance of effluent discharge and emission permits. The Environmental Health Services Act stipulates that a permit is required to be granted by the Director of the Department of Environmental Health for all emission, deposition, issuance or discharge of any regulated air contaminant. All new facilities must obtain a permit prior to initiating the discharge.

### 3.0 PROPOSED PROJECT

#### 3.1 OVERVIEW

The Bahamas Electricity Corporation (BEC) has responsibility for the generation, transmission and distribution of electricity in the Commonwealth of the Bahamas. Due to current and anticipated future demands, BEC has determined that expansion of the existing power generating facilities is considered necessary to meet the needs of all consumers on Abaco. The island is experiencing tremendous economic growth due to various development projects. The proposed site is located at Wilson City and will initially be located on the front 25-acres of a 100-acre parcel of land (Figure 3-1). The power plant site will be located on the southern side of Wilson City Road, approximately 5.0 miles east of the intersection of Great Abaco Highway and Wilson City Road. The proposed power plant will include the powerhouse within which will be installed 4 x 12 Megawatt (MW) engines fueled by Heavy Fuel Oil (Bunker C). The proposed facilities will almost double the nominal generating capacity from the installed capacity at Marsh Harbour. A fuel pipeline is also proposed which will run from the power plant along Wilson City Road and terminate at the coast, south of Wilson City (Figure 3-2). The dock area and associated pier will house pumping facilities to receive waterborne fuel shipments to service the plant. The design build project has been awarded to MAN B&W, who propose to construct, from the ground up, a state-of-the-art power generating facility which will take into account the environmental protection needs of the Bahamas in general and Great Abaco in particular. Figure 3-3 is a MAN B&W template design of a typical power plant layout. Wilson City will conceptually be laid out in a similar fashion. This firm has a long history in serving the power generation needs of the Bahamas, as indicated in the following table.

#### Historical MAN B&W Installations at Clifton Pier

No. of Engines	Engine Type	Output	Location	Delivery
2	9K80 MC-S	57 MW	Clifton Pier	1992
1	10K80 MC-S	33 MW	Clifton Pier	1997
1	10K80 MC-S	33 MW	Clifton Pier	2002

Source: MAN B&W, 2007

### 3.2 BAHAMAS ELECTRICITY CORPORATION

The Electricity Act of 1956 established Bahamas Electricity Corporation (BEC) as a public corporation. As an electric authority, BEC began to generate and distribute electricity in 1909. BEC generates and distributes electricity to New Providence, the nation's capital, and to all major populated communities in the Out Islands, with the exception of Grand Bahama Island.

BEC acquired the privately operated Marsh Harbour Power & Light Company in the 1980's and provides power to the island. The 2001 extension of the Marsh Harbour Power Station, the addition of 2 x 4.4 MW generators and the Abaco distribution system upgrade, met the forecasted load demand. The expansion of the generating system was intended to meet the increased demand, thereby benefiting the continuing development of the island by continued encouragement of economic development for projects in tourism, agriculture and small industry.

The Marsh Harbour Power Station installed capacity is 25.6 MW, with a number of smaller generator sets recently purchased to accommodate anticipated load in the summer of 2007. The number of fixed units and generating ratings are as follows:

#### Installed Capacities at Marsh Harbour

Number of Units	Unit Capacity (MW)	Total Capacity (MW)
4	2.5	10
4	1.7	6.8
2	4.4	8.8

*Source: Environmental Management Audit, 2003*

#### 3.2.1 Abacos Power Needs

In predicting the power needs of the Abacos, in 2005 Mr. Bradley Roberts described BECs proposed improvements. Mr. Roberts indicated that all are aware that electricity was vital not only to basic needs, but also to development. Utilization of water supply systems, telecommunications, computer and other ancillary services all require electricity upon which modern lifestyles are dependent. As such, the absence of electricity is felt

immediately, including the loss of television, internet, air conditioning and medical needs to mention a few.

In Abaco, BEC has power generation stations at Marsh Harbour, Sandy Point, Treasure Cay, Green Turtle Cay and Moore's Island. BEC is also responsible for the distribution of power on Grand Cay via a power purchase agreement with the operators of Walkers Cay. The remote sites present challenges as resources have to be duplicated in many instances.

The growth in consumer demand for power in Abaco over the past few years has increased. Over the past five years, BEC peak load has increased by some 64%. This has presented BEC with challenges in some instances requiring additional generation capacity, as well as initiating a program to replace the older generators with new ones. In this regard, a new power station was proposed to be built on mainland Abaco. Concomitant with the new station, the installation of new overhead lines and underground cables along with a new pipeline to ensure adequate delivery of fuel was proposed (Roberts 2005). While plans for the new station move forward, to address the need for anticipated demand on Abaco, Marsh Harbour has purchased a number of small generators during the interim.

### **3.3 SITE LOCATION**

The proposed site is accessible by driving approximately nine (9) miles south of Marsh Harbour, on Great Abaco Highway, the major transportation artery on Abaco. The site is approximately five (5) miles from the intersection of Wilson City Road and a currently unpaved and intermittently used road that dates back to early Abaco development activities. The site is approximately two (2.0) miles inland from the coast. Spring City (the largest settlement) is located between the site and Marsh Harbour. Spring City is a settlement whose presence is rooted in the former pulpwood and sugar industries and Marsh Harbour Airport.

The subject site is located in a predominantly pine forest area of the island, with pine covered Crown Lands in cardinal locations of the site. West of the site, current pine

covered lands are former sugar cane fields. Northeast of the site, at Pelican Point, are the ruins of the former pulp era settlement location of Wilson City, after which the plant was named. There are currently no developments within a three (3) mile radius of the proposed power plant project. The last Wilson City residents relocated following the demise of the timber industry in 1916.

### **3.4 SITE PREPARATION**

Site clearing will be limited to the needs of the project, and trees not in conflict with the project will be left for both aesthetic and noise attenuation purposes. Site development requires the removal of pine trees and grading of the site for proposed construction. In addition, concrete foundations will be required to support the engines, the final design of which will be predicated on site specific conditions and the completed geotechnical investigations. The construction phases will include: site preparation and excavation, pile installation (if needed), concrete foundation pouring, steel erection, mechanical equipment installation, piping, electrical and controls, cleanup, equipment start up and testing. MAN B&W provides package plant designs based upon the clients power generation needs and site configuration.

#### **3.4.1 Pipeline Corridor (Wilson City Road)**

A fuel pipeline is proposed from the power plant to Wilson City Dock. From a preliminary site inspection, it is anticipated that the proposed route for a trench from the dock to the power plant is considered to be feasible without encountering or traversing any obstacles. From the Wilson City dock, a 12” diameter pipe will be laid out in an underground trench to connect the dock to the power plant. It has been proposed that the pipes will be buried at a depth of approximately 5 ft to protect them from environmental and human hazards. The pipes will be laid in a trench located on the southern and western sides of the road and run parallel to the existing Wilson City Road, the recently cleared and cut Wilson City Road Extension and Dock Road to the power plant facility. After pipe installation, approximately 30” of granular material (gravel) will be used to cover the pipes; the remainder will be filled with normal soil material from the site and compacted.

### **3.4.2 Wilson City Docks**

Construction of a new fueling pier or wharf will be required to facilitate power plant construction and operations. Typical open pier or wharf construction involves the installation of pilings and construction of a decking system. Based upon site conditions, a small area of land will be cleared adjacent to the eastern coast of Great Abaco at the terminal end of the newly constructed dock road from the power plant facility. Associated with the docks will be a pier that is anticipated to extend out into the Sea of Abaco to access deep water for the fuel freighters. The dock, Dock Road and Wilson City Road Extension will be finished with a gravel base and asphalt paving.

### **3.5 MAJOR PROJECT COMPONENTS**

The following section provides a brief description of the main components of the proposed power plant. The main site components include:

- A bunded tank farm, which will include two (2) 1.0 million-gallon Heavy Fuel Oil (HFO) tanks, one (1) 250,000-gallon Automotive Diesel Oil (ADO) storage tank, one (1) 50,000-gallon HFO pre-centrifuge tank, a lube oil storage tank, and a sludge tank;
- Cooling system (direct cooling), with supply and disposal wells located on the property;
- Power house which will include the four diesel generator sets and concomitant foundation;
- Transformer substation; and
- The administration building.

MAN B&W provides a number of template designs, which incorporate the features anticipated for the subject site development. The standard template design layout provides for general access through one gate for both administration and deliveries, although a second gate option is available for administrative personnel. A fuel line will run from Wilson City Dock to the generating plant. Site completion will include paving, and curbing and sidewalks, which will direct storm water to catch basins. The first step in the power plant project construction process will be site preparation. Ingress/egress will

be completed to provide access for construction equipment from Wilson City Road. Following pile installation (if required) and concrete foundation construction, major equipment will be set in place and buildings constructed. Finally, piping, electrical and controls installation will proceed to complete the project construction phase.

The general site layout, illustrating all the major components, is provided in Figure 3-3. Concrete pad foundations will be prepared for the four (4) 48/60 MAN B&W engines. The engines will be placed in a parallel basis, with two engines anticipated to be operational by the summer of 2009, with the remaining engines phased in shortly thereafter.

### **3.5.1 Storage Tanks**

The proposed fuel storage specification includes:

- 2 x 1.0 million gallon HFO tanks, API 650 compliant, x-rayed, painted and hydro tested;
- 1 x 250,000 gallon Light Fuel Oil (LFO) tank, API 650 compliant, x-rayed, painted and hydro tested, the floor painted and inside up to 3ft height. Instrumentation included, Level transducer - HH.H level, Dipping hatch, Spiral stairs, Roof perimeter handrails, Galvanic cathode protection system with test stations. Tank base with environmental protection liner.

The API 650 standard is designed to provide the petroleum industry with tanks of adequate safety and reasonable economy for use in the storage of petroleum, petroleum products, and other liquid products commonly handled and stored by the various branches of the petroleum industry. It is intended to help purchasers and manufacturers in ordering, fabricating, and erecting tanks. Standard 650 covers material, design, fabrication, erection, and testing requirements for vertical, cylindrical, aboveground, closed- and open-top, welded steel storage tanks in various capacities for internal pressures approximating atmospheric pressure, but a higher internal pressure is permitted when additional requirements are met. This standard applies only to tanks whose entire bottom is uniformly supported, and to tanks in non-refrigerated service, that have a maximum operating temperature of 90 degrees Celsius.

### **3.5.2 Bund Wall Containment**

The proposed tank farm will be located within a bund wall secondary containment system. A bund wall secondary containment system generally consists of an impervious embankment of earth, or a wall of brick, stone, concrete or other suitable material, which may form part or all of the perimeter of a compound that provides a barrier to retain liquid. Since the bund is the main part of a spill containment system, the whole system (or banded area) is referred to as the "bund". The bund is designed to contain spillages and leaks from liquids used, stored or processed aboveground, and to facilitate clean-up operations.

A bund consists of:

- An impervious bund wall or embankment surrounding the facility or tanks, with an impervious floor within the banded area, and sealed joints in the floor or the wall, or between the floor and the wall; and
- Any associated facilities designed to remove liquids safely from the banded area without polluting the environment.

As well as being used to prevent pollution of the receiving environment, bunds are also often used for fire protection, product recovery and process isolation. The bund floor and wall must be constructed of materials impervious to the contents of any tank or container within the bund. The banded area must be capable of preventing the migration of any spillage or leakage to the surrounding environment. The bund must be built out of materials that can resist attack by any toxic substances that might be put inside it. A wall of brick, stone concrete or other suitable material could form part or the entire perimeter of a compound.

The proposed Wilson City bund wall specifications include:

- Concrete filled core blocks;
- Reinforcing concrete slab and individual full containment;
- Partition wall for each tank;
- Valves and Oil water separator;
- Disposal well and fire/foam system; and
- Bund approximate total area of 375 ft. x 150 ft. x 3.5 ft.

### **3.5.3 Power Block**

The principal duty of each diesel generator will be to provide base load generating capacity for Great Abaco. The proposed engines are capable of operating continuously burning the specified Bunker C HFO. In addition, the engines will be capable of continuously burning the specified ADO or any mixture of the fuels. The ADO will, however, normally be used for starting and stopping purposes only. MAN B&W has previously supplied engines to BEC at Clifton Pier and on the Out Islands, including Abaco and Eleuthera, and those proposed for Cat Island and Bimini. This would have the advantage of the commonality of a number of critical spare parts.

### **3.6 DIRECT COOLING WATER**

The heat removal needs of the plant will be by direct cooling with water provided by a number of supply wells located on the property. Subsequently, the used water will be disposed via a disposal well also located on the property. In this regard, MAN B&W Diesel Canada Ltd. (MBDCA) had requested Engineering Company of Central America, S.A. de C.V. (EC) to provide a quotation for the necessary studies and site test determination to assess the feasibility of using a borehole cooling system for the cooling needs of the intended Snake Cay power plant station. However, since that site is no longer considered viable, it is anticipated that much of the work completed for Snake Cay may be applicable to Wilson City. The conclusions of the Snake Cay investigation were not made available for this EIA.

MAN B&W's scope of work indicated that it is the intention that the heat removal needs of the plant be met by drilling a set of wells in a field near the plant from which water, in the amount of 475 cubic meters per hour (m<sup>3</sup>/hr), can be extracted. After serving the needs of the power plant, the water will be re-injected at a deeper point, balancing the water extracted from the underground. In response to the request for proposal, EC proposed a two-phased approach:

#### ***Phase 1- Preliminary Studies***

To assess the feasibility of the borehole cooling system, the complete hydrological balance of the area has to be defined, together with an analysis of the geological and

geotechnical characteristics of the zone, in order to determine the presence of an aquifer of enough capacity to feed the water required by the plant and the necessary characteristics to receive the injected water.

To perform the hydrological study of the area, it is necessary to collect the available meteorological data for the zone, from the appropriate sources in The Bahamas. Also, an evaluation of the hydric resources and the evaluation of the type of soils will determine the amount of infiltration water that replenishes the underground water. The activities and studies to be performed on site are as follows:

*Geotechnical and Geohydrological Information*

- Collect information about the geology of the country and especially, Abaco Island;
- Collect existing topographic and hydro-geological maps of the area;
- Verify the geology and capacity of existing wells in the area, if available;
- Evaluate the potential of water delivery in the existing wells, close to the plant; and
- Check the Geotechnical Study performed by the owner on site.

*Geophysical Studies (Goelectrical Resistivity)*

- Goelectrical Resistivity Surveys with vertical electric soundings (VES) to study the groundwater conditions (depth, thicknesses and aquifer boundaries, type of water and the interface between saline and fresh water); Number of arrays according to the well field extension; and
- Determination of layered-earth resistivity model.

*Evaluation of the exploration wells and pump test*

- Check the production/injection capacity of the exploration wells; and
- Check the geologic logging. (Note: Exploration well drilling and pump testing to be performed by others; drill two wells, 50 and 150 ft.)

*Hydrologic Study*

- Collect statistical information from The Bahamas entity about rains and meteorological data, especially from nearby stations;
- Process all the hydrologic information available;
- Verify the presence of collecting beds, creeks and rivers in the area;
- Estimate the balance of the rains and surface waters; and
- Conclusions and recommendations.

*Water Analysis*

- Water sampling. Number of samples to be defined according to evaluation of aquifer characteristics; and

- Chemical and physical analysis of the water, especially the evaluation of hardness, acidity and iron content.

#### *Interpretation of Pump Test/Geotechnical and Geo-hydrologic Information*

- Interpretation and evaluation of pump test results;
- Interpretation of geotechnical and geo-hydrologic information;
- Determination of the aquifer hydraulic characteristics;
- Check local regulations; and
- Calculations and recommendations about the aquifer capacity

#### ***Phase 2-Final Design and Additional Studies***

If the decision is to implement the system, additional tests and deeper investigations have to be executed in order to obtain the construction design and get an efficient system. At this phase, the total digital modeling of the system may be conducted and the behavior of the whole system predicted. EC recommended a thermo-dynamic 3D groundwater model based on the finite-element method. With this model, the interaction between water withdrawal, re-injection and temperature migration can be simulated and evaluated. Additionally, diverse operational modes can be simulated and predicted.

Extracts including the conclusions and findings of this report were not available prior to the completion of the EIA.

### **3.7 REVIEW OF ALTERNATIVES**

#### **3.7.1 Proposed Power Plant Site**

When the need for additional power generation capacity was confirmed, BEC had reviewed a number of siting options prior to the selection of the Wilson City location, including the expansion of the existing Marsh Harbour Power Plant facility and a site at Snake Cay. During this review, a number of engineering, civil and environmental factors were taken into account, which included the following:

- Availability of adequate space at the site for the new facility;
- The availability of space for future expansion;
- Proximity to fuel supply; and
- Limited disturbance to neighbors.

#### **Marsh Harbour Expansion**

With respect to the existing facility at Marsh Harbour, the availability of existing space and space for future expansion was not available. In addition, the close proximity of an adjacent residential subdivision would result in significant disturbance to the residences from the operation of a much larger generating facility, both with respect to noise and odor. Based upon these criteria for which the availability for future expansion of power

generation capacity was required, the Marsh Harbour site was eliminated from further consideration.

### **Snake Cay Location**

The selection of the Snake Cay site, in addition to meeting the initial criteria, also had additional value based upon its somewhat remote location and the availability of water borne access for fuel and materials ideally suited the needs of the project. Its remote location would also tend to diminish the aesthetic impact of a large structural facility, as well as reduce the potential impact from noise pollution on nearby sensitive receptors. However, following completion of an EIA, concerns were raised with respect to construction and operations of both supply and disposal wells in the Marsh Harbour-Lake City aquifer. Other concerns included land use conflicts with the proposed development of a resort at Snake Cay, as well as concerns associated with an industrial facility located proximal to mangroves located along the eastern coast of Great Abaco which serve as a natural fish nursery. Based upon both environmental and societal concerns, the Snake Cay site was eliminated from further consideration.

### **Wilson City Location**

Based upon BEC's experience with the Snake Cay site and prior to the selection of the Wilson City site for consideration, BEC, with the assistance of the BEST Commission, reviewed alternative sites with the view that at least on a macro scale any potential conflicts could be identified and these sites removed from contention early in the siting consideration process. Based upon this preliminary evaluation, Wilson City was identified as a viable site for consideration. Similar in many respects to Snake Cay, the Wilson City site meets both the initial criteria of adequate space at the site for the new facility, space for future expansion, proximity to fuel supply and limited disturbance to neighbors, as well as all the benefits associated with its remote location. In addition, the site is located outside of the Marsh Harbour-Lake City Aquifer.

### 3.7.2 Review of Renewable Energy Alternatives

Renewable resources such as wind power, micro hydro, photovoltaic and municipal waste combustion are not feasible options at the current time, but are subject to future consideration, particularly with respect to the price of fuel. On Abaco, high wind speed is only apparent for short periods of time. Hydro potential does not exist and the amount of power gained from incineration of municipal waste would not be sufficient for a capacity of 48MW. BEC supplies 85 percent of all Bahamian consumers, with an installed capacity of about 400 megawatts. However, with the cost of imported fuel to generate electricity around \$800 million a year (Gotlieb 2008), and increasing concerns of supply security, a convergence of renewable and conventional energy projects is not in the too far distant future. BEC's long-term planning seeks to replace conventional fuels with some combination of renewable energy technologies, at a suggested ratio of at least 9 megawatts of conventional power to 1 megawatt of power from renewable sources.

With this in mind, BEC has invited proposals for the most viable renewable energy technologies for the Bahamas. These candidate technologies include solar power (including solar thermal and photovoltaic), wind power, waste to energy/biomass and hydrokinetics (including ocean wave and ocean tidal systems). The following is a brief overview of these technologies.

- **SOLAR POWER:** Among the most promising alternative technologies for Bahamian conditions is Solar Trough Systems. Trough systems convert the heat from the sun into electricity. Because of their parabolic shape, troughs can focus the sun at 30 to 60 times its normal intensity on a receiver pipe located along the focal line of the trough. Synthetic oil captures this heat as the oil circulates through the pipe, reaching temperatures as high as 390°C (735°F). The hot oil is pumped to a generating station and routed through a heat exchanger to produce steam. Finally, electricity is produced in a conventional steam turbine. Six (6) gigawatts of capacity are now under development around the world. However, these plants typically require up to 500 acres of land for utility-scale generation, which makes them more appropriate for the less-developed out islands, connected via undersea cable to New Providence. Solar power also refers to the conversion of sunlight into electricity by photovoltaic concentrating solar thermal devices. Due to the growing need for solar energy, the manufacture of solar cells and photovoltaic arrays has expanded dramatically in recent years.

- **WIND ENERGY:** Wind power is the world's fastest-growing renewable energy technology with global capacity currently at about 94 gigawatts. Producing no pollution or greenhouse gasses, wind is regarded as a vast source of sustainable energy. Modern wind turbines concentrate the air's kinetic energy into a single rotating shaft, which in turn drives a generator to create electricity. The two main types of turbines are horizontal and vertical axis. The more common and cost-effective horizontal type is parallel to the ground (and airflow) hence the turbine faces directly into or away from the wind. These turbines are efficient and are able to reach the faster winds available at higher elevations. The axis of the vertical turbine is perpendicular to the airflow and has the advantage of not requiring specific orientation. Though less efficient than the horizontal, the vertical axis turbine can have its generator at ground level, making the turbine lighter and easier to service. Most historical objections are being addressed with new technologies with the exception of the visual impact of the turbines. BEC officials plan to visit the 23 megawatt Wigton wind farm in Jamaica to see how the turbines stand up to hurricane conditions.
- **THERMAL CONVERSION:** Ocean thermal energy conversion (OTEC) is a method for generating electricity which uses the temperature difference that exists between deep and shallow waters to run a heat engine. As with any heat engine, the greatest efficiency and power is produced with the largest temperature difference. This temperature difference generally increases with decreasing latitude, i.e. near the equator, in the tropics. The Bahamas is considered an ideal location for OTEC plants, which must be within the tropics, have a steep drop-off where the ocean plunges to over 3,000 feet, and be close to a power grid. An OTEC plant pumps warm surface seawater into a tank. The air in the tank is pumped out to create a vacuum, which vaporizes the water. The steam can be used to spin a turbine to generate electricity, and then passes through a heat exchanger where it is condensed - by cold water pumped up from the ocean - into fresh water.

BEC has appointed a special committee to review the most viable renewable energy technology at the utility scale. The committee's preliminary recommendations call for BEC to build experimental solar power facilities at its Blue Hills and Clifton Pier sites, to explore wave technology, to plan a pilot wind farm, to explore further co-operation on solar power with Cape Systems on Eleuthera, and to study the possibility of consumer-scale implementation of solar photovoltaic through net metering.

As indicated, while exploration into alternative sources of energy continues, none are currently available at the utility level to meet the current needs of the Abacos, although some combination of technologies is on the horizon.

### **3.7.3 Fuel Choice**

Two fuels are currently used for power generation in the Bahamas; these are Automotive Diesel Oil (ADO) and Heavy Fuel Oil (HFO). During fuel selection, the primary aim is to continue the use of these liquid fuels because these are already available to the commonwealth and the infrastructure (e.g. jetties, fuel tanks, as well as supply contracts) have already been established. However, from the environmental protection viewpoint, liquid fuels containing lower sulfur content is appropriate. As discussed in the previous section, a convergence of conventional and renewable energy alternatives is occurring particularly with respect to the price of fuel. The Bahamas has long been an advocate for renewable energy alternatives.

In this regard, the Bahamas is a member of the Caribbean Renewable Energy Program (CREP) which was established in 1998 when 16 Caribbean countries decided to work together to prepare a regional project to remove the barriers to the use of renewable energy and to foster its development and commercialization.

The objectives of the project were to: 1) reduce greenhouse gas emissions by removing barriers to renewable energy development, 2) establish the foundation for a sustainable renewable energy industry and 3) create a framework under which regional and national renewable energy projects are mutually supportive.

In his statement to the United Nations at the fourteenth session of the commission on sustainable development in May 2006, Dr. Marcus Bethel, Minister of Energy & the Environment, indicated that steps were being taken to identify renewable energy options suitable for Small Island Developing States (SIDS) like the Bahamas. Dr. Bethel indicated that energy efficiencies are being implemented through public awareness and education programs on conservation and also the installation of more energy efficient power generating plants. Despite the fact that the Bahamas has substantial solar resources and in spite of the government's removal of import duties on solar panels, the high capital cost associated with this technology is one example of the difficulties being faced by the

Bahamian government and national consumers desirous of making the switch to this alternative source of energy.

The complete electrification of the archipelago has raised the standard of living throughout the nation and, as a result, by 2005 the national consumption of oil was approximately 25,000 barrels per day. As a result, Dr. Bethel indicated that it was imperative for the future of the Bahamas that they diversify to more sustainable and reliable sources, and as such, there is a need for more research and information on suitable renewables for SIDS. As a case in point, most other Caribbean nations rely on oil-fired generation for their electricity needs, as there are limited natural resources on the islands and oil products are relatively easy to transport. Coal is also easy to transport, and as a fuel it is cheaper. However, coal-fired power plants are more than twice as expensive to build, and are usually more suited for large-scale installations. The size of the Caribbean economies is therefore more suitable for oil-fired generation. The cost of oil imports drains away resources earned from the tourism business; instead of fueling domestic development the hard-earned money from tourism goes to pay for oil imports. At the Caribbean electricity prices, many renewable energy applications may become increasingly more competitive (Bethel, 2006).

