ENVIRONMENTAL IMPACT ASSESSMENT
CARIBBEAN CEMENT COMPANY
EXPANSION AND MODERNISATION PROGRAMME

Submitted to:
CARIBBEAN CEMENT COMPANY LIMITED
Rock Fort
St. Andrew
Jamaica

Prepared by:
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EXECUTIVE SUMMARY

The Project

Caribbean Cement Company (Carib Cement) proposes to expand and modernize the plant at Rockfort, Kingston. The proposed programme is phased over a five-year period, with the largest component being the clinker production process expansion. This project will involve the installation of a new dry clinker production line to be constructed over three years. Upon completion, this new clinker production line will replace the existing wet clinker line. The proposed expansion will take place within the footprint of the existing plant.

Carib Cement is the sole manufacturer of cement in Jamaica and was the sole supplier until as recently as 1999. The size of the cement market has grown substantially over the last 10 years: demand has increased by 52% or 5.1% per annum. The domestic market is conservatively forecast to grow by approximately 4% per annum from 862,289 tonnes in 2004 to 1,291,167 tonnes in 2010. Carib Cement presently holds the dominant share of the domestic market and is developing and implementing strategies to meet this increasing demand and to provide even better service to the construction industry. The proposed new production line will have a rated capacity of 1.3 million tonnes per year up from the current 650 thousand tonnes per year produced by the existing plant.

The modernization and expansion of the existing plant is necessary in order to meet the growing demand for cement in Jamaica as well as the need to reduce fuel consumption, improve production efficiencies and environmental performance.

Environmental Impact Assessment

In order to determine the environmental variables influencing the project, Carib Cement retained the firm Environmental Solutions Limited to conduct an Environmental Impact Assessment (EIA) of the proposed expansion works at the plant in Rockfort Kingston. As an integral part of the EIA the current system of manufacturing cement was evaluated. Carib Cement also retained Scheiber, Yonley and Associates, Environmental Consultants, out of Missouri, U.S.A., who are specialists in the field of air dispersion modelling for Cement Plants.

Cement Manufacturing Process

The production of cement includes mining; crushing and grinding of raw materials (principally limestone and clay); calcining the materials in a rotary kiln; cooling the resulting clinker; mixing the clinker with gypsum; and milling, storing and bagging the finished cement. The process results in a variety of wastes, including dust, which are captured and recycled to the process. The process is very energy-intensive and there are strong incentives for energy conservation.

Carib Cement operates a dual process cement manufacturing plant, utilising both the wet and dry process technologies. The dry process, using preheaters and precalciners, is both economically and environmentally preferable to the wet process because the energy consumption (3,200 kilo joules per kilogram (kg)) is approximately half of that for the wet process.

Wet Process

The critical manufacturing step, called "pyroprocessing," takes place in the cement kiln. The prepared raw feed is pumped into the kiln where it is exposed to gas temperatures starting at 260°C at the elevated feed end to over 1,870°C near the product discharge end. After tumbling slowly through the kiln, exothermic chemical changes in the burning zone transform the raw materials to cement clinker, a product physically resembling grey gravel.

The production of clinker in a wet kiln requires that the solid material be heated to approximately 1,400°C to 1,482°C, while the gaseous material reaches a temperature of greater than 1,870°C. Tricalcium silicate is the major strength-producing constituent of cement, and its formation begins in the burning zone at material temperatures above 1,400°C. Other clinker compounds important for the performance of Portland cement are formed by reactions that take place in the burning zone.

Exhaust gases from the kiln are routed to the air pollution control system and then discharged to the atmosphere through a stack.

Dry Process

The (kiln 4 line) dry process is described as follows. Initially, the crushed raw materials (raw meal feed i.e., limestone, clay, ash, sand, and/or iron ore) enter the raw mill to be dried and ground. A fan draws hot combustion gas from the top of the preheater tower into the raw mill to evaporate moisture from the raw meal, as it is ground. The prepared raw meal feed is transported to a blending silo where it is held pending introduction into the pyroprocess.

The dry process, by re-use of the hot gases for drying raw materials and with the use of the vertical tower for calcining the raw material is very energy efficient. The rapid heating of the raw materials is the key to the efficiency of the preheater tower. The entrainment of the raw material in the air stream and collection of the solids through the cyclones transfers heat to the raw materials rapidly and efficiently. The addition of fuel in the precalciner also prepares the raw material for final chemical transformation in the rotary kiln. This efficiency is borne by the typical heat requirement for a preheater/precalciner system that is approximately 3,200 kJ/kg of clinker, compared to about 5,400 kJ/kg of clinker for a wet kiln.

Proposed Project Description

Carib Cement proposes to construct and operate a new dry line production cement facility (kiln 5) on an existing footprint at the company's facility at Rockfort, as well as modify their existing dry line (kiln 4) to improve emissions. They will also shutdown the existing kiln 3 wet process line.

The new dry line clinker production facility will be a 2,800-MTPD plant. The proposed upgrade will increase the capacity of the overall plant by approximately six hundred thousand tonnes of clinker per year, while utilizing the latest technology and innovation available in the cement industry.

The proposed kiln 5 systems consisting of a vertical roller mill, preheater vessels, calciner, kiln, and clinker cooler will all use the most recent technology, thus significantly lowering operating costs and providing the best environmental performance.

Environmental Features of the New Dry Line

The dry line has several built-in pollution control features. These include:

- The use of low NOx burners
- The use of a low NOx calciner**.**
- Firing of fuel in the riser duct of the preheater /precalciner to reduce NO_x emissions.

The decommissioning of the wet line will see significant improvements in:

- Liquid effluent quality
- Water consumption
- Fuel efficiencies

As part of the kiln 4 modifications, the company proposes to improve the environmental performance of this kiln by:

- replacing the electrostatic precipitators (ESP) with the more efficient baghouse filter systems to improve air quality.
- raise the stack height of kiln 4 from 44 m to 68 m to improve the dispersion of air pollutants.
- a low NOx (nitrogen oxides) burner is already installed at kiln 4.

As part of the modernisation programme, Carib Cement will also upgrade or replace a number of the dust collection systems on the plant to bring them in line with the best industry technologies and standards.

The International Finance Corporation (IFC), lead financiers for the Carib Cement expansion project, has recognized that there are significant environmental benefits to be derived from the project. Based on these enhancements, the IFC has begun negotiations with the company as brokers for carbon credits and are presently preparing for the trade of these credits. *"Carbon credits are greenhouse gas (GHG) emission reductions that are created when a project reduces or avoids the emissions of GHGs, such as carbon dioxide or methane, relative to what would have been emitted under a 'business as usual' scenario.*

Socio Economic Benefits.

The project will contribute significantly to addressing the major complaint expressed by near communities in relation to air pollution problems they associate with past and current operations. Plant workers and workers in the industrial corridor near the plant, will also share this benefit. The company is also committed to a programme of skills training to deepen local employment opportunities arising from the project. The creation of the foreshore road leading from downtown Kingston to Rockfort, has resulted in free flowing traffic past the plant, and the new project will not impact negatively on this.