#### **3.7.4 Cooling Alternatives**

There are a number of types of cooling options for power plants, the development and use of which are generally cost driven. These include once through cooling systems (direct cooling), the use of cooling towers (indirect cooling) and the use of air-cooled radiators. The direct cooling method with water obtained from the ocean, or from supply wells like those presently in use at Clifton Pier and Blue Hill Road, is the preferred method of cooling, based upon cost. In the event cooling towers or radiators were considered, the construction of such would potentially double the cost of building the proposed power plant. The additional cost would be borne by both the residential and commercial consumer through an increase in the price of electricity.

## **4.0 ENVIRONMENTAL SETTING**

In order to assess the potential influence of the proposed construction and operation of the project on the ecosystem in the subject area, an overview of environmental considerations or “baseline” of environmental conditions, is necessary. The following environmental review is derived from literature obtained from reasonably accessible sources. It is against this understanding of the environmental paradigm that the site evaluation and project activities will be compared.

### **4.1 PHYSICAL ENVIRONMENT**

The Bahamas archipelago of scattered islands, cays and surface reefs extends in a northwest to southeast trend for approximately 870 miles from the east coast of Florida to the western edge of the Puerto Rico Trench. The region includes the Bahamas Plateau, the Florida Plateau to the west and the Blake Plateau to the north. The northwestern Bahama Islands are isolated land masses that project above sea level from two large carbonate platforms, Little Bahama Bank and Great Bahama Bank. Figure 4-1 illustrates the regional setting of the Bahama Banks. The Bahamian platforms have been the locations of carbonate deposition since at least the Cretaceous period. Landforms in the Bahamas consist of extensively built up carbonaceous deposits of limestone, dolomite and evaporites, which are separated by very deep escarpments and troughs. The thickness of the carbonaceous deposits is not accurately known, but it is assumed to extend to great depth (as much as 6 miles), and is underlain by oceanic crust. Water depth on the platforms is generally less than 33 feet.

The Abacos lies on the eastern flank of the Little Bahama Bank where the water depth across the platform rarely exceeds 50 ft, and is generally less than 20 ft. The Bank is bound by steep slopes that terminate in deep submarine troughs at water depths of thousands of feet. The general bathymetry adjacent to the Little Bahama Bank includes the Northwest Providence Channel in excess of 3000 ft deep to the west and the Northeast Providence Channel in excess of 12,000 ft to the south (Figure 4-1).

The contrasts in submarine geomorphology are reflected by the ecological environment between the protected “leeward” shelf *facies*, and the exposed Atlantic coastline to the east. The facies and their distribution were mapped by Purdy and biotic communities by Newell. The communities are controlled by both substrate and turbulence, and a strong correlation between community and facies has been documented. Table 4-1 indicates the facies composition and distribution in the Bahama Banks.

The shallowness of the Banks does not allow for the greater wave amplitude attainable in deeper water. Water circulation over the banks is governed by a combination of tidal and wave action. Tides are semi-diurnal but are strongly influenced by both wind direction and velocity.

#### **4.1.1 Climate**

The Bahamas climate as a whole is dominated by the influences of the Atlantic Ocean and Caribbean Sea, which have relatively high temperatures throughout the year, being influenced by ocean currents from equatorial latitudes, which form the Gulf Stream to north of the Caribbean. As a result, the area is dominated by the influence of the northeast trade winds for much of the year, and by the North Atlantic anticyclone during the winter.

Despite relatively hot summers and cold spells associated with the migration of air from North America, the Islands are characterized by an absence of temperature extremes. For instance, maximum temperatures rarely exceed 100°F during the summer whilst wintertime temperatures rarely fall below 59°F. Hurricanes are associated with the months between June and November with August and September being of particular significance for these storms. At such times, precipitation may be very high, in excess of 500 mm (19.7 inches) of rain falling over a two to three day period. On average, these phenomenon occur two or three times a year, although their influence may only extend over a relatively small proportion of the region.

#### **4.1.1.1 Winds and Storms**

Review of published records indicates that the mean wind speeds proximal to the site do not vary significantly on a monthly basis, with the highest winds occurring during the winter months on the order of 8-10 miles per hour. The prevailing wind directions, based upon local literature, are from the northeast and southeast. The subject site is located within the Atlantic Tropical Cyclone Basin. The formation of these storms, and possible intensification into mature hurricanes, takes place over warm tropical and subtropical waters. Eventual dissipation or modification typically occurs over the colder waters of the North Atlantic, or when the storms move over and away from the sustaining marine environment.

The tropical storm/hurricane activity occurs from June through November; their frequency is highly variable and their storm paths equally unreliable. It has been estimated that hurricanes, tropical storms and related weather systems are responsible for as much as 75% of the precipitation received by the Bahamas. Between 1871 and 1987, the Bahamas have borne the brunt of 115 such storms, resulting in an average of one storm per year tracking through the Archipelago. This does not include the impact of lesser storms, spawned by similar conditions, which failed to achieve tropical storm status. Generally speaking, the islands to the north tend to experience more hurricane and/or tropical storm activity than the islands in the central and southern Bahamas. Great Abaco was subject to 16 hurricane/tropical storm events during the 1871 - 1987 period. Table 4-2 indicates the regional hurricane and tropical storm frequency of the Bahamas. The Bahamas has felt the affects of more recent named hurricanes including: Hazel (1954), Donna (1960), Betsey (1965), Andrew (1992), Floyd (1999) and Frances (2004), which directly impacted Abaco, as well as Hanna and Ike (2008).

#### **4.1.1.2 Temperature**

The relative geographic positions of the islands produce variations in temperature. The northern islands experience their warmest temperatures during the months of June, July, August and September, when the mean monthly temperature approaches 84°F. Temperatures peak in August and begin to decline in September. By October, the mean

monthly temperature of the northern islands has dipped below 80°F, while the temperatures among the islands to the south remain above that mark. The lowest mean monthly temperatures are recorded in January, when the temperatures in the northern islands fall below 66°F, while the mean monthly temperature of the southern islands remains in the 74°F range. The relative position of Great Abaco in the northern Bahamas lies within the regional temperature band with a mean temperature between 75 and 77°F. Figure 4-2 provides a graphic illustration of the regional temperature across the Bahamas.

#### **4.1.1.3 Precipitation**

The precipitation regime in the Bahamas is seasonal in character with distinct wet and dry seasons. October is the month with the highest precipitation across the Bahamas (with the exception of New Providence which experiences the greatest amount in September). A marked dry season then follows in November. The lowest mean monthly precipitation for the northern islands occurs in December, while the southern islands record the mean monthly lows in April. Great Abaco, located in the northern Bahamas, annual precipitation is between 55 and 60 inches. Figure 4-3 provides a graphic illustration of precipitation regimes across the commonwealth.

#### **4.1.2 Topography**

The surface of Abaco is composed entirely of mid to Late Quaternary carbonate deposits, rocks less than 1 million years old. Eolianite (dune) ridges, with elevations commonly over 80 ft, form most of the relief on Abaco. The high cliffs along the eastern shore of Abaco are commonly the result of erosion of these eolianite deposits. The pits, holes and crevices that are evident on the surface of Abaco are due to dissolution of the soluble carbonate rock by the slightly acidic rainfall, assisted by carbon dioxide from the soil. The sum of all these features, from the small centimeter scale up to the meter scale, forms a dissolutionally controlled surface called the epikarst. The larger, deeper pits are pit caves that help drain the epikarst into the subsurface. They can be in excess of 30 ft deep. The topography at the site is fairly flat at approximately 20 ft elevation, with a gentle rise to perhaps 40 ft to the east. The high ridge, which forms the eastern flank of

Abaco, peaks east of the site at approximately 110 ft, although the ridge is generally at 60 ft elevation. East of the ridge, the topography slopes to sea level.

#### **4.1.2.1 Soils**

The soils of the Bahamas consist mostly of calcareous particles, with some aluminous lateritic soils formed under humid tropical conditions. The soil materials can be divided by their major soil forming constituents which include carbonate sediments, airborne dust, and immature humic materials, the result of decaying vegetation.

These soils, known as azonal soils, are immature and have not yet developed to a stage of equilibrium with the local weathering regime. Typically, these soils tend to be localized. Soil thickness can vary and is usually thin, discontinuous and is thickest when concentrated in shallow solution pits. The predominant pedogenic features in the altered limestone are voids produced by the carbonate solutioning process, around the roots of plants. The soil moisture is characterized by frequent wetting and drying due to the high effective porosity of the underlying carbonates and the intermittent nature of the rainfall.

#### **4.1.3 Geology**

Drilling data from the Bahamian Platform suggests that more than 3.1 miles of carbonate sediment have accumulated on pre-Triassic crystalline bedrock. Table 4-3 illustrates the Geological Time scale for the Bahamas, prepared by the US Geological Survey (USGS, 1984). The upper units consist of Pleistocene and Holocene limestones, including aeolian calcarenites, beach rock, fossil coral reef rock, and sub-tidal facies. Lithified aeolian dune ridges provide topography, with shallow brackish to hypersaline lakes occupying the depressions between. The shorelines are characterized by sand beaches, commonly containing Holocene beach rock, located between headlands composed of older, eroded aeolianites.

A general model for Bahamian geology, describing the depositional and stratigraphic sequence of the Bahama Islands, was first proposed in 1985 by Carew and Myroie. The model was developed using San Salvador Island as a specific example, but has been

successfully applied to other islands. A physical stratigraphy that is consistent with this model is presented in Table 4-4.

Notwithstanding the development of this stratigraphic model, for general purposes, the geology of the islands is essentially a homogeneous body of limestone, which for the basis of this study shall be referred to as the Lucayan Limestone.

The limestone exposed at the surface of the Bahamas is the upper boundary of the Lucayan Limestone, whose average thickness is 130 ft. The texture of this limestone ranges from *mudstone*<sup>1</sup> to *grainstone*, but *packstone* predominates. Overall, *peloids* are the most abundant grain type, but ooids predominate in the upper 30 ft and local zones of corals and coralline algae are present (Dunham, 1960). The Lucayan Limestone is dated as late Pliocene-Pleistocene.

The surface geology of the Bahamas is formed from Pleistocene and more recent deposits, basically reef limestone and its weathered products. *Karst* features created during Pleistocene sea level fluctuations provide caves, blue holes and remnants of cave systems. The topography of the islands is subdued, with low relief, which seldom exceeds 30 ft above sea level. Dune ridges of greater than 100 ft are found on some islands, notably New Providence. Ponds and lakes form between dune ridges.

#### **4.1.4 Air Quality**

Air quality standards prescribe pollutant levels that cannot be legally exceeded during a specific time period in a geographical area. The emissions of air pollutants need to be controlled so that the ground level concentrations (GLCs) for these pollutants do not exceed the ambient air quality standards.

The real concern with pollution emission from power plants is the human exposure to these pollutants. Therefore, the concentration at ground level is an important indicator. Air quality is a measure of the concentration of air pollutants taken continuously or

---

<sup>1</sup> Definitions for words in italics are located in the glossary at the end of this section.

intermittently over a short or long period of time, each measurement of which represents an average concentration over a certain time period. Air quality of an area can be determined either through a network of monitoring stations over the area or through simulation of air quality through mathematical modeling. However, prediction of air quality due to any future activity can only be done using the latter technique.

The ambient GLCs of pollutants not only depend on rate of emissions, but also on the meteorological features such as wind speed, stability conditions, the efficiency of dispersion, and on the temperature and velocity at which the flue gas is released to the atmosphere.

To predict the GLCs, it is necessary to simulate the dispersion of pollutants under atmospheric condition (wind, speed, stability) using air quality models. Air pollution modeling simulates the manner in which wind and atmospheric turbulence disperses and transports the pollutants in the air. The ambient air pollutants of potential concern include sulfur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), and carbon dioxide (CO<sub>2</sub>), which are the emissions from diesel engines. The stationary sources on mainland Abaco are Marsh Harbour, Treasure Cay and Sandy Point Power Plants. Since recent site-specific data is not available at this time, air quality in Abaco will be discussed in context with the emission data available for Clifton Pier and Blue Hill Power stations in the operations section of this report.

#### **4.1.5 Noise**

The area surrounding the proposed Wilson City Power Plant consists of vacant pine covered Crown Lands and former farmland and is isolated with respect to development in all directions. No noise sensitive receptors (e.g., residences) are located within 3,000 ft of the site. The nearest settlement is Spring City, located more than eight (8) miles from the site. Anthropogenic (man-made) noise sources in the area would be from infrequent traffic on Wilson City Road and infrequent aircraft over-flights. On the days of the visual inspections, very little traffic was observed on Great Abaco Road. Tourists and/or residents visiting the settlements or cultural resources to the south are the primary users

of the Great Abaco Road and would bypass Wilson City Road. North of Spring City, Marsh Harbour Airport would be considered the nearest source with potential for elevated noise occurrences. However, this occurrence is intermittent, during take off and landing, and limited to the daytime. Natural noise sources, such as wind, insects and birds, may produce noise levels that exceed those from manmade sources at the receptor locations (e.g., local rural residences (if any), and Spring City) at night when traffic is minimal. Historic noise data collected by BEC from the local power stations indicated that Marsh Harbour, Treasure Cay and Sandy Point were at or exceeded the reference noise standard. The Bahamas is governed by the World Banks' Noise Control Standard, which was formerly set at a maximum controllable limit of 70 decibels (dB) during the day, and 60 dB at night (and currently reduced to 55 and 45 db, respectively). However, based upon their remote locations and absence of proximal receptors, no concerns were indicated.

#### **4.1.6 Water Quality**

##### **4.1.6.1 Hydrogeology**

A major source of water supply in the Bahamas is located in the upper part of the Lucayan Limestone formation. The upper part of the formation (approximately 100 ft) is poorly consolidated oolitic/pelitic limestone. Below this formation are alternating beds of slightly cemented skeletal sands and cavernous limestone. Karst development is a major part of the deposits that form the Bahama Islands. Features of Karst development range from small scale pitting in coastal outcrops to deeper sink-holes and caverns in older material.

The major source of fresh water in the Lucayan Limestone is rainfall, which percolates through the thinly developed soils on the islands. The fresh water occurs as lenses that float on top of the denser brackish water. The water in the Lucayan Limestone is influenced by a variety of sources including tidal action, rainfall, barometric variations, evapotranspiration, and groundwater discharge at the coast, as well as by urban development and withdrawal. Generally, the location and extent of fresh water in the Lucayan Limestone depends on the island size, shape, climate and the presence of less

permeable discontinuity surfaces. The precipitation on Abaco is between 55-60 inches annually, which recharges the fresh water lenses across the island.

#### **4.1.6.2 Island Aquifers**

Fresh water supplies on small islands were first investigated by Badon Ghyben and Baurat Herzberg. These investigators determined that small islands, composed of permeable material, are underlain by salty groundwater, as well as being surrounded by sea water. The fresh water takes the form of a fresh water lens, “floating” on the more dense salty water. The Ghyben-Herzberg principle suggests that, as with any other floating body, a ratio exists where part of the fresh water lens is above sea level and part is below. In addition, this body of floating water is in dynamic equilibrium, by continually receiving replenishment from rain, with leakage occurring at lands edge discharging to the sea. These lenses are 9 to 18 ft thick in the smaller islands, while they range from 45 to 90 ft on larger islands. The contact between fresh water and seawater is not a well-defined boundary; instead, there is a zone of intermixture, commonly called the “zone of diffusion”, which separates the overlying fresh water from the underlying seawater. This zone of mixing, if subject to hydraulic head fluctuations caused by tides, will be enlarged. Figure 4-4 is an idealized section through a small island, illustrating the Ghyben-Herzberg principle for island aquifers. If there is a limited resource with respect to development in the Bahamas, it is fresh water.

#### **4.1.6.3 Groundwater Sources**

Abaco Island possesses good fresh water resources from the Lucayan Limestone aquifer lenses. Very large to large quantities of water are available from four relatively large freshwater lenses: (1) Normans Castle, (2) Marsh Harbour-Lake City, (3) Lake City-Crossing Rocks, and (4) Crossing Rocks-Hole in the Wall. The lenses vary in thickness and the water table is encountered between 2 and 20 ft below the surface. The lens at Norman's Castle reaches a maximum thickness of 55 ft and one borehole can produce a maximum yield of 60 gallons per minute (gpm). The area between Marsh Harbour and Lake City is well developed with regard to groundwater resources, as this lens serves the population of Marsh Harbour and its surrounding communities. The lens also reaches a

maximum thickness of over 50 ft and each borehole can produce yields between 30-45 gpm. The lens extending from Lake City to Crossing Rocks has a maximum thickness of 45 ft and thins southward where the water becomes brackish near Guinea Schooner Bay. Maximum yields in this area are 30 gpm. The area between Crossing Rocks and Hole in the Wall contains a thick (40-60 ft) and extensive freshwater lens that may produce yields greater than 40 gpm, which covers approximately 33% of the total island area, and is suitable for hand pumps. Given the geological conditions, uncased boreholes should be used to abstract groundwater from the limestone aquifer. Also, abstraction should be spread over many boreholes. A series of test boreholes should be drilled to confirm not only the presence and extent of the lens, but also the depth of the salt water/fresh water interface.

The following table presents suggested borehole depths based on the original thickness of the lens and water column. Also, pumping rates should be monitored such that drawdown does not exceed 0.10 ft for lenses greater than 30 ft thick and 0.01 ft for lenses less than 30 ft thick. (USACOE, 2004) The aquifer locations are illustrated in Figure 4-5.

Recommended Borehole Depths for Abaco

Original Lens Thickness (ft)	Depth of Water in Borehole Below the Water Table (ft)	Location
60 - 70	17 - 20	Crossing Rocks to Hole in the Wall
50	13	Norman's Castle Marsh Harbour to lake City
40	10	Norman's Castle Lake City to Crossing Rocks
30	7	South of Cedar Harbour
20	5	Treasure Cay to Dundas Town
20	3	Coastal sand aquifers, scattered throughout the island

Source: *Water Resources of the Bahamas, US Army Corp of Engineers, 2004*

#### **4.1.6.4 Water Use and Distribution**

On Great Abaco, the Water and Sewerage Corporation is providing water through distribution systems serving Little Abaco as well as the Coopers Town, Treasure Cay, Marsh Harbour, Spring City, Casuarina Point, Crossing Rocks and Sandy Point communities. These systems are considered to be some of the best water supply systems in the Bahamas. Collectively, including Moore's Island and Grand Cay, they provide about 1.5 million gallons of water per day. More recently, there has been improvements/expansion to systems in Treasure Cay, Marsh Harbour Wellfields, Casuarinas Point and Crossing Rocks because of the increased demand on their supplies. In addition, the Sandy Point system was recently upgraded in order to cater to increasing water demands in that community. While most of Abaco has access to piped water from the Water and Sewerage Corporation, a few communities or areas without the necessary infrastructure obtain water from rainwater catchments or barged water from Marsh Harbour Wellfields. Proposed remedies include entering into relationships with other settlements.

## **4.2 NATURAL ENVIRONMENT**

### **4.2.1 Terrestrial Ecosystems**

#### **4.2.1.1 Fauna**

The birds of the Bahamas originate primarily from the United States, Cuba and the Caribbean. The majority of birds in the northern Bahamas are of North American origin, while more Caribbean species are found in the south. Only a few species of birds are endemic to the Bahamas. Inagua is ornithologically the richest island. The lagoons and mangroves attract a variety of herons and egrets. Sea birds and waders are common along protected coasts, as are hummingbirds, and many North American migrants. The Wild Birds Protection Act is designed to ensure the survival of all bird species throughout the Bahamas.

About 230 species of birds either migrate to, or live in, the islands. Some of these are considered rare or endangered. These include the Bahama Parrot (now only found in the Abacos and Great Inagua), Bahama Woodstar, Hummingbird, Bahama Swallow, Osprey,

Kirtland's Warbler, Golden-winged Warbler, the Red-bellied Woodpecker, West Indian Flamingo and the West Indian Tree Duck.

The Bahamian fauna is also comprised of an abundance of invertebrates including many species of ants, spiders, paper wasps, honey bees, land crabs, conch, crawfish, some 90 species of butterflies and the giant bat moth.

The islands are home to 13 species of mammals, of which 12 are bats. The other is the Hutia, a rodent-like creature that nearly became extinct, but which is now thriving. There are also established populations of wild pigs, donkeys, raccoons, and on the Abacos, wild horses. In addition, many species and subspecies of reptile, thought to have originated and evolved from common ancestry, occur in the islands, examples of which are the Anolis lizards and rock iguanas

The pine forests of the northern Bahamas are recognized for the presence of birds. Above the pines can be seen the Turkey vulture (*Carthus aura*), which have been observed on Andros, Abaco and Grand Bahama. Other notable bird species include the Bananaquit, Bahama Woodstar Hummingbird, Cuban Emerald Hummingbird and the Red-legged Thrush. Over thirty different warblers may frequent the Bahamian pine forest. Two are residents: the endemic Bahama Yellowthroat (*Geothlypis rostrata*) and the Pine Warbler (*Dendroica pinus*). The rest are winter visitors or migrants, such as the Cape May Warbler (*Dendroica tigrina*) or Black and White Warbler (*Mniotilta varia*) who may return year after year to the same wintering grounds. One of the rarest birds sought by bird watchers is the Kirtland's Warbler (*Dendroica kirtlandii*). Scientists estimate the total population at approximately 1,500. Migrating from Michigan to the Bahamas, this endangered species is the subject of a joint Bahamas National Trust and Ministry of Agriculture & Fisheries monitoring program (part of the Nature Conservancy's Wings over the Americas Program). Recent sightings of this bird in the Bahamas have been at the Rand Nature Centre in Grand Bahama and in Abaco National Park. Another rare occupant of the pinelands is the Atala Hairstreak (*Eumaeus atala*), a one-inch-butterfly found on Abaco, Grand Bahama and New Providence. The Atala Caterpillar feeds

exclusively on the Saga Palm (*Zamia integrifolia*), also known as Coontie, which is not really a palm, but a member of an ancient order of plants known as cycads. These living "fossils" are slow growing and their unprotected seeds make them poor competitors in the changing environment. Human harvesting of the rootstock for sago flour and destruction of the natural habitat are making the future dim for the survival of both the Saga Palm and the Atala Hairstreak. The pine forests of the Bahamas are also home to Wild Boar which is popular game species on the island of Abaco. There are also populations of feral cats and raccoons. Quail, Wood Doves and White-crowned Pigeon, which feed on Poisonwood, may also frequent the pine forest and several migratory species of duck, such as the Blue-winged Teal, utilize the ponds and lakes of this ecosystem.

#### **4.2.1.2 Flora**

The Bahamas has over 1,300 species of plants, many of which are not found anywhere else in the world. Common plants include the Bahamian Pine, Mahogany, Lignum Vitae, Sea Grapes, Orchids, Guinep, Pigeon Plum, Guana Berry, Bay Geranium, Cereus (a cactus) and others. There are also three Mangrove species: Black, White and Red Mangroves. The most northerly islands are dominated by the Caribbean Pine, whereas the southeastern islands are dominated by hardwood coppice, and have xerophytic vegetation in places. A few introduced or exotic species have become nuisances and have displaced the local vegetation; these include the Australian Pine (*Casuarina*), Brazilian Pepper and Bottle Brush (*Callistemon*) trees.

#### **4.2.1.3 Pine Forests**

The proposed power plant is located within an area of the pine forest ecological environment. The forests in general include the Caribbean Pine (*Caribaea vs bahamensis*) also known as Yellow Pine. Other floras which can be found in the Bahamian Pine Forest are *Bletia purpurea*, purple-flowered orchids, *Andorpogon glomeratus*, also known as Bushy Beard Grass, and *Pteridium aquilinum*, Southern Bracken Fern. Shrubs that populate the area are Wild Guava (*Tetrazygia a bicolor*), Five-finger or Chicken's Foot (*Tabebuia bahamense*) and Snowberry (*Chiococca alba*). The Scale Leafed Love Vine (*Cassytha filiformis*) winds its way through the understory and

around Poisonwood (*Metopium toxiferum*). The Sabal Palmetto (*Coccothrinax argenta*) may dominate ground flora in certain pine forest areas.

The pine forests are referred to as a “Fire Climax Community,” which means the Caribbean Pine is a light-demanding species that requires open areas with no competition from shading broad-leafed plants. Caribbean pinelands are called "Fire Climax Communities" by botanists, for if periodic fires do not occur to remove the shading broad-leafed understory, juvenile pines cannot get sufficient light to take hold and replace the adult trees as they die off. Without fires, the broad-leafed coppice, a hardwood forest, would succeed the pinelands.

Extremely well adapted to fire, the Caribbean Pine adults are rarely killed by the flames. Their fire resistance is due to volatile resins in the bark which explode when heated, putting out any small fires which start at the bark. Juvenile pines are not as resistant as the adults and are generally killed, but reseedling takes place around the base of the adult trees rapidly.

The general history of the use of the pine forest follows. The Caribbean Pine has been used by Bahamians for hundreds of years. Large-scale commercial exploitation of the resource did not begin until the early 1900's. In 1905, a sawmill was constructed near Wilson City, Abaco where it ran for twelve years. As local pinelands were utilized, the mill was moved to other areas and by 1943, all of the virgin pine of Abaco had been cut except for an area north of Crossing Rocks and a forest between Norman's Castle and Marsh Harbour.

Pine forests only occur on the northern islands of the Bahamas, including Grand Bahama, Andros, Abaco and New Providence. Areas of pine forest which are protected are the Rand Nature Centre and the Lucayan National Park, Grand Bahama and the Abaco National Park in southern Abaco.

## **4.2.2 Aquatic Ecosystems**

### **4.2.2.1 Marine Platform**

The Abacos form the eastern margin of a broad, shallow marine platform which is fringed by reefs and/or cays. The presence of the fringing reef dictates the ecological environment of the “leeward” side of the reef. The Bahamas platforms (Great Bahama and Little Bahama Banks) are low energy marine platforms in which the sediments are mostly pelleted muds that have been intensely bioturbated by invertebrates.

In regions of higher energy, particularly on the outer margins of the marine platform, sandbelts (sandbars) occur. Mobile sand belts usually have impoverished benthonic faunas because of the instability of the substrate. The region of more active sand movement grades into marginal areas where mobility is less and colonization by grass has occurred. It is in these areas, with a more stable substrate, where platform benthic communities and abundant burrowers will occur.

The western shore of Great Abaco is less well defined than the windward shore and the land slopes gradually onto the shelf and below sea level. In the bight formed by Great Abaco, a very shallow area of lime mud called “The Marls” is present. The Marls are sometimes described as a wetland, comprised of mangrove creeks and small islands that provide a nursery for young fish and invertebrates, and a habitat for ducks, egrets and herons.

### **4.2.2.2 Reefs**

The reefs in the Bahamas Islands are rich in their diversity and population. A number of basic reef types are recognized which are generally defined by their overall structure and the geological conditions under which they evolved.

Reefs may be described as a mass of organic material consisting in part of organisms which have grown in-situ, material derived from organic debris which has been transported to the site of the reef, and chemically precipitated materials. Fringing or barrier reefs, typical to the Bahamas, occur offshore so that a lagoon is formed between

the reef and the coastline. The seaward extension of the reef is limited by the maximum depth of water in which the reef building organism can flourish. Erosion of the seaward face of the reef produces a mass of debris upon which a living reef can develop in the optimum depth of water.

The frame of the individual reefs is composed of coral welded by red algae and in some cases calcareous algae is more important than the coral. Muddy water is an inhibitor to reef growth. The presence or absence of the reef or reef belt is of fundamental importance in determining the energy input into the shelf and the ensuing hydraulic regime controls the distribution of the shelf facies or biotic community.

Other types of reef that are recognized are the “patch reefs” and “edge reefs”. The patch reef can vary in size from quite small to often very large. Patch reefs occur as isolated reefs that grow up from the ocean bottom of island platforms and may occur behind a fringing reef, if one is present. The edge reefs exist in areas where deep water occurs near shore on the leeward sides of some of the islands. The edge reef forms a nearly continuous mass varying in width from about 20 m (65.6 ft) to about 120 m (394 ft), along the “leeward” edge with a sandy slope, and with scattered patch reefs occurring landward.

A coral zonation pattern has been recognized in which a transition occurs from an absence of living coral in the near shore, to dead coral fragments on the outer shelf (Spencer-Davis, et. al, 1971). The “reef edge” is the zone of most active coral growth. Figure 4-6 graphically illustrates, from land to open ocean, the Spencer-Davis reef zonation pattern.

#### **4.2.2.3 Coastal Environment**

The coastline in the Bahamas can be subdivided into two distinct groups: sandy coasts and rocky coasts, which are both the results of the relative energy the coastal area is exposed to.

## The Sandy Seashore

Along a sandy shore there are no large rocks, algae or tidal pools. The sandy seashore can be divided into four general zones: Intertidal, Pioneer, Fixed Dune and Scrub Woodland.

- **Intertidal Zone:** Between the low tide and the high tide mark is the intertidal zone. When the tide goes out the creatures living in this zone are left stranded. They have to endure the heat of the sun and the higher salinity of the water resulting from evaporation. The intertidal zone fauna includes sea worms, sand fleas and sand crabs.
- **Pioneer Zone:** So named because it is where the first plants try to grow over sand. These plants must adapt to loose, shifting sand and poor soil. There is no protection from wind or salt spray. Plants here are usually low growing vines with waxy leaves. Some plants found in the pioneer zone are the Purple Seaside Bean (*Canavalia obtusifolia*), Saltwort (*Batis maritima*), Goat's Foot (*Ipomea pes-caprae*), and Sea Purslane (*Sesuvium portulacastrum*).
- **Fixed Dune Zone:** The next zone is the fixed dune, so named because as the plants in the pioneer zone grip the sand around their roots and make the beach more stable, the sand mounds into small hills or dunes. Plants in this area must cope with dry infertile soil and sea spray. Some plants in this zone are the Sea Oats grass (*Uniola paniculata*), Gale of Wind (*Phyllanthus niruri*), Spider Lily (*Crinum zeylancium*), and Bay Geranium (*Ambrosia hispida*).
- **Scrub Woodland Zone:** This zone is high up the shore. The sand is stable and more varieties of plants are found, gradually taking on the appearance of a broad-leafed coppice. Problems here include high salinity and lack of water. The flora of this zone includes Cocoplum (*Chrysobalamus icaco*), Buttonwood (*Conocarpus erecta*), Silver Top Palm (*Cocothrinax argentata*) and Seagrape (*Coccoloba uvifera*). The remnants of animals in this zone occur as the hard outer carapace or broken shells which have been washed ashore by the tide.

## The Rocky Seashore

Many shores in the Bahamas are made of limestone rock that has worn away to form ridges and crevices. They form ideal habitat for a variety of marine plants (algae) and animals. The ridges and crevices provide protection from the waves and provide a safe haven for creatures to hide from predators. The plants and animals of the rocky shore face problems similar to those found in the sandy shore. They are tossed about by the waves with the movement of the tide; they face intense heat and high salinity, extreme

variations in oxygen availability and high vulnerability to predators' when stranded in pools at low tide.

The ecologic assemblage of fauna and flora of the rocky shore belong to many different biological groups which have adapted to this particular environment including: Molluscs, Crustacea, Echinoderms, Annelida and Fish, including varieties of Barnacles, Sea Urchins (sea egg) and Crabs; Chitons, Limpets and Sea Anemones. The flora, or algae, in this zone is grouped into three headings according to their color: red, brown and green. The faunal species of the rocky shore zone include: Peacock Worms (*Sebellidae sp.*), Limpets (*Acmaea sp.*), Rock Oyster (*Ostrea sp.*), Chitons (*Curbes*), Sergeant Major, Rock Beauty, Blenny, Sea Urchins (*Iytechinus*), Common Blue Crab (*Collinectes aspidus sp.*), Common Hermit Crab (*Pargarus longicarpus sp.*) and Clubbed Finger Coral (*Porites porites*).

Of particular note with respect to the ecological diversity of the coastline is that the Bahamas is signatory to the Biodiversity Convention, which means that they have pledged to the world to preserve the biodiversity of the Bahamas. The seashore is an example of a unique ecosystem with a great variety of flora and fauna.

#### **4.2.2.4 Wetlands**

Wetlands are most properly described as those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation, typically adapted for life in saturated soils. Soils present in wetlands generally are classified as hydric or alluvial, or possess characteristics that are associated with reducing soil conditions. The prevalent vegetation in wetlands generally consists of facultative or obligate hydrophytic macrophytes that are typically adapted to this soil condition. There are three types of wetlands recognized in the Bahamas; these include coastal wetlands (tidal marshes and swamps), mangrove wetlands (dominated by button wood/black mangrove), and freshwater wetlands.

BEST has listed 45 sites through the islands as wetlands. In addition, the National Creek and Wetlands Restoration Initiative (NCWRI) has slated 30 sites for restoration. The location and number of the sites are as follows: Andros 13 sites; Long Island 4 sites; Exuma 5 sites; Abaco 5 sites; and Eleuthera 3 sites (BEST, August 2003). The five (5) Abaco sites include the causeway between Great and Little Abaco, Israel Creek, Loggerhead creek, Cherokee and Casuarina Point.

#### **4.2.3 Protected Habitat**

The Abacos are home to a number of national parks or preserves, which are areas of pristine beauty and biodiversity and within which the flora and fauna are protected. Abaco's sea parks are national parks that were established by the Bahamas National Trust (BNT). The primary function of the Bahamas National Trust is to build and manage national parks and protected areas in the Bahamas. These areas are strictly “no-take” areas and as such nothing may be removed from within these park boundaries. These areas from north to south include Walkers Cay National Reserve, Black Sound National Reserve, Fowl Cay National Preserve, Tillo Cay National Park, Pelican Cay Land and Sea Park and Abaco National Park. Figure 4-7 provides an illustration of the locations of the protected habitats. A brief description of each park follows.

##### **4.2.3.1 Walkers Cay National Park**

Walker's Cay National Park was established in 2002. It is comprised of 3,840 acres and is located on the northern-most islands of the Bahamas. This barrier reef has stunning coral formations and underwater cathedrals and is teeming with an endless variety of marine life and has visibility of 100 feet.

##### **4.2.3.2 Black Sound Cay National Reserve**

Black Sound Cay National Reserve is located off Green Turtle Cay covering 2-acres of mangrove vegetation. Established in 1988, the small park protects waterfowl and migratory bird habitats, as well as an important waterfront ecosystem.

#### **4.2.3.3 Fowl Cay National Reserve**

The area between North Man-O-War Channel and Scotland Cay has been set aside as the Fowl Cay Preserve and is protected under the Bahamas National Trust. The preserve protects conch beds and coral reefs. The preserve is bordered on the south by North Man-O-War Channel, on the west by the string of cays and rocks with Fowl Cay to the north and Upper Cay to the south. The ocean-side border to the east is the breaking barrier reef. The northern edge is the channel immediately south of Scotland Cay.

#### **4.2.3.4 Tilloo Cay National Reserve**

Tilloo Cay National Reserve is an 11-acre wilderness shoreline, where sea birds such as the elegant, long-tailed Tropic Bird nest.

#### **4.2.3.5 Pelican Cays Land and Sea Park**

Pelican Cays Land and Sea Park (PCLSP) is protected and maintained by the Bahamas National Trust, which was granted a 99-year lease by the Bahamas Government. The park consists of a 2,100 acre area just north of Cherokee Sound in Great Abaco that contains stunning undersea caves, extensive coral reefs and is noted for its fish, plant and bird life. PCLSP is located adjacent to the barrier island system that protects the Sea of Abaco from the Atlantic Ocean.

#### **4.2.3.6 Abaco National Park**

The Abaco National Park (ANP) can be found in the southeastern portion of Great Abaco Island between Crossing Rocks and Hole in the Wall. Abaco National Park is located approximately 40 miles south of Marsh Harbour. The Park begins approximately 4 miles south of Crossing Rocks and extends south and inland to approximately two miles above South West Point. This area encompasses 20,500 acres.

ANP is covered with Pine Woodlands, which occur in well-drained or fresh water-saturated limestone rock. The limestone is heavily pitted, with solution holes often present. The Pine Woodlands of the ANP occur on a thin layer of soil or no soil at all. Beneath the pines, the understory shrub and herbaceous layer can be found 3-6 ft above

the ground. This layer is composed of woody shrubs, palms, ferns, grasses, and herbaceous plants.

ANP is also home to the Bahama Parrot, as well as other birds with potential conservation concerns. The Bahama Parrot is a subspecies of the Cuban Amazon Parrot. Historically, the Bahama Parrot occurred on seven Bahamian islands. Today, they are only found on Abaco and Great Inagua. In Abaco, the parrot utilizes both Pine Woodland and coppice for foraging. Parrots feed on the fruits of many shrubs including Wild Guava, Poisonwood and Pigeon Berry. During the breeding season and when there is little food to be found in the coppice, Bahama parrots in Abaco eat the seed of pine trees. This provides a rich source of protein essential for the development of Bahama parrot chicks.

The Abaco Bahama Parrots breed in limestone cavities on the ground of ANP and surrounding areas. Bahama Parrots are monogamous and form mating pairs for life. Female parrots lay two to four eggs on the bare floor of the nest cavity in late May and early June. She incubates the eggs for 28 days. During egg laying and incubation, the female stays in the nest hole, leaving only for 10-30 minute intervals to be fed by the male. Chicks hatch 12-72 hours apart. Parrot chicks hatch blind and completely featherless. For the first few days after hatching the female remains in the nest hole and the male enters to feed her and the chicks regurgitated food. By three weeks, chick eyes have opened and feather sheaths have erupted on their skin. They are fully feathered and ready to fledge by the time they are eight weeks old.

Major threats to the species include predation by introduced species (i.e., raccoons, cats) and damage or alteration of habitat due to natural disasters and humans. Bahama Parrots are protected by the Wild Bird (Protection) Act and by The Convention for the International Trade of Endangered Species (CITES).

## **4.3 EXISTING SITE CONDITIONS**

### **4.3.1 Inspection Methodology**

An onsite inspection of the proposed power generating facility project site, the estimated 2 mile pipeline corridor (Wilson City extension and dock unpaved road), and Wilson City shipping/docking terminus was made to note the environmental setting of the project site and to document and evaluate the impacts (if any) on the micro ecosystem in the vicinity of the proposed construction activities. KES personnel conducted the initial pedestrian evaluation followed by a low altitude aerial reconnaissance on September 18, 2008. Photographs illustrating site conditions are located in Appendix B. The subject site is located approximately 5.0 miles east of Great Abaco Highway, on Wilson City Road. The inspection process began at Wilson City road, followed by review of Wilson City extension and dock road and terminus, evaluating areas of interest along the proposed pipeline route and an inspection of the proposed power plant site.

### **4.3.2 Site Reconnaissance**

#### **4.3.2.1 Wilson City Road**

Access to the proposed power plant site from Great Abaco Highway is via Wilson City Road (aka Abaco Farm Road). This road was formerly the access route to Wilson City during the years 1906 through 1916, when Wilson City was instrumental to Abacos' wood industry. Following closure of the mill in 1916, and in the absence of any need to access Wilson City, there was no requirement for maintenance, and as such Wilson City Road is today little more than a somewhat drivable trail through the pine forest. KES representatives drove the almost five miles along the unpaved road to the power plant site. The route is characterized by pine forest on both sides of the road. The forest is unique based upon its lack of age diversity, and the spacing between each tree. According to the literature, the former old growth pine had been harvested during the 1960s and seedlings had been planted to reestablish the forest. In addition, many of the cleared areas west of the power plant site and Great Abaco Road were converted to sugar cane fields. The differences in the current forest character are discernable, based upon the planting pattern of the seedlings and cleared former fields. Along Wilson City Road, a number of access roads were noted. These trails were historical routes into the former sugar cane

fields during the 1970s, which for the most part are now overgrown. Between Great Abaco Road and the proposed Wilson City Power plant site there is no evidence of any settlements.

#### **4.3.2.2 Power Plant Site**

The proposed power plant site is located on the southern side of Wilson City Road, approximately 4.9 miles from Great Abaco Road. A driveway from Wilson City Road through pine forest provides access to the approximately 100-acre parcel. As a precursor to proposed development, the front 25-acres of the 100-acre site were recently cleared. Survey flags delineated the approximately 1,200 x 912 ft cleared site. The cleared parcel consisted of undulating and exposed limestone characteristic of Abaco, whose surface geology is described as carbonate limestone with pits, holes and crevices generally known as Karst. While the site elevation was generally flat, east of the site is the ridge whose elevation forms the eastern flank of Abaco. The areas immediately abutting the cleared parcel consisted of undulating and exposed limestone covered by pine forest canopy with a broad leaf understory.

#### **4.3.2.3 Wilson City Dock**

The proposed fuel pipeline will extend from the power plant site east to terminate at a new docking pier. The fuel pipeline will follow the route of Wilson City Road. This route then continues northeast along the recently cleared trail for the purpose of this report known as the Wilson City Road Extension. This extension was cleared for the expressed purpose of providing access to the Sea of Abaco. This recently cleared route follows the coastal walking path adjacent to Spencer's Bight to Wilson City. At the time of the investigation, the coastal road elevation was very close to sea level. The landward side of the road is marked by the north face of the coastal ridge.

Prior to reaching Wilson City, the newly cleared trail turns right and is referred to as "Dock Road." This new trail runs almost east-to-west and over the undulating coastal ridge before dropping gently to the proposed docking pier location. The water depth in the vicinity of the proposed docking facility is approximately 9 ft (mean low water) and

attains a depth of 16 ft near Pelican Point or greater leading to North Bar Channel. The exposed limestone platform proximal to the proposed docking facility along this portion of the Abaco coast consists of hard, pitted coralline limestone. The exposed hard rock was eroded and severely pitted as a result of coastal wave action. Very little sand was noted interspersed between the rocks and is occupied by sparse opportunistic vegetation. East of the proposed dock are the barrier islands of Lynyard Cay, which provides protection in the Sea of Abaco from the open Atlantic. The depth to water in the Sea of Abaco is generally between 6 and 10 feet.

### **4.3.3 Aerial Photographic Review**

Review of satellite aerial photographs of the subject site and site vicinity illustrate the subject site (after ground-truthing) consists of pine forests, which are resident on Crown Land. The immediately abutting and adjacent properties are similar to the subject site. However, the aerial photographs revealed large tracts of land west of the site that are sparsely covered with pine. These lands are thought to be the former cleared acres of agricultural lands used for sugar cane production. During the low altitude site reconnaissance, the extent of the pine uplands proximal to the site, the coastal ridge and vegetation covered area surrounding Pelican Point, and the area of the proposed docks were clearly discernable. Figures 4-8, 4-9, and 4-10 provide aerial views of the proposed power plant site and dock area.

### **4.3.4 Environmental Review**

Based upon the visual inspection of the proposed development, the environmental review has been divided into ecological areas. Each of the encountered ecological elements will be discussed in the following sections.

#### **4.3.4.1 Geology**

While no subsurface geological investigations were conducted as part of the EIA scope of work, lithological interpretations are based upon review and interpretation of literature and onsite reconnaissance. The site inspection indicated that massive limestone was exposed at road cuts along Great Abaco Highway, and as undulating rock exposed along

Wilson City Road and at the subject site. In addition, the shoreline along Spencers Bight and at the proposed dock consisted of an exposed hard rock limestone platform that was severely pitted by wave action.

This limestone is comprised of medium to fine-grained calcium carbonate sediments of typical limestone composition, including coralline algae, pellets, ostracod tests, foraminifera tests, bryzoan, corals, pelecypods, gastropod, and echinoderm skeletal material. The cementing agent is calcium carbonate, and in some cases calcium magnesium carbonates (dolomite). This “hard rock” limestone is the Lucayan, upon which the Abacos is developed and according to the literature is Pliocene-Pleistocene in age. Literature has also indicated that the upper carbonate formation may be at least 100 feet thick. The limestone base is present at the surface throughout the area of proposed development, and it is this material which will be encountered during trenching for the proposed fuel pipeline as well as foundation materials for the power plant.

#### **4.3.4.2 Soil**

The site reconnaissance of the proposed power plant site and Wilson City Road indicated the soil type consisted of immature soil, in various stages of development, that was generally very thin or absent. In areas where the soil was poorly developed, limestone and lime rock was exposed.

#### **4.3.4.3 Flora**

Approximately 25-acres of the site had been cleared prior to the visual inspection but the cleared acres were considered to be typical of the remaining 100-acres parcel and the adjacent lands. The subject site and adjacent sites are located on vacant Crown Land that was formerly used for logging purposes. The current pine trees are second-generation trees planted to replace old growth trees to regenerate the forest. As a result, the trees formerly located in the power plant site, as well as on the adjacent properties, are unique by their lack of age diversity and their spacing. The forest consists primarily of upland pines (Caribbean pines) with an understory of ferns, palmettos and palms. A few

introduced or exotic species were apparent along the roadside; these include the Australian Pine (*Casuarina*), and Bottle Brush (*Callistemon*) trees.

#### **4.3.4.4 Wetlands**

Wetlands in the Bahamas generally include tidal marshes, swamps and mangroves. According to the visual inspection, while no tidal marshes or mangroves areas are located adjacent to the proposed power plant site or the proposed dock, mangroves are noted in the vicinity. The bay north of the site is known as Spencer's Bight, which includes areas known as Sucking Fish Creek and Nurse Cay. The bay to the south is known as Little Harbour, which includes the Robinson Creek marshland area located on the eastern side of the coastal ridge, proximal to the power plant. These two bays, like many of the protected bays along the east coast of Great Abaco, include mangroves, which as their names suggest, are important as natural fish hatcheries.

#### **4.3.4.5 Fauna**

During the visual inspection of the pipeline route, subject site and immediately abutting vegetative areas, no nests or nesting was observed. No birds or wild animals were discerned in the site vicinity. It was reported, but not confirmed that a wild boar was observed during site clearing as well as White-crowned Pigeons which are known to frequent the forest. Table 4-5 is a list of birds that were reported in "South Florida Birding Report" to have been observed by bird watchers in the vicinity of Marsh Harbour over a two day period. The list includes varieties common to the Bahamas, as well as those that may be considered to be migratory.

#### **4.3.4.6 Ecological Review**

Subsequent to the initial inspection, an ecological review was conducted to provide an assessment of the vegetative communities based upon literature review, and prior experience in the Bahamas. The three primary areas of the expansion project, e.g. the plant site, pipeline and dock, coincidentally are associated with three terrestrial communities as described below. The nature of the marine environment affiliated with the dock facility

was not documented, and is not known at this time. Botanical references included Cutts (2004) and Wood (2003).

### **Power Plant Site**

The entire 25-acre primary site is characterized as cleared limestone and barren, with only a few solitary hardwoods and recent recruitment of bracken (*Pteridium aquilinum*). Given the remaining debris piles and apparent uniformity of the surrounding landscape, the pre-existing community type was likely secondary growth pine forest dominated by Caribbean pine (*Pinus caribaea*). The surrounding forest structure has relatively consistent canopy height and trunk girth indicating pine of similar age, the likely result of historic logging and/or clearing activities. In many areas, the midstory remains open and ground cover dominated by bracken, the likely result of low intensity fire events, as also evident from charred trunks. Other small shrubs and ground cover species frequently encountered in such open areas include Wild Guava (*Tetrazygia bicolor*), Cocbey (*Cordia bahamensis*), Poisonwood (*Metopium toxiferum*), Mosquito Bush (*Strumpfia maritima*), Love Vine (*Cassytha filiformis*), and Broomgrass (*Andropogon* sp.). In other areas, a low midstory has become established and appears characterized by typical scrubland or low coppice, hardwood flora.

### **Pipeline Alignment**

Review of project photographs and 1975 Bahamas Topographic Map depicting project limits and pipeline alignment indicates the pipeline will traverse pineland and coastal coppice communities, and possibly fringe ironshore in areas. Given the historic logging of Caribbean pine on Great Abaco Island, the nature of the pineland is characterized as described above. The coastal coppice is recognized as diverse, and frequently includes such trees and shrubs as Poisonwood, Lignumvitae (*Guaiacum sanctum*), Gumbo Limbo (*Bursera simarouba*), Torchwood (*Amyris elemifera*), Five-leaf (*Tabebuia bahamensis*), Wild Tamarind (*Lysiloma latisiliquum*), Cocobey, Sword Bush (*Phyllanthus epiphyllanthus*), Cocoplum (*Chrysobalanus icaco*), Bahamas Pigeon Plum (*Coccoloba tenuifolia*), Seagrape (*Coccoloba uvifera*), Haulback (*Mimosa bahamensis*), Silver Thatch Palm (*Coccothrinax argentata*), Cuban Holly (*Ilex repanda*), Common Snake Bark (*Colubrina arborescens*), Wild Dilly (*Manilkara bahamensis*), Trema (*Trema*

*lamarckiana*), Red Calliandra (*Calliandra haematomma*), Joewood (*Jacquinia* sp.), Frangipani (*Plumeria obtusa*), Bahama Stopper (*Psidium androsianum*), and Varnish Leaf (*Dodonaea viscosa*). Ironshore areas impacted by the alignment appear to be predominantly vegetated by young Australian pine (*Casuarina equisetifolia*).

### **Dock Facility**

The dock facility will impact two terrestrial habitats, coastal coppice and ironshore. Vegetation common along the lower elevations of the coastal coppice includes Seven-Year Apple (*Casasia clusifolia*), Sea Grape, Green and Silver Buttonwood (*Conocarpus erectus*), and Saltwort (*Batis maritima*). Salt and wind shear have stunted much of the vegetation in this area. At higher, landward elevations, the low coppice vegetation is more diverse and inclusive of hardwood flora described along the pipeline alignment above. The ironshore environment is characterized as limestone with honeycomb weathering within the intertidal and spray zones. The intertidal zone is not vegetated. Above the mean high water line the common pioneer species are Saltwort and young Australian pine, which have generally gained a foothold in solution holes.

### **4.3.4.7 Site Conditions Summary**

Review of the proposed project site revealed that it is located in pine forest, where first logging and then sugarcane fields have modified the landscape, the recovery of which continues to the present day. Historical anthropogenic activities were recorded for the site vicinity, but no evidence of any settlements was observed currently at the site or in the site vicinity. The area known as Wilson City (ruins) is east and north of the proposed power plant site. Since the demise of the timber industry, the mill and the town closed down by the 1920s and all building materials had been salvaged by the 1930s. The area today is generally only accessible by water and is overrun by vegetation. Caribbean Pine was the only protected tree noted during the inspection that may be potentially impacted by any additional land clearing and pipeline alignment. No protected wildlife was observed at the power plant site, and no protected trees or wildlife were observed within the area of the proposed docks. It is our understanding that the project activities have no relevance or intention for the capture of wildlife designated as protected, or to remove flora for the purpose of sale or export, and that any proposed and/or potential impact to

vegetation and wildlife is limited to site development activities. Based upon the ecological review, recommendations include the following:

- Particular care should be undertaken during construction of any new structure water ward of the mean high water line to avoid potential impact to marine life such as sea turtles and corals.
- Contact and coordinate with the BEST Commission relative to proposed plans, excavation, vegetation removal, and potential incidental take and/or displacement of wildlife prior to any construction activities. BEST contact information is as follows: P.O. Box N 3730, Nassau, The Bahamas; Phone: 242/322-4546.
- Erosion control and best management practices should be implemented during construction activities in vicinity to wetland and marine environments to prevent sedimentation and/or turbidity that may adversely effect wetland vegetation, sedentary fauna, and corals

#### **4.4 SOCIOECONOMIC ASPECTS**

##### **4.4.1 Land Use**

The Commonwealth of the Bahamas lies approximately 80 kilometers (km) from the east coast of Florida and consists of nearly 3,000 coral islands, cays and reefs. Twenty-nine of the islands are inhabited. The area of the Abacos is made up of many cays, which spread over the second largest area (649 square miles) of the Bahamas, Great Abaco and Little Abaco, known as the Main (or Great) Island, stretch 100 miles long and are rarely more than four miles wide. Many cays are off the eastern shore, forming a natural barrier from the Atlantic Ocean, two to five miles from the Great Island.