Potential Environmental Impacts

The potential environmental impacts are set out in an impact matrix found in Chapter 5. The main potential impacts, both negative and positive, as identified in the matrix relate to:

A. Negative

- Air Quality
- Roads and Traffic
- Waste Management

B. Positive

- Marine water quality
- Air Quality
- Fuel efficiencies
- Increased opportunity for the construction industry in Jamaica
- Increased employment opportunities in Jamaica

Findings

The environmental impacts are dealt with in detail in Chapter 5. One of the main issues is a perceived air quality problem. Air dispersion model runs for the existing Carib Cement operations, the proposed expansion, as well as all existing sources were generated.

The results of the modified Carib Cement sources model run, (Table 5.7) revealed that SO_2, lead, ozone, and carbon monoxide (CO) all met the National Ambient Air Quality Standard (NAAQS) minus the background for all applicable averaging periods. NO_x annual average meets the standard once it is assumed that 75% of NO_x is NO_2 as recommended by the Air Quality Guideline Document. However, the NO_x 1-h predicted concentration exceeds the standards even after the 75% conversion is applied. Hence, the Ozone Limiting Method (OLM) as an approach recommended by the USEPA was utilized. The generated predictions using this model fall within the 1-h NO_x standard.

PM exceeds the NAAQS standard minus the background by 8 $\mu g/m^3$ for the annual average and only by 2 $\mu g/m^3$ for the 24-h averaging period. While PM does not meet the model target it is not a significant impact for PM. For there to be a significant impact of PM there must be at least an increment of 21.0 $\mu g/m^3$ for an annual average or a 24-hour average of 80.5 $\mu g/m^3$. The increment model run gave results of an annual average less than 0 μg/m^3 and a 24-hour average of 23 μg/m^3; hence, there is no significant impact for PM. Additionally the plot files show that the area most impacted by the predicted pollutant concentrations is the northwestern section of the Carib Cement facility. This pattern is consistent with the fact that the most predominant wind direction blows from the southeast.

Conclusions

All the potential impacts identified can be effectively mitigated to reduce the risks and to meet the required environmental standards. Some of these measures are built into the new line and others can be designed and incorporated into the operation without difficulty.

A critical element of the operation must be the monitoring of the internal and external environment in order to detect and correct any variances. Furthermore, the monitoring programme should include the community through routine sharing of information.

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1.0 INTRODUCTION

1.1 BACKGROUND

This document presents the findings of an Environmental Impact Assessment (EIA) of the proposed Caribbean Cement Company Limited (Carib Cement) Expansion Project. Carib Cement is carrying out a modernization and expansion programme of the plant at Rockfort, in Kingston (Figure 1.1). The programme is phased over a five-year period, with the largest component being the clinker production process expansion. This project will involve the installation of a new clinker production line to be constructed over three years. Upon completion, the new "dry" clinker production line will replace the existing wet clinker line. The proposed expansion will take place within the footprint of the existing plant.

Carib Cement is the sole manufacturer of cement in Jamaica and was the sole supplier until as recently as 1999. The size of the cement market has grown substantially over the last 10 years: demand has increased by 52% or 5.1% per annum. The domestic market is conservatively forecast to grow by approximately 4% per annum from 862,289 tonnes in 2004 to 1,291,167 tonnes in 2010. Carib Cement presently holds the dominant share of the domestic market and is developing and implementing strategies to meet this increasing demand and to provide even better service to the construction industry.

Modernization and expansion of the existing plant is necessary in order to meet future demand and to reduce operating costs. The proposed new production line will have a rated capacity in excess of 1 million tonnes per year up from the current 650 thousand tonnes per year produced by the existing plant. In general the new production line will reduce fuel consumption and improve efficiencies and environmental performance (Section 2.2).

Under the Natural Resources Conservation Authority (NRCA) Act (1991) significant expansion of industrial plants is included on the list of prescribed activities that require an application for permission to implement. The National Environmental Planning Agency (NEPA), which administers the NRCA Act, has requested that an Environmental Impact Assessment (EIA) be conducted for this project to support the application for a permit (Appendix I).

Environmental Solutions Limited (ESL) was retained by Carib Cement to prepare the EIA. The Terms of Reference for the EIA are provided at Section 1.2 below.