A review of the development of first Wilson City and then Snake Cay to the north reflects a period of economic growth and economic decline beginning in the 1900s and ending in the early 1970's for Abaco in general. This period was marked by the rise and fall of the logging industry and its attempted replacement with the sugar industry and its subsequent decline. The following is a brief history of Abaco, as it relates to Wilson City and Snake Cay.

- 1900s  
Bahamas Timber Company holds the 100-year timber license, which is later transferred to the Abaco Lumber Company.
- 1906  
Governor William Grey Wilson approved an agreement which permitted the cutting and exporting of Caribbean Pine which covered much of Great Abaco at this time. A saw mill and town were constructed named Wilson City, after the then Governor, and was located at Spencer and Pelican Points. When Wilson City opened in 1908 it included a power plant, ice plant, general store and company provided brick and wood constructed housing and dormitories.
- 1916  
A combination of equipment failure and lack of timber forces the Bahamas Timber Company to close down Wilson City. The mill was subsequently relocated to Norman's Castle, north of Marsh Harbour, but the work camp at Norman's Castle, unlike Wilson City, was not built with the idea of permanence.
- 1920-1930  
Subsequent to Wilson City being dismantled in 1916, salvage of building materials continued through the 1920s and 1930s.
- 1956  
National Container Corporation buys Abaco Lumber Company.
- 1956/57  
Owens-Illinois, a container and packaging company, purchases National Container Company, and gains access to harvest the Abaco Pine forests for pulpwood.
- 1959  
A channel is dredged and a shipping terminal is constructed at Snake Cay.
- 1959  
The *Robert Fulton*, a Hudson Riverboat was moored at Snake Cay to house administrative offices, a clinic, and a school. Owens-Illinois begins road infrastructure on Great Abaco to allow transportation of logs to Snake Cay for export. Spring City is begun as a village to house Owen-Illinois Bahamian staff. Lake City, located 0.5 miles north of Casuarinas Point Road, is built to house Owens-Illinois woodcutters.
- 1961  
Campbell Town, operated by Owens-Illinois for Haitian woodcutters, is located one (1) mile inland from Snake Cay.

- 1966  
Logging was anticipated to last until 1969, by which time all the usable old growth pine trees would be depleted. Owens-Illinois left 5 prime seed bearing trees on each acre so that the forest could replenish itself, but recognized commercial exploitation would not be possible again until some-time after the year 2000. As pulp wood cutting operations came to a close, Owens-Illinois looked for other ways to utilize its investment in road, buildings and labor.
- 19xx  
Owens-Illinois exchanged the 100-year timber license for the title to 50,000 acres of Crown Land located inland from Snake Cay and adjacent to Great Abaco Highway.
- 1966  
Sugar mill construction, with a capacity of 50, 000 tons, begins south of Wilson City Road. A subsidiary of Owens-Illinois, called Bahamas Agricultural Industries Limited (BAIL), was established to run the sugar operations. The fields were 2-3 miles wide and seventeen miles long and extended south of Wilson City Road.
- 1966  
The “Lake City” and “Campbell Town” lumber industry associated towns are closed down and removed. The *Robert Foulton* is demolished at Snake Cay, and the debris is moved into the woods south of Great Abaco Road.
- 1969-1970  
Cane is harvested and sugar is exported, but yields per acre are significantly less than anticipated.
- 1970 - 1977  
Sugar mill is closed, then sold, disassembled and exported.

Wilson City was the first town of its kind in Abaco and was conceived as a model and modern city to house its work force and was instrumental in the early development of Abaco. The historical activities first at Wilson City and then at Snake Cay reflect a period of economic growth and decline on Abaco, which centered on the growth of the logging industry, and subsequent replacement by the sugar industry. Currently, the immediately adjacent properties to the Wilson City Power Plant site consist of crown lands that are vacant and covered with pine forests. Access to the Wilson City area, until recently, was either waterborne or by walking from the terminal point of Wilson City Road.

#### 4.4.2 Population

The subject site is located approximately 10 miles south of Marsh Harbour, the largest settlement on Abaco. The population of the Abacos from the 1990 census report was 10,003, which increased to 13,170, as reported in the 2000 census. The population of Marsh Harbour, along with its two satellite communities of Dundas Town and Murphy Town, was approximately 3,600 in 1990, and was 4,700 in 2000, and is the Bahamas third largest metropolitan area. In addition, approximately 98,000 tourists visit the Abacos annually. A summary of Abacos population growth is provided below.

**Abaco Population Growth**

Census Year	Abaco Population
1970	6,501
1980	7,271
1990	10,061
2000	13,170
2010	*14,000-17,000

*\* Assumptions based upon historical trend*

#### 4.4.3 Economy

The Bahamas is driven by tourism and financial services. Tourism provides an estimated 40% of the gross domestic product (GDP), with an additional 10% of GDP resulting from tourist-driven construction. Tourism employs about half the Bahamian work force. In 2005, more than 5 million tourists visited the Bahamas, 87% from the United States. The Bahamian economy is based principally on tourism, with lesser contributions from banking, fishing and agriculture. The islands are singularly lacking in mineral resources, with aragonite mining from the seabed, and salt extraction by solar evaporation in the dry southeast being the only minerals exploited commercially. Agriculture and fisheries together account for 3% of GDP. The Bahamas exports lobster and some fish but does not raise these items commercially. There is no large-scale agriculture, and most agricultural products are consumed domestically. Following an outbreak of citrus canker on Abaco in 2005, the Bahamas lost a main agricultural export, and the Ministry of Agriculture banned the export of plant materials from Abaco.

A summary of each economic sector follows:

- **Tourism** — Tourism became a major industry for the Bahamas following the Second World War. The number of yearly visitors has risen from 45,000 in 1950 to about 4 million in 2000, producing one of the most remarkable and resilient economies of any small state in the world — one that has provided sustained growth over many decades. About 60 percent of visitors arrive by sea and the rest by air, contributing a total of \$1.5 billion to the Bahamian economy, and supporting more than half of the workforce in the country. In addition to an equable climate and a friendly culture, tourists are attracted to the Bahamas by a clean, healthy, and beautiful environment. Marine biodiversity, in particular, has been an important lure for high-spending visitors seeking recreational fishing, scuba diving, other water sports, and fresh seafood.
- **Financial Services** — Banking and financial services account for roughly 15% of the GDP of the Bahamas and directly contribute over \$300 million a year to the economy in salaries, fees, and other local overheads. More than 4,000 people are employed in the financial sector. In addition to a well-developed commercial banking network dominated by Canadian institutions, there is a large international offshore sector that provides asset management services.
- **Agriculture** — The value of agricultural production is currently \$50 million per year supported by approximately 8,000 hectares of land in production concentrated on Abaco, Andros, Grand Bahama, and Eleuthera. Domestic crops include citrus, bell peppers, tomatoes, potatoes, onions, avocados, pumpkins, corn, pigeon peas, cassava, cabbages, and tropical fruits. Six poultry farms are located in New Providence producing 16 million broilers and 4 million eggs annually for local markets. Livestock includes pork and mutton and total red and white meat production in 1999 was about \$1.2 million.
- **Fisheries** — The Bahamas supports the largest area of productive shallow water in the western Atlantic and its Economic Exclusion Zone incorporates habitats ranging from sea grass beds and coral reefs to deep oceanic waters. The Bahamas supports one of the world's major Spiny Lobster fisheries as well as the most important fisheries for conch and Nassau Grouper in the western Atlantic and Caribbean. Commercial fisheries generate \$70 million a year in exports, accounting for approximately 2.25 % of the GDP.

#### Relevance of Economic Sectors

SECTOR	GDP %	Labor Force %
Tourism	60	50
Financial Services	15	40
Agriculture / Fishing	3	5
Industry	0.10	5

Source: *Bahamas Handbook, 2006*

#### **4.4.4 Abaco Economy**

Tourism on Abaco took off in the mid 1970's with three condominiums in Treasure Cay. There are now six condominium communities in Treasure Cay and one in Marsh Harbour. The tourism impetus was twofold: yachting and second home ownership. The latter led to hundreds of rental facilities, along with Bahamian owned cottages that make Abaco a unique vacation venue as rental cottages sometimes come with a boat and a golf cart. There are over 1,500-second homeowners on Abaco and some 40 to 50 new homeowners come each year. Over 6,000 yachts visit Abaco every year, enjoying the many cays and the ideal sailing area of the Sea of Abaco between the mainland and the cays. The Abacos are home to approximately 13,200 residents or 4.32% of the Bahamian population. It is the third most populated island group in the Bahamas. Annually, approximately 98,000 tourists visit the Abacos. The primary sources of income for Abaconians are tourism and fishing. Many small marinas are available that support and drive the tourist industry, currently the most important sector of the Abaco economy. The so called "cottage tourist industry" is based upon small hotels, rental houses, charter boats and eco-tourism, due largely to the attractiveness of the Abacos natural environment, e.g. clear waters, pristine beaches and productive fishing grounds. Although somewhat dated, Table 4-6 is a summary of marinas in the Abacos, with an indication of their capacity, by the number of slips.

#### **4.4.5 Non-Government Organizations**

A non-governmental organization (NGO) is any non-profit, voluntary citizens' group, which is organized on a local, national or international level. Task-oriented and driven by people with a common interest, NGOs perform a variety of service and humanitarian functions, bring citizen concerns to governments, advocate and monitor policies and encourage political participation through provision of information. Some are organized around specific issues, such as human rights, environment or health. They provide analysis and expertise, serve as early warning mechanisms and help monitor and implement international agreements.

NGOs usually exist to further the political or social goals of their members or funders, which may include improving the state of the natural environment, improving the welfare of the disadvantaged, or representing a corporate agenda.

**Friends of the Environment (FRIENDS)** is one such NGO with respect to protection of the Abaco environment. FRIENDS is a not-for-profit society incorporated under the Bahamas Companies Act of 1991. With respect to the former proposed power plant site at Snake Cay, FRIENDS comments and concerns were detailed in a letter dated March 27, 2007 to the attention of (former) The Right Honorable Perry Christie, Office of the Prime Minister (2002-2007). A copy of the letter is attached as Appendix C. While the Snake Cay site is no longer a viable option for a power plant, a number of the concerns that were raised have relevance to the Wilson City location. A response to their concerns as they relate to Wilson City is provided in Section 8.0.

## **5.0 ANTICIPATED ENVIRONMENTAL IMPACTS**

### **5.1 IMPACTS DURING CONSTRUCTION**

This section discusses the potential impacts from the installation of the proposed power plant and associated facilities on the natural resources and environment of the site and vicinity. The proposed power plant will include the powerhouse within which will be installed 4 x 12 Megawatt (MW) engines fueled by Heavy Fuel Oil (Bunker C). A fuel pipeline is also proposed which will run from the power plant along Wilson City Road and terminate at Wilson City Dock.

#### **5.1.1 Erosion/Sedimentation Impacts**

The proposed project requires land clearing and site preparation for the installation of the power block and associated facilities. Twenty-five (25) acres of the site have been cleared, while the remaining area is undeveloped and consist of pine forest uplands. No wetlands are present within the project boundaries. The proposed construction area is not anticipated to impact the entire 100-acres available. While tree removal will be required in any area where construction conflicts exist, tree removal from the entire 100-acre property is not proposed, but only where required for the needs of the project, currently set at 25-acres. All land clearing, where required, will be conducted in accordance with the requirements of the Forestry Act and the Act to Regulate the Removal of Hills and Trees.

General site preparation and construction activities associated with the overall development of the Project site include the following:

- Construction of temporary storm water basins/ditches;
- Sequential dewatering of low areas of the site;
- Clearing/grubbing of all un-cleared portions of the construction area and laydown area;
- Stabilizing, grading, filling, and contouring the area for power plant facilities;
- Construction of permanent storm water management basins;
- Performing groundwork as necessary for construction of facility footings, foundations and underground utilities including electrical, water, wastewater, and other piping systems;

- Power plant facilities construction; and
- Earthmoving, grading, re-contouring and landscaping.

Site preparation will consist of clearing and grubbing, followed by grading and leveling. Vegetative debris from site clearing will be disposed and topsoil that is suitable for reuse will be stockpiled for landscaping and for establishing vegetation after construction has been completed. During early site preparation activities, temporary storm water management structures and soil erosion and sedimentation control devices (e.g., ditches, retention basins, berms, siltation fencing, and/or hay bales) will be used to minimize runoff during the construction phase.

Site preparation and construction activities will not require any explosives. If suitable fill material cannot be obtained onsite, appropriate materials will be imported from regional contracted sources. The plant site, excluding the buffer area to Wilson City Road and perimeter trees, will be cleared of all vegetation and organic matter in conflict with the proposed construction. Rough grading, excavation, and backfill activities will be performed to prepare the site for underground utilities, concrete foundations, and surface drainage. Structural backfill materials may be imported to the site for constructing concrete foundations and to raise grade site elevation to achieve proper drainage. Piling for concrete foundation supports may also be required and would be performed immediately after clearing, grading, and earthwork activities are substantially complete. After construction of the power plant project is essentially complete, any remaining areas that do not have an impervious surface will be re-vegetated with native plant materials.

The plant site will be altered to construct the new facilities. Existing vegetative cover has been cleared on 25-acres of the 100-acre parcel. Structural and general fill will be added to elevate the site to design elevations. Foundations may require pilings, which will allow existing (if any) soils to remain in place. Soils excavated for the major equipment foundations may be used as general fill or structural fill, if appropriate. Fill may be required to raise portions of the site to grade.

Since the site is in a generally flat area, albeit uneven due to the Karst type erosion (i.e. little topographic relief), the fill should not cause adverse impacts to site topographic conditions. Very little, if any, runoff flows onto the proposed site. Therefore, the fill will not impede existing drainage patterns. Added fill, with compaction, will shift areas of percolation within the site. Runoff will be managed with the storm water management system to mimic pre-construction conditions. During construction, erosion at the site will be managed with the erosion control plan. After construction, pervious areas will be planted predominantly with native vegetation to control erosion.

## **5.1.2 Water Quality Impacts**

### **5.1.2.1 Impacts to the Sea**

Although provisions for drainage will be necessary as part of the construction phase of the project, there may be some increase in sediment and suspended solids levels as a result of surface erosion from exposed surfaces. No impacts to the sea and coastline are anticipated for activities located at the power plant, where the bulk of construction related activities will be centered. However, during pipeline installation, particularly where the trench crosses the coastal area adjacent to Spencer's Bight, Best Management Practices (BMPs) will be employed to ensure excessive silt and sediments do not enter the water where mangroves are present nearby.

At the proposed Wilson Dock location, it is anticipated that an area will be cleared to accommodate docking facilities. Associated with the docking facilities, a pier will be constructed perpendicular to the coast that will extend out to deep water in the Sea of Abaco, anticipated to be approximately 9 ft deep. Actual measurement of the depth of mean low water will be required to ensure adequate clearance for shallow draft freighters. Typical open pier or wharf construction involves the installation of pilings and construction of a decking system. Typical closed pier or wharf construction involves installation of anchored sheet piling with compacted fill.

Piling installation is primarily achieved by using a crane-mounted drop hammer with the crane typically situated on a barge. Sheet piling installation is primarily achieved using a

crane mounted vibratory hammer. Construction materials are typically staged either on shore or on a material barge. The barges can be moored by use of mooring spuds or multiple anchor moorings.

The barge mounted cranes are used to retrieve and set the piles in place. Crane leads are utilized to position the pilings in during the driving process. Starter holes are sometimes required to keep the piling tips in position on harder bottom surfaces. Once positioned, the drop hammer is used to deliver repeated blows to the pile until the desired depth is obtained. Several types of drop hammers are currently in use today including diesel, steam, air and hydraulic. Hammer selection should be appropriate for the soil conditions to prevent damage to the piles during installation. A heavy ram with low impact velocity is preferable to avoid critical tensile stresses. Test piles are sometimes installed to determine the subsurface conditions. Pile jetting is also utilized for setting pilings or assisting pile driving. However, this technique is typically reserved for granular soil types and is generally not considered for rocky conditions as are prevalent at the site.

If a fueling wharf is desired, the installation of sheet piles involves erecting a driving guide to ensure proper alignment of the sheet piles along the length of the pier or wharf. Once the driving guide is in place, the sheets are set in place and driven with a vibratory hammer. The next sheet is interlocked with the preceding sheet and driven to depth. The process is repeated for the length of the bulkhead. The sheets are then anchored using tie-back rods and deadmen anchors. With the anchors in place, the bulkheads can be backfilled. Hydraulic fill is sometimes used where dredging operations are taking place. The backfill can then be finished with compacted rock and asphalt, concrete, or left unfinished with compacted fill.

Construction of the pier or wharf deck can be done using heavy timber, cast in place concrete, or metal framing with metal grate decking. Each system has advantages and disadvantages. Once the pilings are in place, concrete pile caps are installed to create the foundation for the pier or wharf framing and deck. Due to coral limestone soils, concrete piles are most likely preferable.

Several issues can be encountered during the construction of a pier or wharf. These issues include, but are not limited to geology, hydrology, air quality, marine navigation, noise, pollutants from construction equipment, and disposal of dredged material. In addition, potential pollutants due to the use of heavy construction equipment should be properly managed. The equipment involved utilizes hydraulic fluid, diesel fuel, and other industrial pollutants. Care should be taken during all refueling processes and equipment should be inspected regularly to ensure there are no leaks into the surrounding water. In event of a spill, it will be managed in accordance with the project's Environmental Management Plan and Spill Prevention Control and Countermeasure (SPCC) plan.

Localized areas of increased turbidity can be encountered during the pile driving activity although impacts (if any) are anticipated to be temporary. Little or no impacts to water quality with the exception of localized silting and sedimentation is anticipated. Use of BMPs during construction, such as sediment booms and/or silt and sediment curtains positioned to contain the disturbed sediment would keep any impacts to a minimum. In fact, a properly constructed pier can provide a beneficial marine habitat that allows areas for marine life to hide from predators and supports a healthy marine environment.

#### **5.1.2.2 Impacts to Groundwater**

The proposed power plant site is located east of and near the margins of the aquifer that serves Marsh Harbour and the surrounding communities. The lenses vary in thickness and the water table may be encountered between 2 and 20 ft below the surface. Based upon the importance and sensitivity of this aquifer, as well as a good construction practices, all precautions necessary will be required to reduce the potential for site impacts to a minimum.

While the proposed site preparation and facility construction activities for the power project are not anticipated to cause any short-term or long-term groundwater impacts to the site or adjacent site, Best Management Practices will be employed during construction to ensure impacts (if any) are minimal and are properly mitigated. Fluctuations in groundwater levels are expected to occur throughout the year due to

rainfall, by surface percolation and infiltration through the limestone and site related drainage. As a result, minor dewatering systems may be required and maintained during certain phases of construction (e.g., during engine foundation installation). After excavation, backfill, compaction, construction of the permanent plant drainage system and certain concrete construction activities are complete, the dewatering system, if required, will be removed. Any restoration needed for affected areas will follow after the dewatering equipment is removed. The implementation of appropriate erosion and sedimentation controls will also minimize adverse water quality impacts during site preparation.

Spills of fuel oil can have a potential adverse impact on soil, groundwater and particularly surface water during both the construction and operational phases of the project. During construction, all fueling will be conducted in a manner consistent with the spill prevention and response plan prepared by the construction contractor. During construction, fuel oil will be dispensed from skid tanks located onsite to construction vehicles and equipment by fuel trucks. Fuel for construction activities will be delivered to the site by fuel truck drivers, who will be required to receive spill plan training prior to beginning work. The trucks will be equipped with oil spill response materials. The truck driver will check the capacity of the receiving tank and then monitor the transfer to heavy equipment or day tanks. Each transfer will be documented. Implementing management controls should minimize the potential for adverse impacts due to spills during site construction.

During construction all contractors, technicians and laborers will be required to implement practices to minimize the potential for spills of fuels or chemicals. Maintenance will be performed only in designated areas. In the unlikely event that spills do occur, they will be managed in accordance with the project's Environmental Management Plan and SPCC plan.

To further minimize potential environmental impacts, KES recommends that full-time environmental monitoring is conducted during construction, particularly during all

refueling operations to minimize potential concern. The environmental monitoring could be a third party contracted under the environmental safety department, or a member of the safety department with the authority of “stopping the job” in the event that non-compliance of environmental regulation is being observed.

The proposed project includes the installation of supply well(s) and an injection disposal well. The actual depths of the supply and disposal well will be based upon the results of the geotechnical study and will take into account the occurrence of the local aquifer. According to the USACOE 2004 study, the Marsh Harbour-Lake City aquifer freshwater lens reaches a maximum thickness over 50 ft, and as such it is anticipated that both the supply well and injection well will take into account the presence and thickness of the aquifer.

The wells must be designed to meet the necessary requirements for their intended industrial use and public safety. At a minimum, the wells should be properly grouted and cased to limit/reduce potential contaminants from impacting the upper freshwater lens, as well as to reduce the potential for deterioration of the well walls and surrounding bedrock.

The drilling method should take into account the fragile nature of the aquifer, and the porous nature of the bedrock. As a result, reverse air circulation should be considered as a preferred drilling method. This drilling method is environmentally friendly and does not require the introduction of potential contaminants into the borehole, e.g. by the use of drilling fluid, as in the case of mud rotary drilling.

Careful monitoring and detailed logs of the drilling process should be kept during well installation. The logs should include detailed site lithology, loss circulation zones (if rotary drilling used), depth to water, and contamination zones encountered (if any). Well construction details should include casing size and depth(s), packer size and depth, injection tubing size and depth, injection interval, open hole dimensions or perforation or

screen depths and well completion depth. As previously indicated, the final specifications for the well construction will be available upon completion of the geotechnical study.

### **5.1.3 Air Quality Impacts**

Three general activities will generate air emissions during construction of the Wilson City Power Project. First, land clearing, site preparation and vehicle movement will generate fugitive dust emissions. Second, open burning of cleared land debris may be required and would result in air emissions, and third, internal combustion engines will release nitrogen oxides, carbon monoxide and other combustion products.

The quantity of any emissions released during the construction process will generally be very low, but will vary on an hourly and daily basis as construction progresses. Fugitive dust emissions will be greater during the land clearing and site preparation phases. Fugitive dust emissions will also be greater during the more active construction periods as a result of increased vehicle traffic on the site.

Open burning would result in emissions of PM, CO, NO<sub>x</sub>, and hydrocarbons. This activity would be conducted intermittently for short periods of time. The land clearing and construction debris to be burned would generally consist of wood products and other relatively clean-burning components. Emissions would depend upon the amount and moisture content of the debris.

Increased emissions from internal combustion engines will occur during site preparation and facility construction due to the amount of onsite construction equipment using engines for site excavation and grading, concrete placement, and structural steel and major equipment installation. Potential minor sources of volatile organic compounds include evaporative losses from onsite painting, refueling of construction equipment and the application of adhesives and waterproofing chemicals.

Potential air quality concerns associated with the heavy construction equipment and the increased traffic related to construction activities include sulfur dioxide, carbon monoxide, oxides of nitrogen, hydrocarbon emissions and dust.

The background levels of these pollutants are considered to be non-existent based upon the low frequency of traffic use on Great Abaco Highway proximal to the site. However, even with the predicted increase in construction related traffic and associated site activities, any increase in these pollutants is considered to be insignificant.

Dust and grit are expected to be present during the construction phase in dry months. This will end when the major civil works finish. Some dampening of the exposed areas, by employing dust control methods, may therefore be necessary during periods of dry weather in order to reduce the risk of dust entrainment in the ambient air.

Peak dust generation, if construction activities coincide, will be during the drier months of January and February and this dust will tend to become dispersed within the ambient air as a result of vehicle movements. It will therefore be necessary to ensure that loads are covered to prevent fine dust blowing from open-top trucks. In dry periods, it may also be necessary employ dust control measures.

#### **5.1.3.1 Emission Control Measures**

Fugitive dust emissions from the construction site will be minimized using appropriate dust suppression control methods. These standard control methods will include paving or placement of gravel on roads, applying dust suppressing chemicals or water to roads and other exposed surfaces, or other methods, as needed. The existing public road (i.e., Great Abaco Highway) upon exiting Wilson City Road and the site is paved. Wilson City Road and more heavily traveled roads on the site will be paved at the end of the construction period. Spilled and tracked dirt (or other materials) will be removed from the adjacent road in a timely manner. Of course, all construction related fugitive dust emissions will be temporary and will stop once construction is completed. Emissions from open burning

will be limited by removing materials whose burning would produce excessive smoke (e.g., green vegetative materials).

#### **5.1.3.2 Potential Impacts and Monitoring Programs**

The air quality impacts caused by construction activity will vary as a function of the level of activity, the specific nature of the activity, the weather conditions while the activity is occurring, and the emission controls applied to the activity. However, even under worst-case conditions, the maximum ambient impacts caused by construction emissions are expected to be very small and limited to the specific area of the site under construction. Also, any potential emissions are expected to be well below any applicable ambient air quality standard. Therefore, no air quality monitoring programs are needed or will be conducted during the construction of the power project.

#### **5.1.4 Noise Impacts**

Construction of the proposed project is expected to take place for several months, with varying degrees of activity occurring during different phases of construction. Construction phases are expected to include excavation, concrete pouring, steel erection, mechanical/electrical installation and cleanup.

Noise during construction of the Wilson City Power Plant should be typical of noise associated with industrial facility construction activities. Noise sources that are associated with most large industrial construction sites (including power plants) include air compressors, track hoes, backhoes, graders, bulldozers, scrapers, front-end loaders, cranes, hoists, generators, boom trucks, portable welders, and various heavy trucks and smaller vehicles. The exact noise levels are a complex function of variables such as the actual noise levels emitted from each major noise-emitting equipment, their location and orientation within the construction area, and their operation and load.

To estimate the plant construction noise impacts, the composite noise levels listed in the Power Plant Construction Noise Guide were used (Barnes et al., 1997). The composite noise levels are based on intensive noise monitoring during the construction of 15 actual

power plants. The noise monitoring for the composite levels was done at locations selected to avoid undue excess attenuation from atmospheric conditions and terrain. The construction equipment was characterized as typical; it was neither unusually noisy nor quiet. The noise measurement data from the 15 power plants were normalized to consistent propagation conditions as follows: 59° Fahrenheit, 70 percent relative humidity, no wind or temperature gradients, flat terrain, and no soft ground (vegetation) losses.

For each phase of construction, the composite noise levels (defined in the Guide) provide long-term averages (Leq) at multiple distances from a hypothetical power plant construction site. These levels were then used to predict noise levels at the nearest residential use (LT-1), located northeast of the proposed plant site, using simple spherical divergence of the sound wave energy from the site to LT-1, which is approximately 0.4 mile. No additional excess attenuation due to vegetation, wind, atmospheric absorption, or temperature gradients was assumed. The results of the modeling are presented below. The results of modeling indicate that worst-case construction noise would be at or below Bahamas daytime noise standards.

<b>Maximum Estimated Construction Noise Levels (dBA)</b>		
<b>Construction Phase</b>	<b>Maximum Estimated Noise Levels at a Sensitive Receptor and on site During Construction</b>	
	<b>LT-1 (0.4 Mile From Plant Construction Activity)</b>	<b>100 Feet From Construction Activity</b>
	<b>Leq</b>	<b>Leq</b>
Excavation, site preparation	56	80
Concrete pouring	52	76
Steel erection	56	80
Mechanical, electrical	51	75
Clean-up	46	70

Given the attenuation properties of the adjacent vegetation, as well as the fact that noise levels decrease with distance from the noise source (e.g., for every doubling of the distance between the source and the receptor, such as going from 50 to 100 feet from the source, noise levels will decrease between 6 and 7.5 dBA). Therefore noise from Wilson City construction would be lower at more distant noise-sensitive locations. As a result, it is unlikely that construction related noise would be discernible at Spring City, almost seven (7) miles from the site.

#### **5.1.5 Solid and Hazardous Waste Impacts**

During the site clearance stage, it is anticipated that relatively large quantities of solid waste would be generated consisting of top-soil, sub-soil and bedrock. The generation and disposal of site wastes is not considered to be a problem. Part of the excavated material would be used for leveling and grading and the balance would be stockpiled at designated locations on the site. Other solid wastes including sewage, cooking waste and general solid waste are often associated with a relatively large workforces. Cooking wastes and general garbage will be collected at regular intervals and landfilled at an approved disposal site. Sewage waste (construction type portable toilets) will be used, and waste properly disposed.

During trenching for the pipeline, any construction waste (sand, limestone and/or rock) not utilized as fill material during trenching activities should be removed from the pipeline route and properly disposed. The pipeline route should be restored to its original condition, prior to alteration by the project. In addition, all solid waste and surplus materials should be removed from the project site and properly disposed.

#### **5.1.6 Fire Risks**

Fire and explosion hazard impacts are not expected during the construction phase due to the limited quantities of flammable and combustible materials to be imported to the site. The availability and use of portable extinguishing systems would limit the impacts of small fires, and personnel will receive training on the proper use and locations of this equipment. During construction, any waste disposal burning will be conducted in a

cleared and dedicated area under controlled conditions, on those days when ambient air conditions will not permit embers to drift into the surrounding pine forest. Prior to construction, all contractors will be informed of the sensitivity of the surrounding pine forest and the potential for fire.

### **5.1.7 Hurricane Risks**

The official Atlantic hurricane season runs from June 1 through November 30, although hurricanes can form as early as late May and continue into December in the Caribbean Sea or the Gulf of Mexico. The official season covers more than 99% of all tropical cyclones in any year. Hurricane season reaches its peak around mid-August through October. The Bahamian archipelago extends longer than the entire length of Florida and storms in any given season in general do not impact all islands in the Bahamas in that season.

Herbert Saffir devised a five-category damage scale in the early 1970's. The scale had the advantage of relating ranges of sustained winds to effects on vegetation and structures. Robert Simpson, a former director of the National Hurricane Center, added additional reference to expected storm surge. The National Hurricane Center adopted the Saffir/Simpson Hurricane Scale to relate hurricane intensity and damage potential. This scale uses the storm surge, central pressure, and/or the maximum sustained winds to classify Atlantic hurricanes, as indicated on Table 5-1.

According to the Caribbean Hurricane Network statistics, tropical systems passing within 69 miles of Abaco (Marsh Harbour) using coordinates 26.54N and 77.15W between 1851 and 2006 have included 42 tropical storms and 39 hurricanes. The hurricane category followed by number of storms was as follows: 1:11, 2:10, 3:12, 4:4 and 5:2.

Taking into account the propensity for hurricane occurrence, the proposed plant and associated facilities and structures have been designed and engineered to withstand a Category 5 hurricane.

## **5.2 ECOLOGICAL IMPACTS**

### **5.2.1 Terrestrial Systems**

During construction activities, land clearing is a necessary component of the proposed development activity. The most common plant species is the second/third generation pine tree with their broad leaf understory. Land clearing, as proposed, will be limited to that required for the needs of the project, and will be conducted in such a manner that is protective of the environment, in accordance with the Forestry Act and the Act to Regulate the Removal of Hills and Trees. As previously indicated, there are no wetlands within the 25-acre project boundary, and none are anticipated for the remainder of the parcel

### **5.2.2 Faunal Systems**

Construction impacts to wildlife resources at the project site may occur in the form of direct impacts (displacement, mortality) in the proposed construction area, or indirect impacts (noise, human presence) in onsite (if any) or surrounding natural habitats. On the project site and adjacent areas that are covered with natural vegetation, proximal and mobile fauna, if present, will likely be displaced. The most conspicuous faunal element is birds. Since direct clearing of natural habitat is proposed and has been conducted for the project, some disturbance of nesting birds should be anticipated during construction activity, if present. However, due to their mobility and the abundance of similar and adjacent habitats, construction activities are unlikely to significantly impact them. During the visual inspections of the site and proposed pipeline route in immediately abutting vegetative areas, no nests or nesting was observed. No birds or wild animals were discerned in the site vicinity. However, as previously referenced, Table 4-5 is a list of birds that were reported in “South Florida Birding Report” to have been observed by bird watchers in the vicinity of Marsh Harbour over a two day period. The list includes varieties common to the Bahamas, as well as those that may be considered to be migratory. As previously indicated, the Bahama Parrot and other important bird species have been observed proximal to Marsh Harbour. Accordingly, during the construction phase of the project, birds and other animals such as wild pigs, if any, would likely relocate to undisturbed areas of the forest.

### **5.2.3 Aquatic Systems**

#### **5.2.3.1 Wetlands Impacts**

There are a number of types of wetlands recognized in the Bahamas which includes coastal wetlands (tidal marshes and swamps) and mangrove wetlands (dominated by button wood/black mangroves. Mangroves are present west and south west of the coastal road at Spencer's Bight (e.g., Sucking Fish Creek). During trenching activities for pipeline installation, particularly where the trench follows the coast, as previously indicated, Best Management Practices will be employed to ensure excessive silt and sediments do not enter the this area by the use of silt curtains and bales.

#### **5.2.3.2 Coastal Impacts**

The coastal ecology may include benthic habitat and shallow water marine habitats adjacent to and attached to the limestone at the proposed pier location. During installation of the support piles and construction of the dock and pier, nearby biota may be minimally impacted by vibration during hammering in the piles. Minor sedimentation may occur, the areal extent of which is anticipated to be limited.

### **5.2.4 Protected Habitats**

No impacts to Abaco National Park or any of the other preserves or national parks in Abaco is anticipated during the construction phase of the project. However, Pelican Cays Land and Sea Park (PCLSP) is located proximal to the project site. While no concerns are anticipated during the construction phase, concerns have been identified during the operations phase. Specifically, once the new dock is operational and accessed by fuel laden shallow draft freighters who are navigating through the Sea of Abaco, a potential for concern exists. This concern was presented in a letter with respect to Snake Cay, to the former Prime Ministers Office by FRIENDS. A response to this concern is addressed in Section 8.0 of this report.

## **5.3 IMPACTS ON HUMAN POPULATIONS**

### **5.3.1 Land Use Impacts**

The proposed power plant is located in an isolated area with the nearest settlement approximately 7.0 miles to the north on Great Abaco Road. The existing land uses in the area surrounding the proposed project include pine covered Crown Lands in cardinal directions of the project. Based upon the scope and location of the proposed project, little or no impact is anticipated to the nearest closest receptors, e.g., Spring City (Figure 5-1).

Construction related noise is not anticipated to be a concern to the nearest receptor, but to mitigate this potential concern, construction will normally occur during daylight hours and will run one shift per day. In addition, any excessive noise generated by construction related activities will be short term and short duration, and will generally not exceed the Bahamas noise guidelines.

### **5.3.2 Visual and Aesthetic Impacts**

The remoteness of the site location and the presence of the pine forest provide a visual buffer, which will tend to reduce the aesthetic impact of the large industrial facility. The site should not be visible to traffic on Great Abaco Road.

### **5.3.3 Impacts on Neighborhoods and Communities**

The closest active settlements from the proposed power plant site are Spring City, approximately 7.0 miles to the north, Marsh Harbour (including both Dundas Town and Murphy Town), approximately 14 miles to the north, and Lake City/Cherokee area, located approximately 7.0 miles to the south from the Wilson City/Great Abaco Highway intersection. The Great Abaco Highway links all settlements. As previously indicated, no noise impacts generated during the project's construction phase are anticipated at the nearest receptor. However, Spring City might see a notable increase in road traffic as freight is moving from Marsh Harbour to the site. No direct impacts to the communities or neighborhoods are anticipated.

### **5.3.4 Relocation Impacts**

Based upon visual inspection of the site and site vicinity, the proposed power plant site, pipeline, roadway and terminal facility are absent any residences. As a result, no relocation impacts are anticipated.

### **5.3.5 Traffic Impacts**

It should be anticipated that an overall increase in traffic would occur directly as a consequence of the proposed construction. Construction traffic from equipment and materials deliveries will occur either from the newly constructed dock, or from the Marsh Harbour port facility. Use of the Wilson City dock (if viable) and associated road will reduce the potential for traffic impacts to Marsh Harbour. At the Marsh Harbour port facility, both M/V Legacy and Abaco Shipping provide twice weekly freight service from Nassau and Palm Beach, Florida. An increase in traffic will occur to and from the project site subsequent to freight arrival. The temporary traffic impacts are not expected to significantly affect local residents since residential development is sparse in the immediate site vicinity. However, some impacts will be felt in Marsh Harbour as trucks drive to and from the site to the port facility for freight. No significant traffic problems are expected during the construction period, other than minimal delays for start and stop time for the workers commuting to their residences and due to occasional heavy equipment moving to and from the site. Construction traffic generation should be viewed at most as a temporary inconvenience. The use of the newly constructed dock at Wilson City will reduce the impacts to Marsh Harbour.

### **5.3.6 Economic Impacts**

#### **5.3.6.1 Construction Employment**

While the contract for the civil works will be the responsibility of the power generation vendor, it is anticipated that 100% of the construction workers will be hired from within the Bahamas with a large portion from the Abacos and neighboring Out Islands. In addition, general contractors/vendors, consultants and engineers from the United States (or elsewhere) will provide technical and specialized services, not available in the Bahamas. The construction impacts on the local employment opportunities are beneficial,

although relatively short term. Indirect employment in the local area will occur primarily in retail, health services, eating and drinking establishments.

#### **5.3.6.2 Housing Impacts**

The location of the project is isolated, but proximal to Marsh Harbour, which will provide most if not all of the service needs of the project. Since a significant portion of the construction workers will be hired from Great Abaco, there should not be an impact to housing availability. In addition, many rental units and hotels are available for any additional expatriate workforce. The construction of the project may have a significant impact on the housing availability in the local communities. It will however increase use of rental units or hotels and will provide a positive short-term economic benefit. The anticipated size of the construction work force was not available at the time of the EIA.

#### **5.3.6.3 Public Facilities and Services**

As with the housing impacts, construction related impacts to public services and facilities, such as police, fire, and medical services and water, wastewater and solid waste disposal are not expected to be significant. With minimal relocations to the project area expected, existing facilities and services will be adequate to meet the demands on these services. The selected general contractor will be responsible for removing and disposing of construction related debris.

#### **5.3.7 Cultural Resource Impacts**

As previously discussed, no construction-related environmental impacts are expected to the Abaco's protected habitats. In addition, fugitive dust emissions will be properly controlled so that no impact on visibility will occur. Also as discussed, due to attenuation with distance, construction noise will not affect the quality of life at Spring City. Some minor inconvenience may occur through increased traffic and equipment creating conflicts on Great Abaco Highway. A significant portion of the Abaconian economy is based upon the natural beauty provided by the Abacos, resulting in a large boating or cruising community. Increased water borne freight traffic may occur subsequent to the construction of the Wilson City dock and its use for freight transfer. However, during

construction of the power plant, no conflicts are anticipated with recreational users in the area.

#### **5.4 IMPACTS DURING OPERATIONS**

This section discusses the potential impacts from the operation of the proposed power plant and associated facilities on the natural resources and environment of the site and vicinity. Power plants invariably have potential for environmental impacts during the operational phase of the project. During the operational phase of diesel engine projects, the following impacts are normally of most significance:

- Air quality impacts
- Ecological impacts
- Impacts associated with the abstraction and discharge of water
- Impacts arising from solid waste management
- Noise and vibration impacts
- Soil, groundwater and surface water contamination
- Accidents/explosions
- Socio economic impacts

##### **5.4.1 Air Quality Impacts**

The combustion of fossil fuels for power generation inevitably results in emission of gaseous pollutants to the atmosphere. The pollutants of potential concern are sulfur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>). In the Bahamas, both HFO and a light fuel oil known as ADO are used to fuel the Commonwealths power plants, and are the basis for the country's power generation.

The HFO used for the diesel engines at Clifton Pier Power Station, and proposed for Wilson City, is specified to have a sulfur content of less than 1.5%, while the ADO used at Blue Hill Station and the Out Islands must be below 0.5%. Sea-going tankers deliver both types of fuel oil to Clifton Pier, and tankers also deliver ADO for use at the Out Islands stations. ADO is a well-refined product, which can be used without prior treatment, while HFO requires the removal of water before use. This is achieved at Clifton Pier by a combination of gravity settlement and centrifuging.

In general, the most significant emissions from the combustion in diesel engines are sulfur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), and carbon dioxide (CO<sub>2</sub>). Smoke and carbon monoxide (CO) are much less problematic as developments aimed at improving combustion efficiency in diesel engines have also addressed these pollutants. Each of these pollutants is discussed below.

- *Sulfur Dioxide*

As fuel oils have organic origins, varying amounts of sulfur are found present in the oils with typical values varying from 1 to 3.5%. The fuels used for Bahamian power plants are specified with low sulfur content (HFO: 1.5%; ADO: 0.5%). Sulfur is subsequently oxidized to sulfur dioxide (SO<sub>2</sub>) and sulfur trioxide (SO<sub>3</sub>) on combustion with these two pollutant species being collectively referred to as SO<sub>x</sub>. In reality, approximately 98% of SO<sub>x</sub> from diesel engine emissions is in the form of SO<sub>2</sub>.

- *Oxides of Nitrogen*

Nitrogen dioxide (NO<sub>2</sub>) is one of the two main oxides of nitrogen formed during fossil fuel combustion, the other being nitric oxide (NO). These two components, collectively referred to as NO<sub>x</sub>, are formed in varying proportions although NO is typically the more abundant. NO is subsequently oxidized to NO<sub>2</sub> on release to the atmosphere.

- *Suspended Particulate Matter*

Although liquid fuels such as ADO contain relatively low concentrations of mineral matter, which forms ash, emissions of suspended particulate matter will arise as a result of diesel engine operation. This quantity of material would be present in the form of ash present in the fuel, ambient dust not entrapped within the air intake filters, and un-burnt carbon arising from incomplete combustion. The emissions of this pollutant are currently limited through regular maintenance to optimize combustion conditions.

- *Carbon Dioxide*

As with all power plants relying upon the combustion of fossil fuels, the diesel units inevitably lead to the emission of CO<sub>2</sub>. However, the higher thermal efficiency of diesel engines ensures mass emissions of CO<sub>2</sub> per kWh produced are comparatively low. Furthermore, the relatively low carbon intensity of fuel oil when compared with solid fuels reinforces such benefits.

The Bahamas is in the process of developing ambient air emissions standards and guidelines for the protection of human health and the environment (draft 2005). The proposed regulations are very similar to existing US EPA ambient air quality standards. For the purpose of evaluating the impacts from the proposed project, US EPA emission standards were used.

The US EPA and state environmental regulatory agencies review new and modified sources of air pollution by evaluating both stack emission rates or concentrations and ambient concentrations of pollutants in comparison to established stack and ambient standards, respectively. For the primary sources of air pollution associated with the Wilson City project, the heavy fuel engines, US EPA has established Standards of Performance for Stationary Sources (40 CFR Part 60), which are applicable to stationary engines with heat inputs greater than 100 MMBtu/hr.

**Bahamas Promulgated Air Emission Standards (draft 2005)**

<b>Pollutant</b>			<b>Averaging Period</b>	<b>Limit value (ug/m3)</b>	<b>Notes</b>
SO <sub>2</sub>	1	Hourly limit value for the protection of human health	1- Hour	350	Value not to be exceeded more than 24 times a calendar year
	2	Daily limit value for the protection of human health	24-Hours	125	Value not to be exceeded more than 3 times a calendar year
	3	Limit value for the protection of ecosystems	Calendar Year and Winter (October 1st – March 31st)	20	
NO <sub>2</sub> & NO <sub>x</sub>	1	Hourly limit value for the protection of human health	1- Hour	200	NO <sub>2</sub> not to be exceeded more than 18 times a calendar year
	2	Annual limit value for the protection of human health	Calendar Year	40	NO <sub>2</sub>
	3	Annual limit value for the protection of vegetation	Calendar Year	30	NO <sub>x</sub>
PM <sub>10</sub>		Stage 1			
	1	24-Hour limit value for the protection of human health	24-Hours	50	Value not to be exceeded more than 35 times a calendar year
	2	Annual limit value for the protection of human health	Calendar Year	40	
Lead	1	Annual limit value for the protection of human health	Calendar Year	0.5	
	2	Annual limit value for the protection of human health	Calendar Year	40	PM <sub>10</sub>
Ozone	1	Eight-hour limit value for the protection of human health	Eight hour moving average	110	For the mean value over 8-hours
	2	Vegetation protection limit value		200	For the mean value over 1-hour
				65	For the mean value over 24-hours

*Source: The Environmental Planning and Protection Act of 2005. Pollution Control and Waste Management Regulations (preliminary draft may18, 2005, do not cite or quote)*

The EPA regulates emissions of nitrogen oxides (NO<sub>2</sub>) and sulfur dioxide (SO<sub>2</sub>) by limiting stack concentrations of these pollutants as a function of heat rate and fuel nitrogen and sulfur content. It is anticipated that the maximum NO<sub>2</sub> and SO<sub>2</sub> emissions from the proposed Wilson City engines will be designed to meet the EPA requirements.

Pursuant to US EPA New Source Review regulations, in order to be granted a permit to construct, new or modified major sources of air pollution must demonstrate that the source will operate without preventing or interfering with the attainment or maintenance of any applicable Ambient Air Quality Standards or Prevention of Significant Deterioration Increments. A summary of the National Ambient Air Quality Standards (NAAQS) and EPA-defined significant impact levels is presented in the following table. In practice, sources of air pollution that result in air quality impacts that are less than significant impact levels are not considered to have the potential to cause adverse air quality impacts and, therefore, are not required to perform extensive impact analyses involving the interaction of impacts from multiple sources.

US EPA National Ambient Air Quality Standards<sup>(a)</sup>

Pollutant	Averaging Period	National AAQS		Significant impact levels (b)
		Primary (ug/m <sup>3</sup> )	Secondary (ug/m <sup>3</sup> )	
SO <sub>2</sub>	3-Hour	-	1300	25
	24-Hour	365	-	5
	Annual	80	-	1
NO <sub>2</sub>	Annual	100	100	1
PM10	24-Hour	150	150	5
	Annual	50	50	1
CO	1-Hour	40,000	40,000	2000
	8-Hour	10,000	10,000	500
Lead	3-Month	1.5	-	

*Units are micrograms per cubic meter (ug/m<sup>3</sup>)*

(a) All short-term (24 hours or less) values are not to be exceeded more than once per year. All long-term values are not to be exceeded, except for PM10, which is not to be exceeded by the average of the annual averages from three successive years. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility; damage to animals, crops, vegetation, and buildings.

(b) In practice, EPA considers that those source of air pollution that result in air quality impacts less than these levels do not have the potential to cause adverse air quality impacts and, therefore, are not required to perform extensive impact analyses.

It is anticipated emissions of concern will be guaranteed by the vender to be in compliance with required guidelines.

#### **5.4.2 Acid Precipitation**

Concomitant with concerns of noxious emissions from the power plant is the potential for acid rain. Generally 'acid rain' refers to precipitation that incorporates acids and acidic materials. Acid precipitation, strictly defined, contains a greater concentration of hydrogen ions (H<sup>+</sup>) than of hydroxyl (OH<sup>-</sup>) ions, resulting in a solution pH less than 7. Under this definition, nearly all precipitation is acidic. The phenomenon of acid deposition, however, is generally regarded as being anthropogenic, that is, resulting from human activity.

Theoretically, the natural acidity of precipitation corresponds to a pH of 5.6, which represents the pH of pure water in equilibrium with atmospheric concentrations of carbon dioxide. Atmospheric moisture, however, is not pure, and its interaction with ammonia, oxides of nitrogen and sulfur, as well as windblown dust results in a pH between 4.9 and 6.5 for most "natural" precipitation. The areas of highest precipitation acidity (e.g. lowest pH) tend to correspond to areas within and downwind of heavy industrialization and urbanization, where emissions of sulfur and nitrogen oxides are high. An example of such an area is the industrialized northeast of the United States. It is in these areas, with these emissions that most acidic precipitation is thought to originate. However, in comparison, the scale and magnitude of the urbanization and industrialization that is present in the USA is not represented in the Bahamas or specifically in the Abacos.

The proposed power plant site as a new stationary point source is unlikely to contribute significantly, if at all, to the acid rain phenomena based upon it use of low sulfur content fuels and the combustion efficiencies of new and state of the art diesel engines. Furthermore, based upon the remote location of the site, and the height of the emissions tower, it is also anticipated that atmospheric dispersal of any potential air contaminants

will be effective and no impacts to the closest potential receptor is anticipated. Published records indicate that prevailing wind directions for Abaco are from the northeast and southeast and as such downwind areas are typically far off shore.

The effect of acid deposition on a particular ecosystem depends largely on its acid sensitivity, its acid neutralization capability, the concentration and composition of acid reaction products, and the amount of acid added to the system. The impact of acid deposition on terrestrial and aquatic ecosystems is not uniform. While increases in acid deposition may stress some ecosystems and reduce their stability and productivity, others may be unaffected. The degree and nature of the impact depend on the acid input load, organism susceptibility, and buffering capacity of the particular ecosystem. BEC will be conducting an air quality monitoring program, to confirm that the operational emissions of the power plant remain within accepted Bahamas/US EPA/World Bank Guidelines.

### **5.4.3 Ecological Impacts**

Review of the potential ecological impacts and proposed mitigation are summarized below:

#### **5.4.3.1 Faunal Impacts**

The effect of air emissions from the stacks upon breeding birds (if any) proximal to the site will not be clear without careful monitoring. During the preparation of the EIA, no nest or nesting birds were observed on or proximal to the subject site. Recommendations for a monitoring program include review of areas immediately adjacent and proximal to the site. Since birds are generally mobile, it is anticipated they will relocate beyond the sphere of influence of the plant.

#### **5.4.3.2 Floral Impacts**

The affect of emissions on the adjacent pine forest is not anticipated to be a concern, particularly since the annual air quality levels are within those approved for human health. Air emissions are not likely to affect local vegetation, which is further buffered by

the high alkalinity of the local geology and the hardy salt resistant nature of the native species.