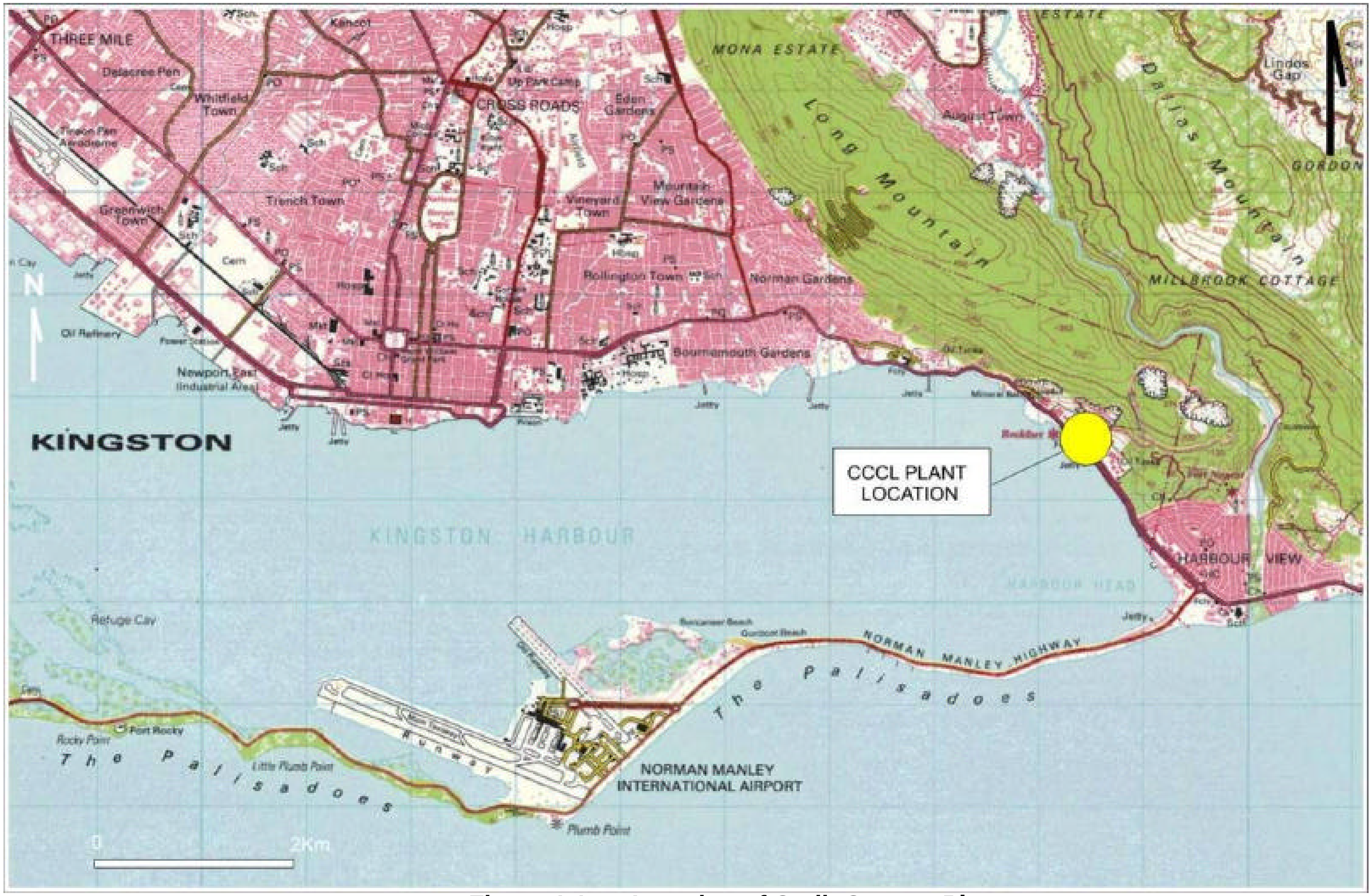

Figure 1.1 Location of Carib Cement Plant

1.2 TERMS OF REFERENCE

The Terms of Reference for the Environmental Impact Assessment of the proposed cement plant expansion at Rock Fort, St. Andrew are provided below. These have been adapted from World Bank guidelines and take account of NEPA's generic guidelines for EIA preparation.

By letter dated November 19, 2004, (Appendix I), NEPA requested that an EIA be prepared and indicated that the terms of reference must include detailed air dispersion modelling.

Introduction

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

Background Information

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

Study Area

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

EIA Team

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

Scope of Work

The following tasks were undertaken:

<u>Task 1. Description of the Proposed Project</u> (Section 2) - A full description is provided of the overall project and its existing setting using plans, maps and graphic aids as appropriate. This includes: location; general layout (size, capacity, etc.); areas slated for development, pre-construction and construction activities; construction methodology (earthworks, bunds, etc.), site management, operation and maintenance activities; project life span; plans for providing electricity

and water; and employment. Specific attention is given to issues of air quality, energy consumption, raw material supply, and waste generation and management.

Task 2. Description of the Environment (Section 4) – A description of the physical, ecological, demographic, socio-cultural and institutional setting of the project is provided. Information that provides an insight into previously existing conditions of the site and the influences of past development initiatives is reviewed and presented. Baseline data on the relevant environmental characteristics of the study area assembled, evaluated and presented. These include the following:

a) **Physical environment** (Section 4.1): terrestrial and coastal features; topography; geology; soils; climate and meteorology; ambient noise; hydrology; drainage and storm water runoff; and Kingston Harbour water quality[1]. Existing sources of pollution and the extent of contamination relevant to the project area are identified. The natural hazard vulnerability of the site is also considered, particularly with respect to potential earthquakes, hurricanes and storm surge. A stand-alone air dispersion modelling report was requested by NEPA to be a part of the EIA (Section 5.2).

b) **Biological environment** (Section 4.4): flora and fauna of the terrestrial ecosystems on and adjacent to the project site. Reference is also made to the Kingston Harbour. Rare or endangered species, species of commercial importance, and species with potential to become vectors or nuisances are specified.

c) **Social environment** (Section 4.5): present and projected population size, land use, community structure, issues related to squatting and relocation, current development plans, recreation and public health, public and community perceptions of and attitudes to the proposed project, and any historical sites affected by the project. Solid waste management issues related to the project are identified.

Task 3. Legislative and Regulatory Considerations (Section 3) - The pertinent environmental laws, regulations and standards governing land use control, environmental quality, health and safety, sewage effluent discharge, protection of sensitive areas, and protection of endangered species are identified.

Task 4. Determinations of Potential Impacts (Section 5) – The major issues of environmental concern were identified and their relative importances to the design of the project are indicated. Long-term and short-term impacts, construction and post-construction phase impacts, positive and

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

negative impacts, and direct and indirect impacts were dstinguished. The significant impacts and those that are cumulative, unavoidable or irreversible are identified.

Special attention was given to the following matters:

- Air quality and air dispersion modelling
- Vegetation clearance, and placement of buildings and services installation.
- Modification of existing drainage patterns and surface runoff during construction and post-construction phases.
- Raw material quarrying, transport and storage
- Solid waste management during construction and post-construction phases.
- Environmental health within the plant and in surrounding areas
- Traffic movement
- Employment and effects on existing users of the adjacent coastal areas; community involvement, and public perceptions of the project.
- Potential impacts of the development on adjacent property owners.
- Natural hazard vulnerability

Task 5. Mitigation and Management of Negative Impacts (Section 5) - Feasible and cost-effective measures to prevent or to reduce the significant negative impacts to acceptable levels are recommended.

Task 6. Environmental Management and Monitoring Plan (Section 7) - The outline of a plan for monitoring the impacts of the project and the implementation of mitigating measures during construction was prepared. This plan is to be detailed after the permit for the project is granted and the construction plans for the project have been finalized, at which time the plan is to be submitted to NEPA for approval.

Task 7. Determination of Project Alternatives(Section 6) – Alternatives to the project including the no-action option and alternatives treatment processes and site location are examined.

Task 8: Assist in Inter-Agency Coordination and Public/NGO Participation - EIA Review by Regulatory Agency. - The environmental assessment was coordinated with the government agencies and the views of local NGO's and affected groups were obtained. Public hearing on the EIA findings as required by the NEPA permit approval process will be managed and coordinated.

6. Report - The environmental assessment report is concise and limited to significant environmental issues. The main text focuses on findings, conclusions and recommended actions

and is supported by summaries of the data collected and citations for references used in interpreting those data. The environmental assessment report is organized according to the outline below.

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

1.3 STUDY TEAM

Environmental Solutions Ltd developed out this EIA. The multidisciplinary team engaged to do the assessment included local expertise in environmental impact assessment, environmental engineering, coastal and terrestrial ecology, environmental chemistry, and social impact assessment. The team members were:

Environmental Solutions Ltd.:

Eleanor B. Jones, M.A. - Environmental Planner –Team Leader

George Campbell, M.Sc. – Social and Economic Analyst

Aedan Earle, M.Phil. – Geologist

Margaret Jones Williams, Ph.D. - Ecologist

Sharonmae Shirley, M.Phil. – Environmental Chemist

ESL Associate:
Steven Haughton, M.Sc. – Environmental Engineer

Scheiber, Yonley and Associates
Brad Phillips

Nalin Joslin

1.4 METHODOLOGY

1.4.1 Physical Parameters

Information was gathered on the existing physical environment, particularly as related to climate, geology, topography, soils, hydrology and drainage, air quality, water quality, and noise.