#### **5.4.3.3 Wetlands**

While no wetlands are located with the property boundary of the power plant site, a marshland area is located adjacent to the bay of Spencer's Bight. However, no impacts are anticipated during the normal operation of fuel transfer from the dock to the power plant facility.

#### **5.4.3.4 Protected Habitat**

No impacts are anticipated to the protected habits such as Walkers Cay National Reserve, Black Sound National Reserve, Fowl Cay National Preserve, Tillo Cay National Park, and Abaco National Park during the operation of the facility. However, with respect to Pelican Cay Land and Sea Park, which is located northeast of the power plant at Pelican Point, there is some trepidation associated with shallow draft freighters accessing the Wilson City dock. The freighters may access the Sea of Abaco via North Bar Channel from the Atlantic, which will take them directly through the park or alternatively they may select the route to the dock via Little Harbour to the south. There is no expectation of a concern during normal operations; however in the event of a hurricane or other catastrophic event, which causes the freighters to discharge fuel in this area, it would be prudent to ensure the appropriate response plans are in place. A fuel discharge proximal to the park in this area would result in an ecological disaster. Figure 5-2 illustrates the location of the park.

#### **5.4.3.5 Marine Ecology**

During the day-to-day operation of the power plant, no impacts are anticipated to the marine ecology. With respect the physical use of the docking facility at Wilson City, the use of shallow draft ships that frequent the Sea of Abaco are anticipated to have little or no physical impact to the marine life, as the draft of the ships used for fuel delivery are not much greater that the larger cruise vessels that already use the Sea of Abaco. The frequency of the ship use of the docks, anticipated to be once or twice per week, is also

not anticipated to cause undue physical hazard to the users of the Sea of Abaco. All commercial ship captains are certified and trained as Sea Captains and all are aware of the Mandates of International Convention for the Prevention of Pollution from Ships (MARPOL), the Bahamas Maritime Authority requirements, and compliance with the Code of Safety for Caribbean Cargo Ships, and/or the Code of Safety for Small Commercial Vessels trading in the Caribbean.

#### **5.4.3.6 Landscaping**

At the completion of construction activities, landscaping should include the abundant use of native plant species.

#### **5.4.4 Supply and Discharge of Water**

According to BEC, the project proposes a once through cooling system by direct cooling with water obtained from newly installed supply wells. Direct cooling water will be abstracted through a newly installed proposed groundwater supply well. The groundwater quality will be saline since it is anticipated that water will be derived from below the freshwater lens of the Marsh Harbour-Lake City aquifer, from the sea water horizon, as it infiltrates the highly porous Lucayan limestone base-rock below the site. The abstraction of this saline water for cooling water power-plant water supply avoids the need of impacting this very important and limited resource. This resource is used by the Water and Sewerage Department to provide potable water to all the communities proximal to Marsh Harbour and Spring City, which accounts for the majority of the population and tourists who enter Abaco. However, the production rate, concomitant drawdown and the resultant radius of influence from the new wells, with respect to producing wells in the wellfield, as well as existing residential users, should be evaluated to confirm no detrimental impacts are caused by the production capacity of the new well. The cone of influence should be evaluated with respect to the nearest withdrawal wellfield array located at Spring City. Based upon its distance from the site, no detrimental impacts are anticipated. The final determination of the potential for detrimental impacts (if any), is pending the conclusion of the report commissioned by MAN B&W, and being prepared by EC.

#### **5.4.4.1 Groundwater Modeling**

According to the EC proposal, a three dimensional finite element groundwater model will be used to predict groundwater impacts at the site. Other modeling tools such as “Modular Three Dimensional Finite Difference Flow Model” (MODFLOW) and other predictive models such as MODPATH, developed by the USGS, are also available. However, regardless of the predictive modeling tool used, subsequent to construction (assuming the modeling results are positive), it is recommended that monitoring of the influence of the withdrawals from the newly installed well(s) should also be conducted.

Measurements should include:

- Baseline water quality data to evaluate the shallow water quality in the vicinity of the plant. Much of this data should be available from water quality analysis conducted by the Water and Sewerage Department from their data for the Marsh Harbour-Lake City Wellfield.
- Subsequent to groundwater withdrawals, additional water quality data should be collected initially at startup of the production well, and subsequently at a frequency that will enable any small changes in water quality, e.g., increases in chlorides, to be observed.
- Depth to water measurements to observe whether there has been a reduction in groundwater levels that results in movement of the freshwater lens/salt water interface.
- Noting whether induced movement or induction of pollutants into the water supply is occurring resulting in a significant reduction in water quality.

#### **5.4.4.2 Groundwater Injection Concerns**

For comparison, at the Blue Hills Power Station, which is also located over an existing aquifer (Clifton Pier is not), the existing main cooling water, the greater portion of which is used in the once-through condenser of the steam turbo-alternator (i.e., TA6 on the combined cycle plant), is abstracted from the ground via wells at the northeast corner of the site. Subsequently, the spent cooling water is re-injected to the ground. It has been previously reported that there is some chemical treatment of the cooling water for protection against corrosion of the plant. Under normal circumstances, therefore, small quantities of chemical contaminants are injected into the underlying aquifer.

Any changes in the composition of cooling water are likely to be quantitative in nature rather than qualitative. In addition, the cooling water will be re-injected at a temperature above the ambient temperature of the receiving water temperature, which will rapidly return to background conditions as the water mixes and cools. Monitoring data from the Water and Sewerage Department should be able to confirm whether there have been any detrimental impacts to the wellfield water quality.

#### **5.4.5 Solid Waste Management**

It is the intention of the proposed facility that the bulk of generated waste will be disposed onsite through incineration. The project specifications include the installation of an Atlas Incinerator (800 Series). This incinerator has the capability of simultaneous incineration of both sludge oil and solid waste. The proposed waste stream scenario is as follows: the lube oil sludge and leaked lube oil will be collected in the power house in a tank where it will be stored and then transferred to the tank farm where it is stored in the separator sludge tanks ready for disposal. The sludge is disposed of by incineration. Conversely, operational solid waste will be collected and stored prior to disposal by incineration. The types, sources, and management of wastes anticipated to be generated during the operation of the proposed project facilities are as follows:

- Plant Wastes such as office wastes, packaging materials, ashes, garbage, refuse, and rubbish will be generated during the operational phases of the proposed project and general solid waste will be incinerated. Non-burnable wastes will be collected and transported off-site for disposal. Other Plant wastes, such as lead-acid batteries will be segregated from other waste streams, collected and stored in suitable containers, and if not incinerated will be transported off-site and disposed at an approved location by an approved waste transporter, in accordance with the DEH requirements.
- Special Wastes such as hazardous waste, industrial solvents and other chemical wastes, grease trap pumping, septage, and used oil, will be generated during the operational phases of the proposed project. Special wastes could also include items such as waste oils, waste lubricants, paints, maintenance-related wastes, used air and liquid filtration media, and empty or nearly empty chemical containers. Most, if not all, of these materials will be disposed by incineration.
- Process Wastewater, such as cooling water and wash water, will be monitored prior to discharge through the water discharge structure.

- Sewage wastes will be disposed of in an on-site septic system.

While there are definite advantages of incineration such as the reduction in volume of the waste material as it is reduced to ash, particularly on islands with very limited available land for solid waste disposal, incineration produces fly ash and bottom ash just as is the case when coal is combusted. The total amount of ash produced by municipal solid waste incineration ranges from 15% to 25% by weight of the original quantity of waste, and the fly ash amounts to about 10% to 20% of the total ash. The fly ash, by far, constitutes more of a potential health hazard than does the bottom ash because the fly ash contains toxic metals such as lead, cadmium, copper and zinc, as well as small amounts of dioxins and furans. The bottom ash may or may not contain significant levels of health hazardous materials. In the United States, the law requires that the ash be tested for toxicity before disposal in landfills. If the ash is found to be hazardous, it can only be disposed of in landfills, which are carefully designed to prevent pollutants in the ash from leaching into underground aquifers.

Confirmation of the hazardous/non-hazardous status of the ash is confirmed through analytical testing. The Toxicity Characteristic Leaching Procedure (TCLP) is designed to determine the mobility of both organic and inorganic analyses present in liquid, solid, and multiphase wastes. The TCLP analysis simulates landfill conditions. Over time, water and other liquids percolate through landfills. The percolating liquid often reacts with the solid waste in the landfill, and may pose public and environmental health risks because of the contaminants it absorbs.

The TCLP analysis determines which of the contaminants identified by the United States Environmental Protection Agency (EPA) are present in the leachate and their concentrations. At frequent intervals, the slag cake generated by the incinerator will also require disposal. This material should also be analyzed by TCLP to confirm its hazardous/non hazardous character prior to disposal.

#### 5.4.6 Noise and Vibration Impacts

Since the proposed power plant is to be located in a remote location, which benefits from its seclusion and adjacent pine forests, no concerns are anticipated from an aesthetic point of view of the visual impact of the facility. Once operational, additional ambient noises may be of concern. However, package systems are noted for the quietness of their operation, and according to the vender's specifications, ambient noise measurements at the property boundary are less than 75 dBA and the closest, residential receptor is greater than 7.0 miles from the new facility. As such, no excessive ambient noise impacts are anticipated. The location of the facility in the pine forest provides a visual and noise attenuation buffer between the plant and any potential receptors. The following is a discussion of the model used to predict operational noise.

The Bahamas is governed by the World Bank Noise Guidelines, referenced in the following table, which indicates when noise measurement from a known source should not exceed 55 dBA during the day, and 45 dBA at night at the nearest sensitive receptor.

<b>Noise Level Guidelines</b>		
	<b>One Hour <math>L_{Aeq}</math> (dBA)</b>	
<b>Receptor</b>	<b>Daytime 07:00 - 22:00</b>	<b>Nighttime 22:00 - 07:00</b>
Residential; institutional; educational	55	45
Industrial; commercial	70	70

*Source: World Bank Environmental Guidelines (April 2007)*

The guidelines indicate that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred

method for controlling noise from stationary sources is to implement noise control measures at the source. Methods for prevention and control of sources of noise emissions depend on the source and proximity of receptors. Noise reduction options that should be considered include:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, application of sound insulation;
- Installing acoustic barriers without gaps;
- Locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Siting permanent facilities away from community areas, if possible; and
- Taking advantage of the natural topography as a noise buffer during facility design.

A point of reception or receptor may be defined as any point on the premises occupied by persons where extraneous noise and/or vibrations are received. Examples of receptor locations may include permanent or seasonal residences, hotels/motels, schools and daycares, hospitals and nursing homes, places of worship, and parks and camp grounds. In general, the background or ambient noise levels that would be present in the absence of the facility or noise source(s) under investigation represent the noise level limit. The primary noise sources during the facility operation are from the four diesel engines. During the design of the proposed power plant facility, in order to reduce outdoor noise levels, MAN B&W used silencers where appropriate and the attenuating capacity of the walls, doors and roof of the power house structure.

The potential operational noise impacts were assessed at the property boundaries by MAN B&W, the results of which, and the inputs used, are provided in Appendix D. A noise model was the primary analytical tool employed in the assessment. Noise level input data used in the model included the design of the diesel power plant, number and types of engines, followed by the acoustic data of the components. The noise emission calculation was conducted in accordance with ISO 9613-2. This part of ISO 9613

specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level under meteorological conditions favorable to propagation from sources of known sound emission. These conditions are for downwind propagation, or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night. The output of the noise model indicated the predicted noise levels at the property boundary are between 69 and 73 dBA.

While these levels may be elevated with respect to World Bank Guidelines, at the property boundary, the distance from the closest sensitive receptor is considered to be Spring City, more than seven miles from the site. In addition, no account of the noise attenuation properties of the surrounding topography or the pine forest was included in the model. As previously indicated, given the attenuation properties of the adjacent vegetation, as well as the fact that noise levels decrease with distance from the noise source, noise from Wilson City Power Plant operation would be lower at more distant noise-sensitive locations such as Spring City, if at all. The actual noise impact at Spring City due to the facility is expected to be lower than that measured at the property boundary. It can be concluded that the power plant project will comply with the Bahamas and World Bank standards, based primarily on the remoteness of its location, away from proximal sensitive receptors.

#### **5.4.7 Soil and Groundwater Contamination**

This section provides a description and assessment of potential impacts of the fuel storage, and transfer operations to the local environment and ecosystem.

##### **5.4.7.1 Fuel Management**

The project specifications include the construction of a bunded tank farm, which will house two (2) 1.0 million-gallon HFO tanks, a 250,000-gallon ADO storage tank, a 50,000-gallon HFO pre-centrifuge tank, a lube oil storage tank, and a sludge tank. The bund is designed to contain spillages and leaks from liquids used, stored or processed

aboveground and to facilitate clean-up operations. The proposed Wilson City bund wall specifications include concrete filled core blocks, reinforcing concrete slab and individual full containment, partition walls for each tank and valves and oil water separator. The bund area in the event of a catastrophic event can contain more than 110% capacity of the largest tank ( $375 * 150 * 3.5 \text{ ft} = 196,875 \text{ cubic ft}$ ;  $196,875 \text{ cu ft} * 7.48 \text{ gal/cu ft} = 1,472,625 \text{ gal}$ ). In the event of a discharge or fuel leak, the discharged product will be contained within the bund wall and subsequently pumped out for safe disposal. In addition, the individual bulk storage tanks will be monitored to avoid over-fill by appropriate instrumentation and sensors. In the event that spills or discharges do occur, they will be managed in accordance with BECs Environmental Management Plan and SPCC plan.

#### **5.4.7.2 Impacts to Surface Water During Fuel Transfer**

A major operational concern of any fuel transfer operation is the control, containment and efficient cleanup of any discharges or spills during fuel transfer. In the event of a spill or discharge, the fuel on the water must be contained by floating boom containment, and petroleum absorbent materials applied to absorb the spill. To this end, spill mitigation supplies, including a boom of sufficient length, and absorbent materials should be located at the fuel terminus. In addition, as part of the fuel transfer operation policy, each transfer should only proceed in the presence of a BEC operator, who has deemed the fitting between the transfer hose and fuel pipeline to be secure. The absence of any mitigation equipment in the immediate vicinity of the fuel transfer operation can have a potentially disastrous environmental consequence to the coastal ecosystem.

#### **5.4.7.3 Impacts to Ground/Surface**

In the event of a fuel spill/discharge to land at the Wilson City dock, the spill should be contained and not permitted to discharge to the adjacent surface water body. The spill should be contained and collected with the use of absorbent pads, “spill-dry” or other petroleum absorbent materials. After use, the absorbent materials should be collected and properly disposed. To this end, fuel spill mitigation equipment should be located at the

pipeline terminus, to enable a rapid response to control the movement of any discharged fuel.

#### **5.4.7.4 Impacts to the Subsurface**

The installation of the fuel pipeline includes the addition of galvanic protection against corrosion. However, once the pipeline is installed, additional assurances are required to confirm the pipeline is in fact not leaking.

In accordance with the BEC Environmental Management System, in which fuel transfers are addressed, 100% reconciliation is required detailing the total fuel delivered and transferred to day tanks and burnt, to confirm that no fuel has been lost through leakage. This performance evaluation would appear to be adequate if the lines are to remain void of any product between transfers.

In the event the lines are to remain charged with fuel between transfers, leak detection monitors along the pipeline route may be appropriate. In addition, a valve system along intervals of the pipeline is recommended, such that in the event of a discharge, the required sections of the pipeline can be closed and repairs implemented. Based upon BEC's experience along Carmichael Road in New Providence, the distance between valve sections was approximately 4,500 ft, which proved to be an impractical distance for efficient remediation. As a result, it would be prudent for valve and manhole placement to be located at shorter intervals. Valve placement at intervals of approximately 500 ft is recommended.

#### **5.4.7.5 Direct Groundwater Impacts**

An area of potential concern during the operation of the plant is described as wellhead management. The construction and installation of both the supply wells and the disposal well provide a direct conduit to the underlying Marsh Harbour-Lake City aquifer. As a result, the uses of these appurtenances cannot be used for any other purposes other than their designed intended use. Due to the sensitivity of the underlying aquifer, full time

monitoring is proposed to ensure no deterioration of water quality has occurred associated with power plant operations.

#### **5.4.7.6 Site Drainage Systems**

Design of drainage systems, both within and outside process buildings, should take account of the need to segregate spillages of hazardous materials. Drainage systems to be considered may include sewers, storm water drains, bund discharge, process effluent systems and firewater drainage systems.

In many cases these functions are combined and often firewater and process effluents are drained into main sewerage systems. Where there is a possibility that hazardous substances could be discharged into a drainage system, interceptors or sumps should be provided of sufficient capacity to ensure that an offsite major accident does not occur.

For process effluents arising from leaks or plant washdown, good practice is to provide a local sump, which is sampled before emptying. Such sumps normally incorporate level indicators/alarms for monitoring. Discharge can be to drums via submersible or mobile pumps for onward disposal or via manual or manually operated automatic valves into main drainage systems, if the contents are non-hazardous. As for bund drainage following a storm event, consideration will need to be given for the possibility of valves being left open.

A particular concern is the discharge of non-water miscible flammable liquids, which form a top layer. These could ignite considerable distances from the plant after discharge. More sophisticated interceptors can be provided to facilitate removal of floating flammable liquids. These tend to be designed to meet individual needs and may incorporate conductivity-based level sensors to distinguish between layers. With these considerations in mind, MAN B&W's design for management of waste streams included features to reduce or eliminate the potential for detrimental discharges such as large capacity oil/water separators and interceptors.

#### **5.4.6.7 Operational Mitigation**

The potential for ecological impact, if fuel and other chemicals are improperly managed could, in the worst-case scenario, be catastrophic and permanent. However, if the operation of the BEC facility is conducted in strict accordance with operations and procedures guidelines, presently available as outlined in the Environmental Management System (EMS), in compliance with corporate environmental policy, the potential concerns may be mitigated. The procedures include operational activities, fuel delivery and storage, fuel inventory, general waste disposal, site housekeeping, control of chemicals and environmental incident reporting. Implementation of the EMS during operation of the power plant and associated facilities will ensure that degradation of the islands ecosystem does not occur as a result of inadvertent or inappropriate fuel management practices. The elements of the BEC EMS are attached as Appendix E.

#### **5.4.8 Societal Impacts During Operations**

##### **5.4.8.1 Land Use**

The project is located on undeveloped Crown Land, consisting of Pine Forest Upland. The site is located almost at the terminal end of Wilson City Road. The site is located proximal to a site of cultural interest, which was instrumental to the development of Abaco. The proposed use of the site is in keeping with the historical precedent and will result in the generation of reliable power and is of benefit to the people of Abaco.

##### **5.4.8.2 Visual and Aesthetics**

The proposed Wilson City Plant benefits from its remote location, with respect to area communities. The use of Wilson City Road was limited subsequent to the decline of the timber industry circa 1916-20 and as a farm road during the sugar cane years in the 1970s. With the decline of its use as an agricultural service road, Wilson City Road was relegated to intermittent use as an access route into the forest and for those who tried to access the former Wilson City ruins. As a result, no conflicts with recreational users is anticipated. In fact, improvements to Wilson City road will make ruins accessible to cultural investigators and preservationists alike.

The power plants tallest structures, the 32 m (106-ft) gas exhaust stack will be visible to cruisers and boaters in the Sea of Abaco, and may be used as an additional point of reference. The terrestrial population density of the area is low thus minimizing any aesthetic impacts. Motorists driving on Great Abaco Highway will not see the plant and associated structures. Therefore, impacts to aesthetic quality of the vicinity are negligible. Residential areas, e.g., Spring City, are expected to experience no impacts from the proposed power plant project due to distance from the site and adequacy of existing forested vegetation to screen plant facilities. Most onsite activities will not be visible to anyone outside of the property boundary.

#### **5.4.8.3 Neighborhood and Communities**

In the absence of any communities within the project area of influence, this concern is not applicable to the project.

#### **5.4.8.4 Relocation Impacts**

As previously indicated, and according to published reports, the last residents of the Wilson City area relocated following closure of the wood mill and camp in 1916. As a result, no impacts are anticipated in the project area of influence. This concern is not applicable to the project.

#### **5.4.7.5 Traffic Impacts**

Increase in the use of Great Abaco Highway should be anticipated as a direct consequence of the operation of the power plant. However, this increase is anticipated to be minimal, and no greater than that currently experienced at Marsh Harbour Power Station. The increase in road use is anticipated during peak hours and between changing operator shifts. The number of operators required to service and maintain the plant is not excessive, and vendors plying their services from Marsh Harbour and perhaps Spring City will use the location of the power plant to create a new center for economic opportunity. As a result, the presence of roadside vendors should be anticipated. Proposed improvement to Wilson City Road and the construction of the dock will likely result in additional recreational use of the area, which may also promote vender

opportunities. However, based upon the remote location of the site, no concerns are anticipated with respect to increased traffic activity.

#### **5.4.7.6 Economic Impacts**

According to Bradley Roberts, General Manager of BEC, in the 1950s, when the tourism sector became the driving force of the economy of the Bahamas, the country experienced a surge in demand for electricity. Tourism would not have become the Bahamas most important source of foreign revenue if the islands could not provide visitors with the most basic of needs, including adequate water, sewage and electricity service; add millions of tourists into the equation and you have a mammoth infrastructure challenge. Training, safety and planning are the keys to providing a reliable and adequate supply of electricity. The BEC's System Development Department is continually forecasting growth for plant and equipment facilities, and its planning strategy allows the corporation to stay one step ahead, not only in the capital of New Providence, but also throughout the numerous Out Islands. BEC's medium term planning, which covers a period of three to five years, and long term planning, are reliable tools that have allowed the corporation to always satisfy the increasing demand.

Based upon this anticipated need requirement, acknowledgment of the tourist industry in all of its forms is the most important sector of the Abacos economy. Most Abaconians make their living directly or indirectly from the tourist industry. Short-term economic benefit will be realized by retail drinking and eating establishments, as well as by increased use of available rental property. Long-term benefits will include indirect employment for Abaconians, as a result of improved and reliable electricity and other economic benefits provided by increased tourism. As a result, continued growth of tourism generated revenue into the Abacos economy is anticipated that will be available to aid in the development of the island.

#### **5.4.7.7 Cultural Resources Impacts**

The subject site is currently pine-covered uplands, located approximately 1.5 miles from Wilson City ruins located at Pelican Point. As previously indicated, Wilson City was the first town of its kind in Abaco. The town was conceived as a model and modern city to house its work-force and was instrumental in the early development of Abaco. As such, it was designed for some degree of permanence, unlike the work camps that followed. Remnants of this former use remain, albeit buried in vegetation. After the cessation of the Wilson City timber industry era, and subsequent to salvage opportunities during the 1920s-30s, the area has remained undisturbed until the present time. With the exception of a few intrepid adventurers willing to walk the approximately one mile from the end of Wilson City road, access to the former camp was limited to the water. However, with the proposed improvement to Wilson City road, including the extension to Wilson City dock, access to the ruins will be available to cultural investigators and preservationists, at which point serious attempts at cultural preservation of the remains of the ruins can be made. There are no indications of archeological resources, religious resources or indications of archeological resources which are undiscovered at the power plant site. As a result, no cultural impacts are anticipated to be present or disturbed as a result of the proposed project.

#### **5.5 CONSEQUENCES OF NON-PROJECT IMPLEMENTATION**

As indicated by BEC, the installed capacity at Marsh Harbour is insufficient to meet current and near future demand for power in Abaco. Without additional capacity, the need for load shedding becomes likely in order to maintain a balance between demand and generation capacity. Therefore, the proposed project is designed to meet the current and future needs providing reliable additional electricity generation capacity.

Alternatively, without the additional capacity offered by this project, greater reliance would be placed upon the use of small diesel generator sets for residential, commercial and industrial purposes. These typically burn premium fuels such as high-speed diesel, whilst their energy efficiency and inherent emissions means that their environmental performance may compare unfavorably with larger scale generation. The Bahamas

Government relies heavily on tourism and hence the security of power supply for hotel and other tourism and recreational facilities is highly significant. Any load shedding in this sector will have a corresponding effect upon tourism with the economy suffering as a result. Therefore, non-project implementation is not considered to be a viable option from the point of view of sustainable development and hence the proposed project should proceed.

## **6.0 HISTORICAL ENVIRONMENTAL PERFORMANCE**

Integral to the development of an environmental management plan that is protective of the environment, the past performance of BEC is subject to review. For this review a number of reports and memos were evaluated which illustrates environmental performance, response actions, and corrective actions implemented at Clifton Pier, Blue Hill, and Marsh Harbour power stations. Significant lessons are to be derived from historical practices previously employed (and not employed) in order to be protective of the environment.

### **6.1 HISTORICAL CONTEXT**

The operation of the BEC facilities are conducted in accordance with operations and procedures guidelines, as outlined in the EMS, and in compliance with corporate environmental policy. The procedures include operational activities, fuel delivery and storage, fuel inventory, general waste disposal, site housekeeping, control of chemicals and environmental incident reporting. The policy and procedures were introduced in 1994 and were based on the International Standards Organizations (ISO) 14000 series. The ISO 14000 Environmental Management Standards were developed to assist organizations on how to minimize the way their operations negatively affect the environment (cause adverse changes to air, water or land), comply with applicable laws, regulations, and other environmentally oriented requirements, and continually exhibit operational improvement. A primary component of the ISO 14000 standard is the "Environmental Policy" which must be defined by an organization's top management. These environmental policies must include a commitment to both compliance with environmental laws and company policies, and continual improvement and prevention of pollution. A system is then created, or if already existing documented, that ensures that the environmental policy is carried out by the organization. This involves planning, implementation and operations, checking and corrective action, and management review. The BEC EMS is categorized into operational (OP), non-operational (NOP), external (EXT), and Annual Review (AR) areas, against which performance and improvements

may be evaluated. It was intended that the performance evaluation would be performed annually. The areas of performance are provided below.

<b>CATEGORY</b>		<b>DESCRIPTION</b>
<b>OPERATIONS</b>		
*	OP-1	Inventory of SO <sub>2</sub> , NO <sub>x</sub> and CO <sub>2</sub>
	OP-2	Clifton Pier Air Quality Review
	OP-3	Fuel Purchasing Procedures
	OP-4	Fuel Delivery and Storage Records
	OP-5	Fuel Inventory
*	OP-6	General Waste Disposal
	OP-7	Waste Oil Production Records
	OP-8	Station Maintenance Records
*	OP-9	Noise Control at Operational Sites
*	OP-10	Water Effluent Management
	OP-11	Site Housekeeping
	OP-12	Distribution/Transmission Maintenance
*	OP-13	Staff Environmental Awareness
*	OP-14	General Waste Oil Disposal Procedure
	OP-15	Control of Chemicals
*	OP-16	Environmental Incident Reporting.
<b>NON-OPERATIONS</b>		
	NOP-1	HQ Environmental Performance Review
	NOP-2	Procurement Guidelines
*	NOP-3	Staff Environmental Awareness-General
	NOP-4	New Projects - Feasibility Study
	NOP-5	New Projects - Implementation
	NOP-6	Decommissioning Site Management Procedures
<b>EXTERNAL</b>		
	EXT-1	Public Complaints Record
	EXT-2	Public Environmental Protection
	EXT-3	Promoting Energy Efficiency
<b>ANNUAL REVIEW</b>		
	AR-1	Annual Environmental Performance Review
	AR-2	Environmental Performance Targets for the following year

## **6.2 HISTORICAL ENVIRONMENTAL REPORTS**

Between 1994 and 2003, Annual Environmental Management Reports (1994, 1996, 2001) were prepared by Mott McDonald (Mott), describing observed conditions, comments on performance and recommendations for improvements at BEC facilities, primarily focusing on the Clifton Pier and Blue Hill stations, and commenting on the Out Island facilities. In addition, Triton Environmental Services prepared a Phase I/II Environmental Site Assessment in 1997 for Big Pond, and also prepared an Initial Site Assessment Activities Report, in response to historical concerns for Clifton Pier in 2002. Other source materials included internal memos from the Environmental Health & Safety Department. Based upon review of this information, an assessment of the potential physical impacts that could occur as a result of poor design, poor housekeeping and material handling to the environment are described. Specifically evaluated are air, surface water (ocean), soil, groundwater, noise and housekeeping impacts, which correspond to the operations category code (\*) of the environmental management plan referenced above.

## **6.3 ANNUAL REVIEW CONCERNS**

### **6.3.1 Air Emissions**

According to the Environmental Management Audit 2003, Mott had identified a number of improvements at Clifton Pier, with respect to ambient air quality and the monitoring of air quality and indicated improvements had occurred from the 1994 and 1996 reports in which concern for particulates, plume visibility and plume dispersion were issues. During this period, the individual 26-meter high stacks of the four diesel engines (DA5, DA6, DA7 and DA8) were combined into one single 60-meter high, multi-flue chimney stack, which addressed the dispersion and ambient air quality issues. In addition, the final emissions report prepared for DA11 by MAN B&W indicated all parameters were within limits. Ambient air quality monitoring stations operated by Golder Associates had also been installed. Historical concerns were also noted at Blue Hills in 1996 with the emission of black smoke from their generators; however the conclusion of the Golder 2001 report indicated that the highest pollutant impact areas are predicted to occur in relatively small areas on the hill to the north of the BHPS site and beyond the

northwestern corner of the property. In addition, the modeling analysis indicates that the maximum predicted SO<sub>2</sub> and NO<sub>2</sub> impacts would likely exceed the U.S. AAQS in isolated areas near the plant. Further analysis had indicated that the frequency of occurrences of the short-term SO<sub>2</sub> exceedances was very low. The maximum SO<sub>2</sub> 24-hour U.S. AAQS would be exceeded only two or three days per year, while the maximum SO<sub>2</sub> 3-hour U.S. AAQS would be exceeded less than five periods per year. Currently, ambient air monitoring is conducted internally by BEC, but will be supplemented by an outside vender in response to a BEC RFP, dated February 2008.

### **6.3.2 Surface Water Discharges**

Significant and ongoing assessment and corrective actions were centered on the reported discharges in 1996 of traces of brown oil visible alongside the rocks immediately adjacent to the Station-A cooling water outfall. Inspections within the power station site itself revealed likely causes of the traces of oil at the outfalls. The storm water drains, which are connected to the cooling water outfall system, were widely contaminated with oil. Similarly, the roadways and plant had standing water areas, which fed storm water run-off waters to these drains, and commonly showed evidence of heavy oil contamination. By 1999, complaints were received from the public of a dark sticky substance, which was confirmed to be oil, observed proximal to BEC's western outfall, and by 2002 it was reported that a number of potential sources for petroleum impacts to the subsurface environment are present on the western side of Clifton Pier Power Station. These include discharges associated with product line trenches, free phase petroleum within the secondary containment area of the bulk storage tanks and free phase petroleum in deep wells. These sources have resulted in creating a significant free phase hydrocarbon plume, resulting in the discharges seen emanating from the caves below the cliffs south of Carmichael Road. Corrective actions were implemented in 2001, which continue in one form or another to the present day. Oil recovery at the caves was implemented by the use of a scavenger pump, from which the recovered oil is placed in 55-gallon drums, prior to storage and disposal.

### **6.3.3 Soil/Ground/Land Impacts**

Numerous examples of soil, ground and land impacts were noted at all BEC facilities between 1994 and 2001. The end result of fuel emanating from the caves at Clifton Pier find their origin in the design and operation of the BEC facilities prior to 2001. In 1994, an oil spillage/discharge clean up and bund improvement program was recommended as a result of observed impacts on grounds and bund areas. In 1996, large areas of the site were covered with semi-solidified oil and large oil pools were observed inside the bunds of the two bulk storage tanks (Tanks 1 and 2) and in the pipeline trenches. By 2001, the entire bund surrounding Tanks 1 and 2 was observed filled with oil sludge one to two feet deep. BEC Environment and Safety Department reported that a direct correlation had been observed between the level of oil/sludge within the Tank No. 1 and No. 2 bund and the rate of oil seeping into the cave. This provided strong indication that oily sludge from the bunded area of the '0' Station tank farm was causing contamination of the underlying rock structures and finding its way into the cave. The earthen base of the bund surrounding Tanks 1 and 2, and the presence of holes in the bund walls, had raised concerns regarding the integrity of the bunds to serve their purpose of containment in the event of a major oil discharge. At Blue Hills Station in 1994 it was also observed that a discharge was not contained within the tank bund because the bund did not have a solid impermeable base and because it had been connected to the rainwater drainage system via a grid in its base. As a result, the discharge flowed through this rainwater system to its outfall, to grossly contaminate areas of the site. Chronic discharge problems were also cited for BEC's Out Island facilities.

### **6.3.4 Groundwater Impacts**

It was reported in 1994 that the disposal wells for both the Clifton Pier and Blue Hills station, through which oily wastewater are disposed, were found to be without routine monitoring. Hence, there was no means of assessing the potential for long-term groundwater contamination. In addition, the designed purpose of the disposal wells was to take the wastewaters from plant oil/water separators, when of adequate capacity and operating in a properly maintained condition. Such effluent would contain only a few parts per million of oil. However, evidence from the site inspections in 1996 and 2001

indicated that wastes of much higher oil content were being discharged to the wells. Such misuse of the disposal wells was encouraged by the fact that the flow systems between the oil/water separators and the wellheads were often open. The wellheads, for example, are usually covered only with a grid, rather than a solid manhole cover to prevent easy access. To further exacerbate the difficulties, some of these grids are arranged to also serve as surface water drains, so allowing spills on roadways to be carried into the wells. Observations routinely recorded by Safety and Environmental personnel indicated that all injection wells were found to have traces of sludge in them. At the time of one inspection in 2001, the deep injection well at Station-A was filled with oil sludge apparently 150-200 feet in depth.

### **6.3.5 Noise Emissions**

The Bahamas Government has no ambient noise control limits, but refers to World Bank day and night-time guidelines. It was reported for both Clifton Pier and Blue Hills Station that historically both would exceed these limits proximal to their property boundaries between 1994 and 2001. However, the remoteness of these facilities in general tends to mitigate this concern. In general, no noise sensitive receptors (e.g., residential developments) were close to the site boundaries.

### **6.3.6 General Housekeeping**

Improved housekeeping practices and material handling practices was the recommendation for all BEC facilities between 1994 and 2001. Effective bund management requires that even small oil spills inside the bunds be cleaned-up immediately, before they become mixed with larger volumes of rain or condensate leak water. Similarly, water inside bunds should be drained as quickly as possible so as to avoid later possible contamination by oil leaks and, hence, a greater disposal problem. Rain shelters over bunds would contribute to the production of less oil-water waste. Waste oil management was cited as the major environmental problem in the Out Island operations. Comments were made on widespread and undocumented oil discharges, inadequate bunding and absence of clean-up facilities. Drum management and storage

was also a concern, as they were generally not located on a hard impermeable surface, were not covered and were exposed to the elements and were corroded.

#### **6.4 OPINION**

Many of the existing above and below ground storage tanks in the US and Bahamas are suffering from the effects of old age and corrosion, and are leaking oil into the ground. This is particularly true for single walled steel underground tanks and pipes, as well as for unsealed bund secondary containments, which were constructed during the 1960s, similar to the one present at Station O at Clifton Pier. In response to this concern, the US EPA promulgated regulations designed to prevent leaks and spills, to find leaks and spills, to correct the problems from leaks and spills and to make owners responsible for their leaking tanks. These regulations led to significant improvements in design and operation of fuel storage tanks. In a similar manner, BEC through the introduction of the Environmental Management Plan and Policy, has attempted to and continues to cleanup its act. This has included sealing the bases and making wall repairs to the bund containment systems, improved design for dispersal of stack emissions, and attempting to address environmental awareness to its operations staff. However, in the case of Clifton Pier, significant impacts have been reported which will require ongoing assessment and corrective action to rectify. In the case of other operations, Blue Hill Station today appears to be a modern and well run facility, with many of the concerns documented in the past rectified. In the Out Islands, many of the problems stemmed as a result of lack of storage facilities for the waste oil and inadequate facilities for removal of the waste oil as a cause of the problem. To overcome these problems, tanks were installed at the Abaco Power Station and the waste oil is stored in a banded, sealed compound. A 10,000-gallon tank was also installed at Marsh Harbour for storage of waste oils. Here, waste oil was previously stored outside in 55-gallon drums, on an unbanded concrete plinth, where oil discharges occurred as a result of the barrels corroding. Removal of waste oil from the Out Islands is also better organized, whereby BEC sends a bowser on a boat to the Out Island to collect the waste oil and then returns to Nassau for disposal. Many of the Out Islands have overcome the problem of waste oil disposal by installing waste oil incinerators.

While historical discharges can be firmly placed in the design arena, for what was considered the “norm” of the time, a common theme expressed through the Mott annual reports was the lack of administrative resources in the Environmental Health & Safety Department, which was and is limited to the department head and one member of staff to “police” operational activities. In addition, many operational decisions focused on BECs primary responsibility to produce “power” which has led in some cases to the observed environmental impacts. In the US today, this operational culture has been replaced with one that acknowledges the importance of maintaining the environment, and firmly groups operational, environmental and safety performance as a condition for advancement, and if necessary, for termination. Additional improvements with respect to the environment have been to elevate the status of the Environmental Health & Safety (EH&S) Department, such that operational personnel are required to respond to the EH&S department with respect to operations which may have a deleterious environmental consequence. BEC has recognized that maintaining the environment is of primary importance to a small island, which relies on its ecology and pristine environment as the engine for its tourist driven economy, as a whole.

## **7.0 ENVIRONMENTAL MANAGEMENT SYSTEM**

The environmental management plan (EMP) will be used to ensure that the Wilson City power station is operated with minimum environmental impact. Integral to the development of the plan is the past performance of BEC, specifically at Clifton Pier, Blue Hill, and Marsh Harbour power stations. Significant lessons were derived from historical practices, which were addressed in the design phase of the project. For example, all fuel will be located and stored in a concrete and lined secondary containment (bund) area. Operational due diligence will be accomplished by paying close attention and implementing the mandates of the Environmental Management Plan (EMP).

In order to accomplish this objective, the environmental management systems described will comprise the following: Environmental Management Plan, Environmental Monitoring Plan, and Resources Implementation and Training Program. This EMP will serve as a guideline for the minimum requirements of the detailed procedure to be developed and will be updated and revised as needed throughout the construction and operation phases of the Project. The construction vendor will be responsible for preparing and implementing a detailed worker health and safety plan, a copy of which should be provided to BEC prior to construction.

### **7.1 ENVIRONMENTAL MANAGEMENT PLAN**

It should be stated that full-time monitoring will be required both during the construction phase and operations phase of the project. The EMP task will likely be administered by the Environmental Health & Safety Department, who will have the authority where necessary to “stop the job” if an environmentally detrimental activity is being conducted. The operational level of the EMP team may be third party consultants and engineers who will be resident throughout all phases of the proposed project. Implementation of the EMP will be the responsibility of the Environmental Health & Safety Manager who will be coordinating, arranging the collection and reporting of the results of all emissions, ambient air quality, noise and water quality monitoring.

### **7.1.1 Fuel Management**

Currently it has been proposed that fuel for the site will arrive at Wilson City dock and be piped to the storage tanks located within the bunded tank farm at the power plant. The design of the fuel farm will allow for the catastrophic discharge of the largest tank, which will be fully contained within the bunded area. Any minor fuel discharges or spills will also be contained. In the event of a precipitation event, impacted storm water will be collected in the bund area until released through an oil/water separator prior to discharge. Under no circumstances will untreated storm water be permitted to leave the bund area without benefit of passing through the oil/water separator. During refueling operations, an operator will be located at the Wilson City dock to ensure that the fuel lines are properly attached prior to accepting a new load from the supply ship. All fuel transfers will be conducted in accordance with the SPCC plan (Appendix F). In addition, adequate supplies of spill containment materials will be present at the dock terminus.

### **7.1.2 Management of Lubricating Oil**

The lubricating oil tanks at Wilson City Power Station are located within the lined and sealed bunded storage tank farm. As previously indicated, the design of the fuel farm will allow for the catastrophic discharge of the largest tank, which will be fully contained within the bunded area. Any minor fuel discharges or spills will also be contained. In the event of a precipitation event, impacted storm water will be collected in the bund area until released through an oil/water separator prior to discharge. Under no circumstances will untreated storm water be permitted to leave the bund area without benefit of passing through the oil/water separator. All fuel transfers will be conducted in accordance with SPCC plan

### **7.1.3 Emissions Monitoring**

During the performance tests and initial operation of the power station, the stack emissions will be monitored to ensure that the appropriate limits are being adhered to. Typically, this would be achieved by means of a monthly monitoring and reporting schedule of emission concentrations of NO<sub>x</sub>, SO<sub>2</sub> and CO using portable emission monitors. BEC may be in possession of their own portable combustion emissions

meter(s), which will need to be correctly calibrated prior to emissions monitoring using both zero gas (usually inert nitrogen) and calibration gas, containing known concentrations of the above emissions. This task may be contracted to a third party consulting firm or BEC may elect to have their operating and environmental staff conduct the emissions monitoring, which will form part of BEC's routine monitoring program already in place.

#### **7.1.4 Ambient Air Quality Monitoring**

As a result of an environmental audit of the existing power plants, one of the recommendations for Clifton Pier Power Station is that provision be made for installation of 3 to 5 new, suitably positioned ambient air quality monitoring stations with fully automatic data loggers. This provision should also be made for the new Wilson City Station, thus allowing for continuous measurement of ambient air quality conditions. The cost of each monitoring station will depend on the make, model and type of technology employed, and parameters analyzed which should include measurement of ambient SO<sub>2</sub>, NO<sub>x</sub>, NO and NO<sub>2</sub> concentrations and PM<sub>10</sub> particulate matter.

#### **7.1.5 Water Management**

Cooling water extracted via boreholes is readily available at the site. This cooling water will then be discharged to the brine zone beneath the Marsh Harbour-Lake City Aquifer using a new effluent discharge injection well. Additional training is recommended to educate facility operators of the sensitivity of the underlying aquifer and the importance the protection of this resource is to the people of Abaco. Under no circumstances should untreated contaminated wastewater be permitted to be discharged via the injection well.

Site management will ensure that the potential for oily water discharge via site drainage is minimized by ensuring that the necessary procedures are in place to provide adequate maintenance of oil/water interception units into which all plant discharges are conveyed and installing additional oil/water separators where necessary. Oil/water sloping-plate interceptors have already been included in the project scope to serve the requirements of the proposed new power plant and oil tanks. Based upon experience at Clifton Pier, the

largest capacity systems as are practical should be installed, in order to provide sufficient capacity for the interception of oily condensate from the oil tank heating coils and rainwater drainage streams leading from the bunds surrounding oil and storage tanks.

Good management practices also require the correct labeling of drains, operator training and monitoring of effluent. Oil leakage from the oil tanks themselves will be transferred to the waste oil tanks. However, surface water run-off will be collected by the site drainage system and passed through the oil/water separator prior to discharge to the sewer.

In order to minimize contamination of surface run-off water during the rainy season, where possible, all water collected on the building roofs will be piped to the rain water drains which will themselves be connected to an open drainage channel. The surface of the surrounding plot will be inclined outwards from the building to lead the rainwater away. Drainage ditches will be installed around the periphery of the site in order to collect storm water run-off from the surrounding area and channel it away from the site, thus avoiding any contamination by on site activities.

#### **7.1.6 Maintenance**

The plant will be maintained to ensure that releases to the environment are minimized. Records will be kept to show what maintenance has been carried out. This would apply to a range of areas including combustion optimization, fuel handling and monitoring equipment.

As a result of the historical environmental investigation at BEC facilities, a number of situations were identified from which the corrective action required improvement in the handling of fuels and chemical storage practices, in accordance with the existing EMP. Improvement and use of Best Management Practices will maintain BEC facilities as an environmentally friendly operation.

### **7.1.7 Contaminated Land**

Poor materials handling practices at Clifton Pier, Blue Hills and Marsh Harbour has required the apparent need for extensive ground clean-up and plant up-grading, in order to remedy historical oil pollution problems. The cost of site remediation and mitigation can be avoided by using Best Management Practices when handling fuels and chemicals at the new facility. In the event of a discharge, cleanup activities must be implemented immediately in accordance with the SPCC Plan. Protection of the underlying aquifer is of paramount importance and under no circumstance should the fuel discharge be directed to the storm water conveyance system or the injection well. Additional awareness training for the operators is required to ensure protection of the environment. Tasks required to evaluate a sizable discharge (>25 gallons) takes the form of a soil characterization study, to analyze both surface and subsurface soil samples for petroleum constituents and a range of chemicals, including heavy metals. A number of soil samples are required as well as additional chemical analysis of both soil and groundwater samples, to complete the assessment.

## **7.2 ENVIRONMENTAL MONITORING PLAN**

A monitoring plan and management procedures have been developed for implementation during construction and operation of the Wilson City Power Station to ensure that updated records of environmental parameters are maintained during the construction and operation of the power station.

### **7.2.1 Parameters to be Monitored**

Monitoring of certain parameters during both the construction and operational phases of the power station is essential to ensure that impacts are fully evaluated and that necessary mitigation measures are applied. This is necessary to demonstrate compliance with any current and future standards. Monitoring will apply to the following:

- Atmospheric emissions
- Ambient air quality
- Noise
- Water Quality & Discharges
- Socio-economic Monitoring
- Public Complaints Procedures

- Ecological Monitoring

#### **7.2.1.1 Atmospheric Emissions**

Guaranteed emission levels for the plant at full load capacity have been used to predict the expected atmospheric emissions from the power station, once it is operating, based on the temperature and excess oxygen concentrations prevalent within the combustion chamber. Emissions monitoring will form part of the plant operation procedure. During operation, the emissions from each of the flues or chimneys will be monitored on a regular basis using fully automated gas analysis equipment.

Flue gases will be analyzed for NO<sub>x</sub>, SO<sub>2</sub> and particulates, along with water and oxygen. The data will be recorded over a 24 hourly period and reported on a monthly basis and 24 hourly concentrations as well as calculated tonnage releases of NO<sub>x</sub>, SO<sub>2</sub> and particulates for the month and year to date. Monthly monitoring of combustion emissions will be conducted for the lifetime of the plant.

#### **7.2.1.2 Ambient Air Quality**

The expected level of contribution by the power station to atmospheric pollution in areas within and around the power station site, at ground level concentrations, is currently unknown, but is anticipated to be similar to that existing at the Clifton Pier and Blue Hills Stations.

Following commissioning of the power station, air pollution monitoring will be carried out to measure NO<sub>2</sub> and SO<sub>2</sub> at sites in the surrounding area to ensure that the ambient air quality guidelines are being met. This will typically include at least three monitoring stations proximal to the station, and an additional monitoring station located within the station property boundary.

Ambient air quality monitoring will be conducted on a continuous basis for a two year period. This long term monitoring should be supplemented with seasonal (3 or 4 times a

year) monitoring at each site to provide an indication of 1-hour and 24-hour average concentrations of NO<sub>2</sub> and SO<sub>2</sub>.

### **7.2.1.3 Noise**

A noise survey both within operational areas and at the site boundary should be undertaken at regular intervals during the construction and operation phases and not less than once every 12 months. Additional monitoring may be required at various times in response to public complaints (if any), in order to verify that noise emission limits are being met.

In the initial stages of power plant operation, immediately following commissioning of the power station, noise monitoring will be undertaken both within the site, at the site boundaries and at selected receptor locations up to a distance of approximately 0.5 miles from the proposed site. These monitoring results will be compared with the baseline noise levels monitored at the same positions prior to the commencement of plant construction activities.

The monitoring will therefore verify whether the plant is operating to the levels specified. The monitoring results will also act as a valuable database of baseline noise levels achieved during normal operation of the plant, for different meteorological and station conditions. This baseline will help determine the need for any subsequent design changes or for mitigation of noise levels in the power station area.

### **7.2.1.4 Water Quality and Discharge**

The volume of wastewater discharge from the power station will comprise of storm water and cooling water and other occasional releases, which will be passed to a neutralizing tank for treatment, from where its analysis will be monitored prior to discharge.

Periodically, on a monthly basis, the effluent discharge from the neutralizing tank will be analyzed to ensure that it complies with DEH discharge limits. Groundwater samples and surface water samples will be collected for routine analysis on an annual basis.

Additional monitoring will also be conducted immediately following an incident such as a discharge, in order to provide assurance that there has been no contamination of the groundwater by accidental spillages or leakages or as a result of surface water run-off from the site. Permanent and properly constructed monitoring wells may be installed and strategically located around the property to evaluate the water quality of the Marsh Harbour-Lake City Aquifer, and to confirm no deterioration of the water quality is occurring as a result of the operation of the power plant.

#### **7.2.1.5 Socio-Economic Monitoring**

In order to monitor the socio-economic impacts of the proposed power station on the communities (Spring City) surrounding the site, BEC will task an environmental engineer or consultant to conduct routine socio-economic surveys at selected locations throughout construction and during its operation of the power plant. The socio-economic survey will involve keeping and up-dating information on demographic and unemployment figures within the area and will include a number of different pointers, such the cost of electricity tariffs, food and fuel, in addition to the cost of board and lodgings, rented accommodations, etc.

The socio-economic survey will include a program of public consultation exercises and will be conducted on a quarterly (3-monthly) or six-monthly basis. It is intended that public consultation will be continued in these same communities on a regular basis throughout construction and operation of the proposed power station. Other communities such as Marsh Harbour, based upon its importance and proximity to the site, may also be selected for the survey.

During construction, because of the possible impact resulting from the ingress of a large number of construction workers to the Wilson City site and the need for temporary accommodation within the surrounding communities, monitoring will be conducted on a quarterly basis. Employment records at the power station will be scrutinized to ensure that members of the local community with the necessary skills are employed preferentially wherever possible, and the public consultation exercises may also present

an opportunity to determine the numbers and skills of the local community who are available for employment.

Public consultation will also serve to identify any possible complaints which the local populace may have regarding the construction and operation of the power station and BEC will provide an opportunity to inform the residents about how the project is progressing and to warn them of any foreseen disturbances which might otherwise cause concern.

During the initial years of operation, socio-economic quarterly monitoring is again proposed in addition to quarterly public consultation at the selected monitoring locations. Some additional monitoring locations may be added here to take account of perceived impacts on air quality resulting from dispersion of the power station stack gases. Should the adverse impacts of the power station following implementation of the mitigation measures be perceived to be insignificant, as predicted by this EIA, and should public complaints attributed to the power station be few, then after a period of 1-2 years of operation, the required monitoring will be conducted on a semi-annual or possibly annual basis, depending on the requirements of the designated regulatory authority.

#### **7.2.1.6 Public Complaints Procedure**

The environmental engineer will be responsible for obtaining, reporting and maintaining all environmental data records and for correct implementation of the public complaints and emergency procedures.

All public complaints will be logged on a complaints register to include the name and address of the complainant, the time and date that the complaint is registered and the details of the complaint. Each complainant will then be contacted by the BEC project representative or other nominated representative, either by means of a personal visit or telephone, in order to discuss the details of the complaint, and establish how the complaint can be rectified in the interests of all concerned.