1.4.1.1 Climate, Geology, Topography, and Soils

Information on the climate, geology, topography, soils, was obtained by compiling existing data from reports (Adams, 1972; Downer and Sutton, 1990; ESL, 2001), Grossman *et al*, 1991) as well as from source agencies. Aerial photos, satellite imagery and published maps were also examined. Fieldwork was carried out to augment and verify existing information relating to geology and soils and to obtain first hand knowledge of the topography.

1.4.1.2 Hydrology and Drainage

Surface and ground water characteristics and flows were assessed using field investigation as well as maps, aerial photographs and data from previous reports (Smith, 2004)

1.4.1.3 Air Quality

The objective of the air quality monitoring exercise is to determine the normal concentration of respirable particulates and gaseous emissions in the project area prior to the start of the proposed expansion works. Air quality measurements were taken at nine sites in the project area (Table 1.1 and Figure 1.1). These sites were selected based on their location relative to key community receptors, as well as their current or potential for impairment. The sampling and analytical methods used are based on established procedures in the text Fundamentals of Industrial Hygiene [Plog, 1988]. The methodology used does not conform to all the USEPA guidelines for the assessment of ambient particulates. The USEPA method requires the use of high volume samplers whereas low volume samplers were used in this sampling exercise.

Date	Station Number	Location
27-10-04	1	Hot Dust Dump
27-10-04	2	August Town
22-10-04	3	Caribbean Terrace
22-10-04	4	Harbour Drive
26-10-04	5	Sales Office
14-10-04	6	Below Coal Wharf
26-10-04	7	Mineral Spa
14-10-04	8	Control Maritime Institute
29-10-04	9	Rennox Lodge Primary

Table 1.1 Date and Location of the Air Quality Sampling Stations

Figure 4.6 Locations of Air and Water Sampling Stations

Field measurements for PM10 and PM2.5 were done with the ESL low volume samplers and standard high volume samplers and the results were similar. The test programme was not rigorous, the comparative data serves as an indicator that the results are similar. Further detailed tests would have to be performed to determine the exact correlation.

Particulates

The air quality assessment involved the determination of ambient levels of respirable particulates, PM10 (<10µm). Particulates were measured using Sensidyne (BDX 530) personal vacuum pumps (suction 2-3 1/min), attached to pre-weighed millipore filters. The pumps were placed at the approximate respiratory height of pedestrians for a specified period of time, after which the filters were stabilised and weighed to determine a Time Weighted Average (TWA) value for the particulates.

Gaseous Emissions

Sulphur oxides, nitrogen oxides, and carbon monoxide gases were measured using the Draegar CMS and Teledyne Max 5 direct monitoring meters.

1.4.1.4 Noise

Eight noise-monitoring sites were selected to coincide with the air quality sampling stations. Noise level readings, wind direction and any unusual local noise sources were recorded. In addition, before and after the survey, the instrument was calibrated with an ANSI calibrator, which was pre-calibrated at the factory.

Measurements were taken using Quest Electronics sound level meters, which conform to ANSI S1.4 - 1983, TYPE 2 and IEC 651 - 1979, TYPE 2 standards. The meter was calibrated before and after each set of readings. The sampling and analytical methods used are based on established procedures in Fundamentals of Industrial Hygiene [Plog, 1988].

Daytime measurements were taken at eight stations along the perimeter of the plant (Table 1.2).

Date	Station Number	Location
04-11-04	1	Shale Mill
//	2	Kiln #4- Feed Compressor
//	3	Kiln #3- Cooler Fans
//	4	Raw Mill 2
//	5	Roller Mill-Compressor room
//	6	Coal Mill

//	7	Main Gate
//	8	Weighing Bridge at Sales

Table 1.2 Date and Location of the Noise Level Sampling Stations

1.4.1.5 Water Quality

In order to establish baseline conditions for the coastal zone prior to the proposed expansion of the Caribbean Cement Company, water quality samples were taken at four sampling stations (Table 1.3 and Figure 1.1) in the coastal zone. These stations were based on their location relative to the discharge points of the major surface water channels exiting the Carib Cement compound, and were collected on average, at a depth of 0.5m. The baseline data provide a quantitative measure of the existing conditions and also provide a comparative point for construction and post construction monitoring. After collection they were placed on ice and transported to the ESL Laboratory at 20 West Kings House Road, Kingston 10.

The following parameters were sampled:

- pH
- Conductivity/salinity
- Temperature
- Dissolved Oxygen
- Total Suspended Solids
- Sulphate
- Nitrate
- Phosphate
- BOD
- Oil and grease
- Total and Faecal Coliform
- Metals

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

Date	Station Number	Location
04-11-04	1	Coastal waters at the Carib Cementeastern boundary
//	2	Coastal waters off the mouth of the central drain
//	3	Coastal waters off the mouth of the west drain
//	4	Coastal waters west of coal wharf

Table 1.3 Location of the Water Quality Sampling Stations

1.4.2 Ecological Baseline

The status of the flora and fauna of the study area were determined by a review of current literature relevant to the area, and an assessment of the existing ecological conditions of the surrounding environment was made through site visits to the main operations site on Windward Road.

1.4.3 Socioeconomic Setting

Rapid appraisal techniques were used in 15 communities located at varying distances from the plant to identify issues of relevance to the Project. The process involved windscreen observations, in-depth structured interviews as well as non-structured *ad hoc* discussions with individuals and groups. Both Government agencies and private sector enterprises were canvassed. Population and demographic data were sourced from STATIN, and mining data from the Mines & Geology Division, Government of Jamaica.

2.0 DESCRIPTION OF THE PROPOSED PROJECT

2.1 EXISTING OPERATIONS

Caribbean Cement Company Limited was incorporated in 1947, and the first bag of cement was delivered in 1952. The plant capacity at that time was 100,000 MTPY with one kiln. This was doubled in 1956 to 200,000 MTPY. In 1962, construction started on a third production line, kiln 3, which was commissioned in 1964. When this was completed the capacity was 400,000 MTPY. The construction of the fourth line was started in 1984, with commissioning in 1988. This brought the plant to a current capacity of 600,000 MTPY. Since then smaller upgrades have increased the capacity to a nominal value of 650,000 MTPY.

Carib Cement operates a dual process cement manufacturing plant, utilising both the wet and dry process technologies. The dry process, using preheaters and precalciners, is both economically and environmentally preferable to the wet process because the energy consumption (3200 joules per kilogram (kg) is approximately half of that for the wet process. A detailed description of both the dry and wet cement manufacturing process is provided at Section 2.2.

2.2 THE CEMENT PRODUCTION PROCESS

The production of cement includes mining; crushing and grinding of raw materials (principally limestone and clay); calcining the materials in a rotary kiln; cooling the resulting clinker; mixing the clinker with gypsum; and milling, storing and bagging the finished cement. The process results in a variety of wastes, including dust, which is captured and recycled to the process. The process is very energy-intensive and there are strong incentives for energy conservation.

2.2.1 Wet Process

The manufacture of Portland cement in a wet process kiln (Kiln 3) begins with the acquisition of the major components, limestone, clay, ash, sand, and/or iron ore. After size reduction processes, the raw materials are further prepared by wet milling, where approximately 30%-35% water is added to produce a homogenized kiln slurry, or raw feed material.

The critical manufacturing step, called “pyroprocessing,” takes place in the cement kiln. The prepared raw feed is pumped into the kiln where it is exposed to gas temperatures starting at

260°C at the elevated feed end to over 1870°C near the product discharge end. The kiln is a cylindrical tube on a slight incline that rotates slowly. The slurry, or kiln feed, is heated as it travels down the kiln. As the kiln feed progresses through the kiln, it undergoes physical and chemical changes. After tumbling slowly through the kiln, exothermic chemical changes in the burning zone transform the raw materials to cement clinker, a product physically resembling grey gravel.

In the wet process, the kiln feed loses water as it is heated and passed through the chain section. In this section, chains hung from the inside of the kiln assist in heat transfer to the slurry. Next, calcium carbonate in the material is calcined into calcium oxide (lime), which finally fuses at high temperatures with silicates, iron, and aluminum to produce an intermediate of Portland cement called "clinker." The clinker produced from this process is conveyed through a grate cooler, and is cooled by air from forced-draft fans. The cooled clinker is then stored for subsequent grinding, during which approximately 5% gypsum and/or other additives are added to produce Portland cement, the final product.

The production of clinker in a wet kiln requires that the solid material be heated to approximately 1400°C to 1482°C, while the gaseous material reaches a temperature of greater than 1400°C. Tricalcium silicate is the major strength-producing constituent of cement, and its formation begins in the burning zone at material temperatures above 1870°C. Other clinker compounds important for the performance of Portland cement are formed by reactions that take place in the burning zone.

Fuel utilized in the kiln to drive the cement manufacturing process is typically coal and/or coke or other fossil fuels. All fuel is injected counter-current to the product flow through injection system at the product discharge end of the kiln. Exhaust gases from the kiln are routed to the air pollution control system and then discharged to the atmosphere through a stack.

2.2.2 Dry Process

The kiln 4 line is a dry process which is described as follows. Initially, the crushed raw materials (raw meal feed) (i.e., limestone, clay, ash, sand, and/or iron ore) enter the raw mill to be dried and ground. A fan draws hot combustion gas from the top of the preheater tower into the raw mill to evaporate moisture from the raw meal, as it is ground. The prepared raw meal feed is transported to a blending silo where it is held pending introduction into the pyroprocess.

The first step of the pyroprocessing is feeding the kiln feed into the top of the preheater tower. From the preheating zone of the preheater/precalciner tower, the kiln feed flows by gravity into the calciner where fuel is burned in direct contact with the kiln feed to begin the calcination process of the limestone. The preheater tower consists of multiple cyclone stages, which provide direct contact between the hot combustion gases and the kiln feed.

When limestone is calcined, calcium carbonate dissociates to produce calcium oxide and carbon dioxide (CO_2). This step consumes about 85% of the theoretical thermal energy required by the process and occurs at temperatures of about 900ºC. A majority of the limestone is calcined in the calciner and preheater tower. The remainder of the calcining takes place at the feed end of the rotary kiln.

Once through the calcining zone of the rotary kiln, the partially calcined feed moves into the burning zone. Flame temperatures of about 1870°C must be reached within the rotary kiln to produce material temperatures in the range of 1482°C and bring about the chemical reactions that turn the partially calcined feed into the rock-like, solid nodules or clinker. Fuel enters the rotary kiln pyroprocessing system via the burner nozzles at the clinker discharge end of the kiln.

Clinker is discharged from the lower, hot end of the rotary kiln into the clinker cooler, where forcing air through the moving bed of hot material cools it. The cooled clinker is transported by conveyor system to clinker storage and then to the finish mill system. The pre-heated air from the clinker cooler process is used as secondary combustion air in the rotary kiln, tertiary combustion air for the calciner, and is also used to dry the conventional fossil fuels in the coal mills.

The dry process, by re-use of the hot gases for drying raw materials and with the use of the vertical tower for calcining the raw material is very energy efficient. The rapid heating of the raw materials is the key to the efficiency of the preheater tower. The entrainment of the raw material in the air stream and collection of the solids through the cyclones transfers heat to the raw materials rapidly and efficiently. The addition of fuel in the precalciner also prepares the raw material for final chemical transformation in the rotary kiln. This efficiency is borne by the typical heat requirement for a preheater/precalciner system that is approximately 3,200 kJ/kg of clinker, compared to about 5,400 kJ/kg of clinker for a wet kiln. As a result, the project is being identified as a Clean Development Mechanism one and as such the International Finance Corporation, lead financiers for Caribbean Cement Company's expansion project is earmarking Carib Cement as a recipient for carbon credits.

2.2.3 Proposed Project Description

Carib Cement has proposed to construct and operate a new dry line production cement facility (kiln 5) on an existing footprint at the company's facility at Rockfort, as well as modify their existing dry line (kiln 4) to improve emissions (Figure 2.1). They will also shutdown the existing kiln 3 wet process line. As part of the kiln 4 modifications, the company proposes to replace the electrostatic precipitators (ESP) on the kiln and clinker cooler to more efficient baghouse filter systems, as well as to raise the stack height of kiln 4 from 44 m to 68 m in order to improve pollution dispersion.

The new dry line cement production facility will be a 2,800-MTPD plant. The proposed upgrade will increase the capacity of the plant by approximately one million tonnes of clinker per year, while utilizing the latest technology and innovation available in the cement industry. The proposed kiln 5 systems consisting of a vertical roller mill, preheater vessels, calciner, kiln, and clinker cooler will all use the most recent technology, thus significantly lowering operating costs. In fact the technology will see a low NOx burner and a low NOx calciner associated with the new dry line, while a low NOx burner is already installed at kiln 4. In addition, firing of fuel in the riser duct of the preheater/precalciner will be utilized to reduce NO_x emissions.

Figure 2.2 shows the ILC Low NO_x calciner that is constructed to utilize and favour as many of the NO_x removing reactions as possible. At the inlet to the reduction zone where the coal is introduced the only oxygen available is the amount present in the rotary kiln gases and this favours the NO_x reduction reactions. These reactions require high temperature and this is provided by splitting the raw meal between the oxidizing zone and the reduction zone, thus improving the efficiency of the reaction, and thereby reducing NO_x formation. The temperature is kept between 925-1050 °C or as high as possible without getting any encrustations in the kiln riser and the reduction zone.