#### **7.2.1.7 Ecological Monitoring**

Flora and fauna inventories within the power station area will be monitored on a twice yearly basis, as well as before and during the construction and early operating activities. This may involve the use of specific indicators, such as the occurrence of nests or nesting bird species of importance, e.g., Bahama Parrot. If such a siting is confirmed, a determination will be made as to the next most appropriate response action, which may include, if necessary, a cessation of construction activities. BEC will task an environmental engineer or consultant/ecologist who will be responsible for coordinating the flora and the fauna monitoring program, with emphasis on the undisturbed pine forest immediately abutting and adjacent to the proposed site. It is intended that the implementation of the monitoring program will be conducted on a co-operative basis by the various stakeholders in the area, including Friends of the Environment. The flora and the fauna monitoring may also be contracted out to a third party.

During the construction phase, the project engineer will be responsible for overseeing land clearing activities and will be involved in the scheduling of these activities in order to prevent them from being undertaken during periods of heavy rainfall whenever possible. However, in the event the scheduling of the activities must be undertaken during periods of heavy rainfall measures will be employed to reduce the risks of erosion.

#### **7.2.1.8 Reporting Procedures**

Implementation of the Environmental Monitoring Plan will be the responsibility of the Environmental Health & Safety Manager who will be responsible for arranging and reporting the results of all emissions, ambient air quality, noise and water quality monitoring. The Environmental Health & Safety Manager will also be responsible for obtaining, reporting and maintaining all environmental data records and for implementing corrective actions with regards to both the environment and implementation of responding to public concerns or complaints.

The laboratory technician (or local laboratory) will be responsible for conducting all in-house analysis and for reporting all in-house analytical results directly to the

Environmental Health & Safety Manager, who will in turn be responsible for compilation of all monitored results and for informing the authorities of any possible non-conformity.

There will also be a senior manager nominated with responsibility for environmental matters who can ensure that decisions are made to rectify any problems, for example, modifying plant operations when there is an exceedance of emissions standards or simply when equipment needs repair or replacement.

As previously indicated, there may be occasions where third party consultants are required for specialist monitoring or training. This may arise, for example, if there was a complex noise issue requiring detailed frequency analysis or if training was required in specific areas, such as emission control. The Environmental Health & Safety Manager will be responsible for coordinating any monitoring conducted by a third party. In either case, all monitoring results obtained by outside monitoring bodies will be reported directly to the Environmental Health & Safety Manager.

### **7.3 RESOURCES, IMPLEMENTATION AND TRAINING**

#### **7.3.1 Resources**

The power station operational workforce will include the designated environmental engineer and a senior manager with executive responsibility for environmental matters at Wilson City Power Station, and who may report to Environmental Health & Safety Manager. This officer will be suitably trained and be responsible for the following:

- Ensuring that environmental protection procedures are followed;
- Coordinating environmental monitoring;
- Acting as a contact person for liaison with the public, local organizations and Government;
- Ensuring that data on all environmental aspects of plant operation is continuously updated, and available in a form suitable for immediate inspection by authorized personnel;
- Monitoring hazardous substances on-site to ensure that the possibility of accidental release is minimized;
- Promoting on-site environmental awareness, and;
- Liaison with other local industry.

### **7.3.2 Implementation**

It will be the responsibility of the Environmental Engineer to implement the site Environmental Monitoring Plan and also the Environmental Management Plan and to encourage general site environmental awareness. Where necessary, the senior manager responsible for environmental matters may be required to instigate change to ensure that the environmental standards outlined in this EIA, and any future Bahamas Legislation, are adhered to.

The Environmental Monitoring Plan may also require the employment of a laboratory technician or local laboratory to analyze samples and report these to the Environmental Engineer. The report of the chemical analyses should clearly reference a standard by which water quality can be compared.

Although the ambient air quality monitoring may be performed by an outside contractor, BEC may decide to install their own ambient air quality monitoring equipment including a meteorological station. In this instance, the laboratory technician will also be responsible for maintaining and calibrating the equipment necessary for monitoring.

### **7.3.3 Training**

The designated environmental engineer will be charged with an ongoing program of environmental training. This will include:

- General promotion of environmental awareness;
- Specific training for staff working in sensitive areas;
- Updating staff on changes to environmental standards; and
- Reporting to staff on the station's environmental performance.

## **8.0 ENVIRONMENTAL ACCEPTABILITY OF THE PROJECT**

Review of the compliance of the proposed project and a comparison of unavoidable negative environmental impacts will be discussed in this section. This section will also address the concerns of Friends of the Environment (FRIENDS), an important NGO in Abaco. Considerations for this review include the following:

- BEC, as required through its mandate, has determined the need for additional power generating capacity for the Abacos, to support its continued economic growth and to serve the needs of all its consumers. In fact, it has been determined that without additional capacity, peak load electrical demand may not be satisfied in the near future without the possible use of “load shedding.” Obviously, power blackouts will have a significant negative impact to the Abacos economy and welfare of the residents.
- The selection of the proposed site was made after having reviewed all other options and alternatives, which included engineering, civil and environmental considerations. In addition to meeting the initial criteria, the remote location of the site reduces the aesthetic impact of a large structural facility, as well as reducing and/or eliminating the potential concerns from adverse noise, air quality and odor concerns for nearby sensitive receptors. The benefit of the remote location is that the closest potentially sensitive receptor is Spring City, which is located more than seven (7) miles from the site.
- While some disturbance should be anticipated, during both the construction phase, as well as the operational phase of the project, it is BEC’s contention that this disturbance is kept at a minimum by implementing BMP’s. Therefore, as a result of its remote location, no societal impacts are anticipated.
- During the operational phase of the project, with careful adherence to environmental monitoring programs, as well as implementation of environmental management plans, impacts (if any) will be kept to a minimum, and will not be allowed to detrimentally impact the ecosystem.
- The proposed power plant is located approximately 1.5 miles from the Wilson City ruins located at Pelican Point. While Wilson City is considered a cultural artifact, little if any efforts have been made to preserve the site. However, with the proposed improvements to Wilson City road, including the extension to Wilson City dock, a collateral benefit of the plant will be to provide access to the ruins, for preservation purposes.

- It should also be noted that the needs of the island residents of Abaco outweigh the potential minor impacts to the ecosystem in the vicinity of Wilson City. Every attempt will be made by the project to ensure that the “asset” that is the Abacos (e.g., “pristine beaches, clear water and abundant marine life”) remains so.
- BEC is acutely aware that the economic development of the island is dependent upon a “cottage tourist industry,” which is driven by the natural resources of the island. As such, environmental protection is an integral part of the design of the proposed power plant. It is anticipated that the construction and operation of the power plant will not significantly impact the environment and is in keeping with the need to find a balance between economic development and maintenance of the natural environment. Finding that balance to ensure the needs of Abaco are satisfied and safeguarding the environment is the objective goal of BEC.

## **8.1 FRIENDS OF THE ENVIRONMENT**

As previously indicated, FRIENDS is an NGO whose mandate is the protection of the Abaco environment. The FRIENDS mission statement.... “is dedicated to the preservation and protection of Abaco’s terrestrial and marine environments in order to achieve sustainable living for the wildlife and the people of Abaco.” During the site selection process for a new power plant on Abaco, Snake Cay was considered a candidate site. FRIENDS expressed their concerns regarding this site, in a letter dated March 27, 2007 to the Right Honorable Perry Christie. However, absent a similar letter for the subject site, many of the concerns articulated by FRIENDS for Snake Cay are in fact applicable to Wilson City. As a result, using Snake Cay as a model, each point of concern was evaluated with respect to Wilson City and is discussed as follows:

- 1. The areas immediately adjacent to and north of, the Wilson City dock site are important mangroves wetland, a sensitive nursery for fish, crawfish and other marine life. Nearly 80% of commercial marine life in the Bahamas grows up in the mangroves.*

BEC acknowledges its responsibility as a steward of the ecological well being of the Abacos. In this regard, little or no impacts are anticipated with respect to marine life in the vicinity of the Wilson City dock through the construction phase of the project. During the operations phase, potential impacts are mitigated through the use of state of the art fueling hoses, employed during fuel transfer. This system has been used throughout the world and is a proven design with little or no potential for significant fuel loss. The Bahamas Maritime Authority also requires, for specific tasks such as a

liquid transfer, a responsible officer to be present ensuring correct valve operation prior to transfer. In addition, no impacts are anticipated as a consequence of the operations of the main power plant facility, based upon its distance (2 miles) from the coast.

2. *The potential for contamination of marine life, and wetland greatly increases with the introduction of an industrial operation. Even the smallest spill would be carried into the fragile mangrove ecosystem causing damage for decades.*

The location of the main power plant facility, the main “industrial operation,” as indicated is more than two miles from the coast, and as such no impacts are anticipated from the operations of the main facility. During the installation phase of the fuel transfer pipeline, sediment curtains, buoys, and bales will be used to reduce or eliminate the potential for sediments to enter Spencer’s Bight mangrove areas and the Sea of Abaco. The pipeline will be installed on the newly constructed Wilson City extension and dock road, but almost within the footprint of the road, and as such trenching activities to five feet below grade should not cause any undue concern.

In addition, during the operational phase of the facility, BEC will implement an appropriate Spill Prevention, Control and Countermeasures (SPCC) plan utilizing equipment such as containment booms and absorbent pads which would enable operators to quickly and effectively address any minor spills which may occur. A BEC operator is required to be on hand during all transfer operations, which will also ensure the effectiveness of corrective actions (if required).

In the event of a major spill, such as the 2,000-gallon fuel spill from the MV Legacy at Marsh Harbour in 2005, The Ministry of Transport and Aviation has overall responsibility for oil pollution response in the waters of the Bahamas under the National Oil Spill Contingency Plan of 1998 (NOSC 98). Upon notification of a spill, The Port Authority of Nassau, the international airport at Nassau, and the Bahamas Defense Force, which all maintain 24-hr service, would immediately contact the Permanent Secretary of the Ministry of Transport and Aviation. The NOSC 98 provides the framework for coordination of an integrated response through the development of local plans in the ports, and the establishment of regional and international response linkages. In addition, in acknowledging the implication of small oil impacts to the ecosystem, the Ministry of Transport and Aviation can also provide assistance through the provision of additional equipment for addressing smaller spills described as Tier I (10 barrels of oil) and Tier II (50 barrels of oil). BEC can also employ the services of specialized spill response subcontractors, such as BayChem Spill Technologies in Nassau, to provide additional cleanup services.

3. *The areas proximal to Wilson City and Pelican Cay Land and Sea Park (PCLSP) are important fishing grounds for locals, used for both scale fishing and crawfishing.*

BEC acknowledges the importance of the ecology of the Sea of Abaco and Pelican Cay Land and Sea Park, and their intrinsic value to the citizens of Abaco and as a tourist destination, which helps sustain the Abaco economy. However, just as important, is the need to provide adequate and reliable power to tourists, without which, the tourist industry would relocate, simply through lack of power. The presence of the power plant in of itself located at Wilson City will not directly impact tourists or the “cruising” community.

4. *As a fuel depot, it will require major shipping traffic from the ocean to Wilson City. Currently the only obvious route is directly through the PSCLP. An increase in large vessels traffic could mean possible groundings and damage to the sea bottoms in the shallow Sea of Abaco, wake from the ships disturbing visitors to the national park and causing potential safety hazards. The channel connecting this route to the ocean is also frequented by commercial and sports fishing vessels.*

It is anticipated that any commercial ships that work in the Sea of Abaco will be of shallow draft type, to account for the shallow Sea of Abaco, and as such would not physically impact the sea bottoms. These ships will be typical of the ships that currently provide services to the Cays and settlements of the Abacos, such as the M/V Legacy, as well as those operated by Abaco shipping and other ferry, freighters and mail ships. The reality of the Commonwealth of the Bahamas is that it is primarily a water-based society, whose infrastructure is maintained by shipping commerce.

The preferred route for commercial traffic servicing Wilson City would follow established commercial shipping routes located outside of the barrier islands (Figure 8-1), and would enter the Sea of Abaco at Little Harbour from the south. It is anticipated the BEC would required some assurances that the freighters servicing Wilson City, would in fact use this route and elect not to enter the Sea of Abaco via North Bar Channel, which would require traversing the PSCLP. The contracted commercial shipping provider should confirm this shipping route, at the appropriate time.

Furthermore, all ships that work in Bahamas near Coastal Waters or Bahamans Territorial Waters must be in compliance with the rules and regulations of accepted international conventions, such as the International Convention for the Prevention of Pollution from Ships (MARPOL). In addition, the Bahamas Maritime Authority requires, if international convention are not applicable based upon ships size, compliance with the Code of Safety for Caribbean Cargo Ships, and the Code of Safety for Small Commercial Vessels trading in the Caribbean. Both of these guidelines provide a regional safety standard for small ships engaged in commerce the Caribbean region. The Bahamas Maritime Authority also requires proof of

competency for shipmasters, integral for the safety and operation of the ship, and for preventing collisions at sea.

5. *The Pelican Cays Land & Sea Park, is a major tourist attraction in Abaco, and supports the economy directly through boat rentals, tour operators and dive companies.*

Based upon the location of the power plant, no impacts are anticipated with respect to the operation of the main facility at Wilson City. BEC is cognizant of the importance of constructing and operating the facility in an environmentally responsible manner. The dictates of the Bahamas Maritime Authority and Bahamas National Requirements govern the activities of commercial ships in Bahamian waters, including the dictates of international conventions. The frequency of commercial boats supporting the facility should not exceed those currently providing other services to the Cays, and as such little or no impacts to boat operators, boat rentals, or dive companies are anticipated, based upon the anticipated frequency of dock use. In addition, as previously indicated commercial freighters would be required to access the Sea of Abaco from the south and not traverse PCLSP.

By extrapolating the FRIENDS concerns for Snake Cay, a number of important considerations were evaluated with respect to Wilson City, the most significant of which is commercial access to the Wilson City dock through the Pelican Cays National Park. However, finding the balance between the power generation needs of the Abacos, and the need to be ecologically and environmentally responsible are not mutually exclusive, and are clearly acknowledged by BEC. As a result, the importance for reliable and inexpensive electricity, which provides the basis for Abacos continued and improving standard of living for all of its citizens, should not be minimized on the basis of the “no development” alternative.

## **8.2 COMPLIANCE OF THE PROPOSED PROJECT WITH APPLICABLE ENVIRONMENTAL STANDARDS**

It is the intention of the project through both construction and operations phases to be in compliance with the environmental laws and regulations of the Bahamas, as described in Section 2.0 of this report. In addition, in the event a specific statute is not referenced, where as practical as possible, World Bank and/or United States Environmental Protection Agency guidelines will be used.

### **8.3 COMPARISON OF UNAVOIDABLE NEGATIVE IMPACTS TO PROJECT BENEFITS**

As previously indicated, BEC, as required through its mandate, has determined the need for additional power generating capacity for the Abacos to support its continued economic growth and to serve the needs of all its consumers. The impact of the construction and operation of the facility is of concern, with respect to continued maintenance of biodiversity of the island and the need to operate and build a facility in an environmentally and ecologically beneficial manner without causing irreparable harm to the ecosystem. It is important to note that the selection of the project site was settled upon when:

- The space for the proposed plant and for future expansions was not available at the existing Marsh Harbour site due to societal conflicts;
- Potential sites such as Snake Cay were eliminated due to land use and potential environmental sensitivity issues; and,
- BEC received tacit approval from BEST on the viability of the subject site as part of the pre-selection process following the elimination of the Snake Cay site.

The following is a summary of unavoidable negative impacts and project benefits. Table 8.1 provides a summary of impacts determinations.

#### **8.3.1 Land Use**

The unavoidable loss of 25-acres of upland pine forest and more with future expansions is more than compensated for by the minimization of potential impacts to vicinity receptors. In addition, the construction of the pipeline mitigates potential traffic accidents associated with what would necessarily be high frequency and expensive overland fuel transfer from the government dock at Marsh Harbour.

#### **8.3.2 Geology**

Site clearing and excavation for the engine foundations is required for project development. Alteration of the natural landscape is mitigated by the benefit of the construction of the power plant for the citizens of Abaco.

### **8.3.3 Water Quality**

The project site is located near, but outside of the limits of the Lake City-Marsh Harbour Aquifer, as indicated by the USCOE. This aquifer is particularly important as it provides drinking water to the citizens of Spring City, Marsh Harbour and satellite settlements. However, based upon the power plant location, the potential for direct impact to aquifer water quality is considered to be low. Nonetheless, careful monitoring and due diligences to plant operating procedures is required to ensure that this remains the case. In this regard, full-time onsite monitoring by the BEC Environmental Safety and Health Department or their designated representative is recommended.

Water withdrawals for cooling purposes will be derived from zones adjacent to the aquifer, and used water will be returned via injections well. Use of boreholes for wastewater disposal is widely used in the islands and is considered to be the most cost effective method of wastewater disposal in the power generating industry, since the receiving water quality (seawater) generally has the same composition of the injected wastewater, with only minor quantities of chemicals added as corrosion inhibitors. The use of the disposal wells, if properly used for their intended purpose, is not anticipated to degrade water quality to the proximal Lake City–Marsh Harbour Aquifer.

Alteration of surface water runoff regimes is anticipated from direct infiltration to sheet flow, with the addition of entrained contaminants. All storm water will be directed to onsite drains and will pass thorough oil/water separators, prior to discharge. This will further reduce the potential for adverse water quality impacts.

During pipeline construction increases in sedimentation and siltation may occur. This concern will be mitigated by use of BMPs (Appendix G). The benefit of piped fuel to service the plant, as opposed to trucking the fuel from the government port at Marsh Harbour, is infinitely more desirable, efficient, economical and practical a transportation solution.

### **8.3.4 Biological Resources**

Loss of 25-acres of pine forest habitat is an unavoidable consequence of the proposed project. Potential impacts to flora and fauna will be limited to site development activities. No protected wildlife was observed, although the Bahama Parrot is commonly found in the pinewoods of Abaco. In the event nesting birds are encountered proximal to the site, work would be instructed to stop, otherwise any encountered birds, since they are mobile, would likely relocate to undisturbed areas of the forest. Caribbean pine removal will be conducted only with permit approval.

While no direct impacts are anticipated to protected parks, such as Abaco National Park to the south or Black Sound Cay to the north of the project, concerns for the ecology of Pelican Cays Land and Sea Park (PSLSP) has been raised. This concern centers on commercial ships entering the Sea of Abaco, via North Bar Channel, which transects PSLSP and the ecological disaster that would ensue following a fuel discharge. All ships that work in Bahamas near Coastal Waters or Bahamans Territorial Waters must be in compliance with the rules and regulations of accepted international conventions, such as the International Convention for the Prevention of Pollution from Ships (MARPOL). In addition, the Bahamas Maritime Authority requires, if international convention are not applicable based upon ships size, compliance with the Code of Safety for Caribbean Cargo Ships, and the Code of Safety for Small Commercial Vessels trading in the Caribbean. It is anticipated that BEC will require commercial freight carriers use Little Harbour as the primary route to Wilson City dock, and thus not transect PSLSP. The final disposition of shipping route will be addressed at the appropriate time with the contracted commercial shipping vender.

### **8.3.5 Air Quality**

Fugitive emissions are anticipated during construction. These are anticipated to be localized and of short duration. Indirect impacts from parked cars and use of the parking facilities should be no greater than currently experienced at Marsh Harbour, from which the operations personnel will be relocated. Non-point source emission from vehicles in

general is a systemic problem for all countries where combustion from cars emits the so-called “green house gasses” and is not an item to be address in this EIA.

The pollutants of potential concern during the operation of the plant are sulfur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), and carbon dioxide (CO<sub>2</sub>). Smoke and carbon monoxide (CO) are not a concern for new and state of the art diesel engines, in which improvements in technology and combustion efficiencies have addressed these pollutants. The remote location of the site, effective atmospheric dispersal and the distance of the closest sensitive receptor mitigate any potential adverse emissions. Any potential impacts during construction or operation are mitigated by the remote location of the site and the distance from the closest potentially sensitive receptor. However, air quality monitoring has been recommended subsequent to the completion of the plant.

#### **8.3.6 Aesthetics**

The construction of the large facility, in an area of pine forest, may be considered to be inappropriate use of the land. However, the “no-development” alternative has a potentially more significant impact on the economy of the Abacos, and the tourism sector in particular. As a result, the benefit of the station far outweighs the loss of 25-acres of pine forest. In addition, from an aesthetic point of view, its location and the adjacent pine forest mitigate the presence of the facility.

The facility will operate 24 hours per day, 7 days per week. Adequate lighting is required to ensure the health and safety of the operators. The light is not however to be of a magnitude that will create a glare, although elevated locations, such as the exhaust stack may be fitted with safety lights. The facility may be visible from the Sea of Abaco.

The combustion of heavy fuel oil will result in a potentially objectionable odor. However, the closest sensitive receptor is more that seven (7) miles from the site and no impacts are anticipated at Spring City. Based upon the remoteness of the site, any potential noise exceedances beyond the site’s property line are mitigated by the distance of the closest sensitive receptor.

## **9.0 PUBLIC CONSULTATION**

BEC will be informing the local community of proposed project activities. The information dissemination will likely be conducted through such activities that include notices of town meetings, and discussions with community leaders, politicians, government officials, interest groups and other interested parties. BEC will be documenting the results of all public consultation activities and addressing and responding to identified issues and concerns.

As previously indicated during the building permit application and EIA review process, at the Town Planning Committee meeting, should the Committee deem it necessary and if there is strong public objection to the project, representatives or members of the general public may be invited to voice their views or objections.

Due notice is also taken of any comments made by NGO's, such as Friends of the Environment, and government agencies such as the Ministry of Tourism, Water & Sewerage Corporation and Bahamas National Trust, together with any potential impacts that they might identify as giving cause for concern.

## 10.0 REFERENCES

- ANP, 2006, General Management Plan (4<sup>th</sup> draft) Abaco National Park, October 31st 2006
- Ball M.M. 1967. Carbonate Sand Bodies of Florida and the Bahamas, *Journal of Sedimentary Petrology*.
- Bahamas Environment, Science and Technology Commission 2003. Bahamas Environmental Handbook, BEST Commission, Ministry of Agriculture and Fisheries, Nassau, Bahamas
- Beneby, B. 2003. Personal Communication, Manager, BEC Marsh Harbour, Abaco, Bahamas.
- Bethel, Dr. M. 2006. Statement to United Nations Fourteenth Session of the Commission on Sustainable Development, New York.
- Dodge, S. 2005 Abaco: The History of an Out Island and Its Cay, Third Edition, Published by White Sound Press, New Smyrna Beach, Florida
- Dodge, S. 2003. The Cruising Guide to Abaco, Bahamas, White Sound Press, New Smyrna Beach, Florida
- Dunham, R.J 1960. Classification of Carbonate Rocks according to Depositional Texture, US Geological Survey Presentation.
- Dupuch, S.P. (Ed) 2006. Bahamas Handbook and Business Annual, Etienne Dupuch, Jr Publications, Nassau, Bahamas.
- Erdman, J.S. et al, 1996. Hydrogeology of the Cockburn Town Aquifer, San Salvador Island, Bahamas, Professional Paper, Eighth Symposium on the Geology of the Bahamas.
- Findlay, K. et al, 2003. Clifton Pier Power Station, Environmental Management Audit, Matt McDonald, United Kingdom.
- Ginsburgh, R.N, et al 1964. Distribution of Reef Building Communities in Florida and the Bahamas. *American Association of Petroleum Geologists Bulletin*, Vol 48.
- Ingram, H, 2008 Speech to the Abaco Chamber of Commerce, regarding Abaco Development, and confirming Snake Cay was not suited to BECs use.
- Lynts, G.W. 1970. Conceptual Model of the Bahamian Platform for the Last 135 Million Years, *Nature* Vol 25.

- McCartney, K. 2007. Personal Communication, Project Officer, BEC Engineering Department, Nassau, Bahamas.
- National Oceanic and Atmospheric Administration (NOAA), world wide database for tides and tidal regimes, Washington DC.
- Newell, et al, 1959. Organisms, Communities, and Bottom Facies, Bahama Bank. Bulletin American Museum of Natural History.
- Noseworthy, R. 2007. Electronic Communications, Project Manager, Snake Cay Power Generation Project, MAN B&W
- Purdy, E. G. 1974. Reef configurations: Cause and Affect. Reefs in Time and Space. Special Publication, Society of Economic Paleontologists and Mineralogists.
- Reading, H.G, 1979. Sedimentary Environments and Facies, Blackwell Scientific Publications.
- Roberts, B. 2005. Remarks Managing the Challenges of Growth, Abaco Business Outlook, Marsh Harbour, Bahamas.
- Shaklee, R.V. 1996. Weather and Climate San Salvador Island, Bahamas, The Bahamian Field Station Limited, San Salvador, Bahamas.
- Smith, R.R. 1985. Major Plant Communities in the Bahamas, Professional Paper, First Symposium on the Botany of the Bahamas.
- Tarbox, D, 1986. Occurrence and Development of Water Resources in the Bahamas, Professional Paper, Third Symposium on the Geology of the Bahamas.
- USACOE 2004, Water Resources of the Bahamas, Mobile District & Topographic Engineering Center, US Army Corps of Engineers.
- Wells-Moultrie S. 2006 The evolution of Environmental Management in the Bahamas 1994- 2005, Conference Paper.
- Williamson B. 2008, Personal and Electronic Communications, EIA Project Manager, BEC Environmental, Safety and Health Department, Nassau, Bahamas, williamsonbe@bahamaselectricity.com