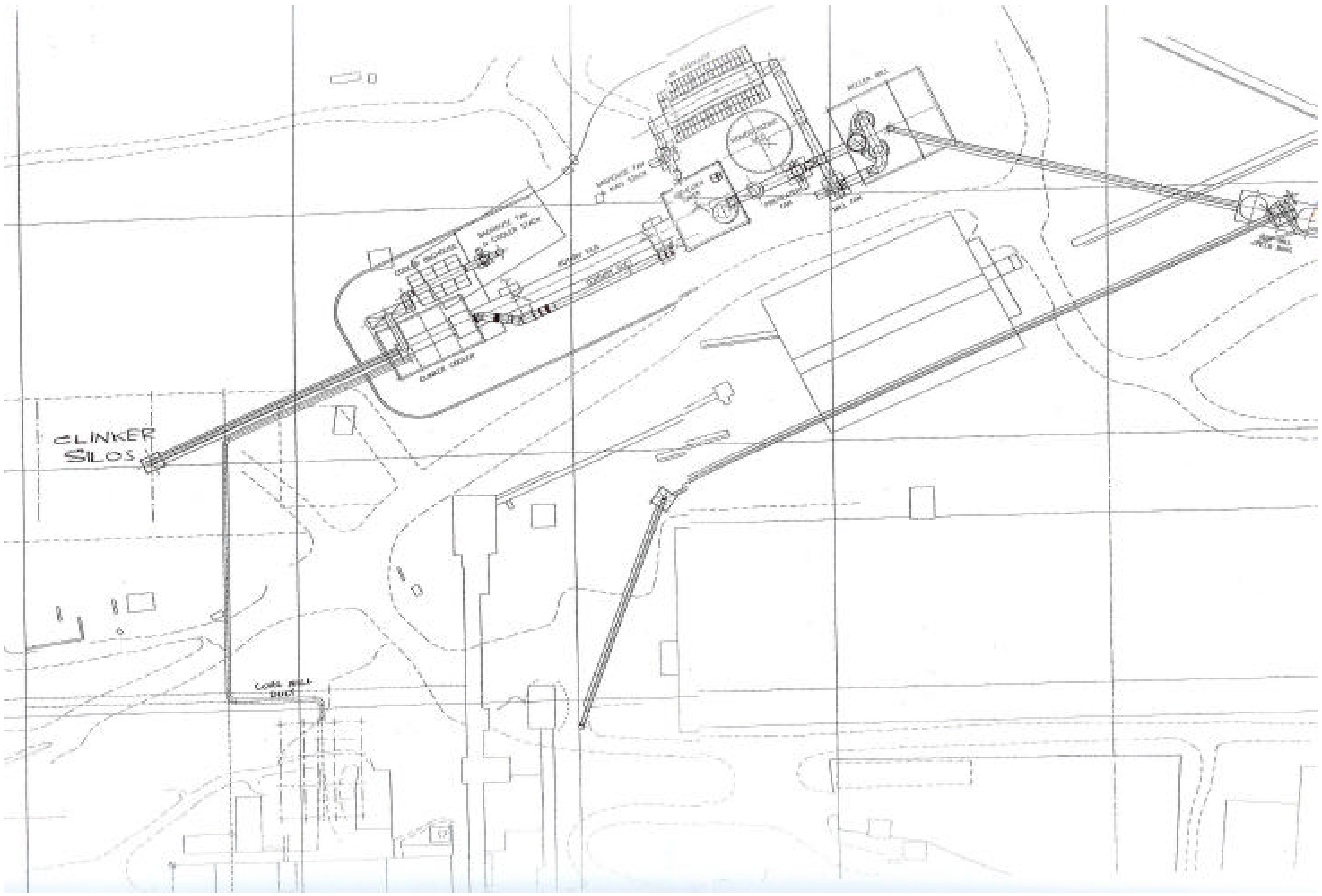

Figure 2.1 Kiln Expansion Configuration

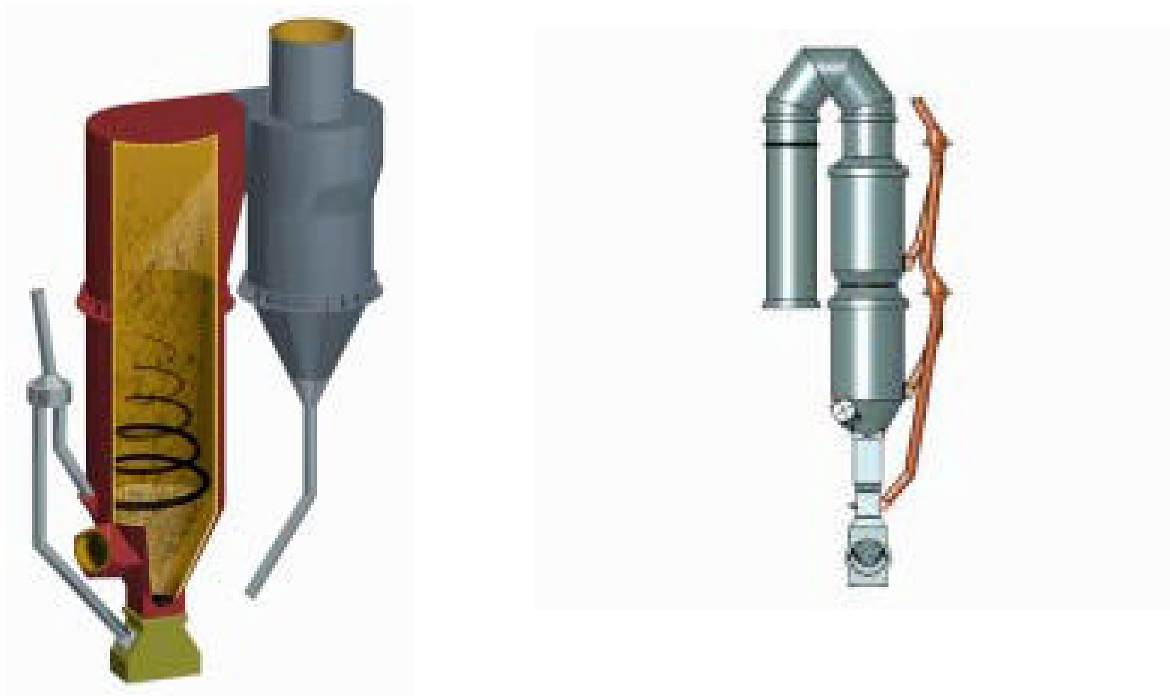

Figure 2.2 ILC Low NO_x Calciner

In addition to the low NOx calciner, kiln 5 also features a DUOFLEX low NOx burner (Figure 2.3). The burner design allows the formation of a good flame profile in the kiln, thereby permitting operations with very little excess air and without the formation of CO. A burner operating with the correct flame momentum, despite the higher flame temperature will result in less formation of NO than a low momentum burner operating with more excess air. The DUOFLEX burner normally operates with 6 – 8 % primary air, but is designed for maximum 10 percent. This will in all cases provide the kiln operator with the necessary tool to quickly stabilize any upset conditions in order to achieve low NO_x formation in all cases.

Figure 2.3 DUOFLEX Low NOx Burner

Carib Cement has established environmental parameters for each of its unit operations by adopting local and international standards. The company has implemented a dust suppression programme and currently has an ongoing suspended particulate and liquid effluent monitoring programmes.

Carib Cement recognizes that achieving high environmental standards is a process that requires consistent and sustained efforts. In developing the proposed project sound environmental management has been the foremost objective of the project engineers and managers. The replacement of the wet process technology with the dry process provides a win/win situation, where efficiencies as well as environmental performance will be improved.

The project team has ensured that the best available technology for ensuring compliance with both the local standards as well as World Bank guidelines will be utilised.

2.3 CARBON CREDITS

The International Finance Corporation (IFC), lead financiers for Carib Cement's expansion project, has recognized that there are significant environmental benefits to be derived from the project. This means that specific consumption of fuel will be more than halved with the modernisation and expansion programme of the plant. This will result in less fuel usage and less greenhouse emissions. The plant will also be more efficient resulting in reduced power consumption.

Based on these enhancements, the IFC has begun negotiations with the company as brokers for carbon credits and are presently preparing for the trade of these credits.

“Carbon credits are greenhouse gas (GHG) emission reductions that are created when a project reduces or avoids the emissions of GHGs, such as carbon dioxide or methane, relative to what would have been emitted under a 'business as usual' scenario. Under the IFC’s Carbon Finance Facilities, the IFC purchases carbon credits for the benefit of the Government of the Netherlands under the international emission reduction transfer rules of the Kyoto Protocol”. (Source - IFC Website).

2.3 PROJECT ENGINEERING

The engineering work to be performed for the project will conform to the latest Codes and Standards applicable in the USA and Jamaica. Documents and drawings defining the project in detail will consist of:

- Plot Plan
- Process and Mechanical Flow Sheets
- General Arrangement Drawings
- Equipment Drawings
- Process Ductwork
- Dedusting Ductwork
- Piping Diagrams
- Utility and Related Drawings
- Chutes, Bins, Spouts and Hoppers
- Maintenance Platforms
- Civil/Structural Drawings
- Electrical Engineering – Power Distribution, Control System
- Specifications
- As-Built (Record) Drawings

3.0 POLICY, LEGAL AND REGULATORY FRAMEWORK

The following pieces of legislation relate to the proposed plan of the Carib Cement to expand and modify its generating facility in Rockfort, Kingston.

3.1 LEGISLATION RELATING TO DEVELOPMENT

The Natural Resources Conservation Authority (NRCA), now the National Environment and Planning Agency (NEPA), has been given responsibility for environmental management in Jamaica under the NRCA Act of 1991. Since the promulgation of the Act, the NRCA has been developing local standards. The Act was strengthened by supporting regulations, which became effective in January 1997. The underlying principles, which have been used in the development of the Act, are:

- The Polluter pays Principle
- The Cradle to Grave approach to waste management

The NRCA Act binds the Crown and as such supersedes all other legislation relating to environmental issues. The Minister is empowered to request an Environmental Impact Assessment (EIA) in relation to certain major projects. Under this authority Carib Cement was asked to complete this EIA as part of its expansion project

3.1.1 The Natural Resources Conservation (Permits and Licences) Regulations (1996)

These regulations came into effect on January 1, 1997 when the Environmental Permit and License System (P&L) was introduced. The (P&L) is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L is administered by NEPA, through the Applications Section (formerly the Permit and License Secretariat). Persons undertaking new developments, which fall within a prescribed category, require permits. Under the NRCA Act of 1991, the NRCA has the authority to issue, suspend and revoke environmental permits and licences. An applicant for a Permit or License must complete a Permit Application Form (PAF) as well as a Project Information Form (PIF) for submission to the NRCA/NEPA.

3.2 LEGISLATION RELATING TO POLLUTION CONTROL

Pollution prevention is significant consideration for Carib Cement's operations and therefore all pertinent policies and regulations need to be complied with. The legislation that relates to Carib Cement's operations is outlined below.

3.2.1 Natural Resources Conservation Authority Act, 1991

The N.R.C.A Act, 1991, empowers the authority to manage, conserve and protect the natural resources of Jamaica by introducing appropriate standards and codes of practice. The body is also responsible for investigating the effect on the environment of any activity that may cause pollution or which involves waste management. Sections of the Act that relate specifically to pollution control state that:

- No person shall discharge on or cause or permit the entry into waters, on the ground or into the ground, any sewage or trade effluent or any poisonous, noxious or polluting matter.
- No person is allowed to construct or reconstruct or alter any works designed for the discharge of any effluent.

The Act also empowers the authority to require of any owner or operator of a facility that is a probable polluter, information on the performance of the facility, the quantity and condition of effluent discharged and the area affected by the discharge of such effluent.

The Authority has the right to consult with any agency or department of Government having functions in relation to water or water resources to carry out operations to:

- Prevent pollutants from reaching water bodies.
- Remove and dispose of any polluting matter or remedy or mitigate any polluted water body in order to restore it.

3.2.2 The Natural Resources Conservation Authority (Air Quality) Regulations, 2002

Part I of this Act stipulates license requirements and states that every owner of a major facility or a significant facility shall apply for an air pollutant discharge license. Part II speaks to the stack emission targets, standards and guidelines (Appendix I).

Emissions from the Carib Cement plant have the potential to influence ambient air quality. The accumulated impact of emissions from Carib Cement L and the other major contributors to the airshed could have significant impacts on neighbouring communities. These impacts will be influenced by meteorological conditions (precipitation, wind direction and speed, etc). The regulations define primary and secondary ambient air quality standards. The standards for those pollutants of particular relevance to the operations at Carib Cement are shown in Table 2.1. The EIA report, including the results of the air dispersion modelling, will address this issue.

POLLUTANT	AVERAGING TIME	STANDARD µg/m^3	
Total suspended particulates	Annual	60	
	24h	150	
PM10 (particulates with diameter <10 microns)	Annual	50	
	24h	150	
Sulphur dioxide		Primary	Secondary
	Annual	80	60
	24h	365	280
	1h	700	
Carbon Monoxide	8h	10,000	
	1h	40,000	
Nitrogen Dioxide	Annual	100	

Table 2.1 Standards for Air Pollutants

3.2.3 The National Solid Waste Management Authority Act, 2000

This Act provides for the regulation and management of solid waste; it establishes a body to be called the National Solid Waste Management Authority; and for matters "connected therewith or incidental thereto". The National Solid Waste Management Authority (NSWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste. The EIA report will address how Carib Cement will meet the requirements of the NSWMA.

3.2.4 Public Health Act, 1976

The Public Health (Air, Soil and Water Pollution) Regulations 1976, aim at controlling, reducing, removing or preventing air, soil and water pollution in all possible forms. Under the regulations given:

- No individual or corporation is allowed to emit, deposit, issue or discharge into the environment from any source.
- Whoever is responsible for the accidental presence in the environment of a contaminant must advise the Environmental Control Division of the Ministry of Health and Environmental Control, without delay.
- Any person or organization that conducts activities which release air contaminants such as dust and other particulates is required to institute measures to reduce or eliminate the presence of such contaminants.
- No industrial waste should be discharged into any water body, which will result in the deterioration of the quality of the water.

Carib Cement's compliance with these regulations is addressed in the EIA report.

3.2.5 The Clean Air Act, 1964

- This act refers to premises on which there are industrial works, the operation of which is in the opinion of an inspector likely to result in the discharge of smoke or fumes or gases or dust in the air.
- An inspector may enter any affected premise to examine, make enquiries, make tests and take samples of any substance, smoke, fumes, gas or dust as he considers necessary or proper for the performance of his duties.

3.3 REGULATIONS PERTAINING TO STANDARDS

3.3.1 Trade Effluent Standards

Since 1996 Jamaica has had draft regulations governing the quality of the effluent discharged from facilities to public sewers and surface water systems. These draft guidelines require the facility to meet certain basic water quality standards for trade effluent including sewage.

3.3.2 Noise Standards

Jamaica has no national legislation for noise, but World Bank guidelines have been adopted by NEPA and are used for benchmarking purposes along with the draft National Noise Standards that are being prepared. The guideline for daytime perimeter noise is 75 decibels. Section 4.2.4 addresses noise issues.

3.4 LEGISLATION RELATING TO FACTORY OPERATIONS

3.4.1 Factories Act, 1968

The Act empowers the Minister of Labour to register factories, inspect and regulate their operations. The regulations updated in 1968 provide for the following:

- The safe means of approach or access to, and exit from, any factory, or machinery
- The fencing and covering of all dangerous places or machines;
- Life-saving and first aid appliances;
- Securing safety in connection with all operations carried on in a factory
- Securing safety in connection with the use of cranes, winches, pulley-blocks and of all engines, machinery, mechanical gear and contrivances generally whatsoever;
- The periodic inspection, testing and classification, according to age, type or condition, of boilers;
- The duties and responsibilities assignable to any person generally, and in particular to employers, owners, and managers in charge of factories, in connection with any one or more of such regulations;
- The proper ventilation of any factory, having regard to the nature of the process carried on therein;
- The sanitation, including the provision of lavatory accommodation (having regard to the number of workers employed) at any factory;

3.4.2 Petroleum and Oil Fuel (Landing & Storage) Act (1925)

This extends to the storage of petroleum in quantities greater than one hundred and twenty imperial gallons in a building specially appointed for this purpose by the Minister.

3.4.3 The Office of Disaster Preparedness and Emergency Management Act (1998)

This Act was established by the Office of Disaster Preparedness and Emergency Management (ODPEM) to develop and implement policy and programmes to achieve and maintain an appropriate state of national and sectoral preparedness for coping with emergency situations.
Carib Cement should have its own disaster and emergency response plan for fire, earthquake, and storm events, specific to its operations, to minimise loss of life, injury and damage to structures.

3.5 LEGISLATION RELATING TO ENVIRONMENTAL SETTING

3.5.1 Beach Control Act, 1956

The NRCA Act, 1991 names the NRCA as the governing body of The Beach Control Act of 1956. This Act states that:

- No person shall encroach on or use the foreshore or floor of the sea for any public purpose or in connection with any trade or business, or commercial enterprise without a proper license.
- The Minister, may upon the recommendation of the Authority, declare any part of the foreshore and the floor of the sea together with the water lying on such a part of the floor of the sea to be a protected area.

3.5.2 The Water Resources Act, 1995

The Act established the Water Resources Authority (WRA) and authorizes this Authority to regulate, allocate, conserve and manage the water resources of the island. The Authority is also responsible for water quality control and is required under Section 4 of the Act to provide upon request to any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources. It is the responsibility of the WRA as outlined in Section 16 to prepare, for the approval of the Minister, a draft National Water Resources Master Plan for Jamaica. Areas to be covered in this Master Plan include objectives for the development, conservation and use of water resources in Jamaica with consideration being given to the protection and encouragement of economic activity, and the protection of the environment and the enhancement of environmental values.

- The Minister may declare an order that prohibits activities such as fishing, the use of boats, the disposal of rubbish or waste, water-skiing, dredging, the destruction of marine organisms or the search for and removal of artefacts from protected areas.

- No person may erect, construct or maintain any dock, wharf, pier or jetty on the foreshore or the floor of the sea, unless expressly permitted to do so through a license granted by the Minister.

- The Authority is empowered to maintain, use and develop beaches for the benefit of the public and to take steps for the establishment of the right of the public to use beaches or to gain access to such.

4. 0 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 PHYSICAL ENVIRONMENT

The Carib Cement facility is located on the south coast of Jamaica, in Kingston Harbour, separated from the Caribbean Sea proper by the Palisadoes sandspit/ tombolo. It lies within the Kingston Metropolitan Area (KMA), with the Liguanea Plains and Kingston to the west, Long Mountain beyond that, the Blue Mountains, to the north, Harbour View and St Thomas to the east and Kinsgton Harbour, the Palisadoes and the Norman Manley International Airport to the south.

4.1.1 Climate

Since local and regional climatic conditions affect the dispersion of pollutants, an understanding of the prevailing long-term climatic patterns and the short term, site-specific meteorological conditions will help to assess the likely impact of emissions from the cement plant on local air quality.

The site is only approximately 6 km southwest of the meteorological station at Norman Manley International Airport (NMIA) and there are no intervening topographical features that would result in differences in meteorology between NMIA and the site. Meteorological data from NMIA will therefore be representative of the site and can be considered site-specific.

Table 4.1 summarises the temperature, rainfall, and humidity values recorded between 1951 and 1980 and this data is indicative of the conditions that have existed at the site. The minimum temperature ranges from 22.3 °C to 25.6 °C with highest temperatures in July and August and the maximum daily temperature ranges from 29.6 °C to 31.9 °C. The relatively narrow range in temperature reflects the moderating influence of the sea. Highest monthly average rainfall occurs between May and October and the annual mean rainfall is 62.1 mm. October has the highest average monthly rainfall (167 mm) and days with rain (10 days).

The main regional scale weather features that affect the island are upper level pressure troughs (an elongated area of low atmospheric pressure at high altitude), tropical waves and incipient storms and cold fronts. Upper level troughs occur year round but are more frequent in the winter when there are more frequent temperate latitude low-pressure systems and fronts. During the winter months, cold fronts associated with low-pressure systems that form over the south central United States can reach Jamaica although the still warm water in the Gulf of Mexico and the

Caribbean moderates them. These fronts can be stationary and produce much rainfall over the northern areas of Jamaica.

The summer troughs are fewer but can be more persistent. The troughs sometimes interact with the easterly waves (a wavelike disturbance in the tropical easterly winds that usually moves from east to west) and tropical storms to produce intense rainfall.

Tropical waves and incipient storms occur in the summer and move from east to west and are good rainfall producers. A tropical wave is a kink or bend in the normally straight flow of surface air in the tropics that form a low-pressure trough, or pressure boundary, and showers and thunderstorms. It can develop into a tropical cyclone.

	JAN	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Annual Mean**
Maximum Temp. (°C)	29.8	29.6	29.8	30.3	30.8	31.2	31.7	31.9	31.7	31.3	31.1	30.5	30.8
Minimum Temp. (°C)	22.3	22.3	22.9	22.6	24.7	25.3	25.6	25.3	25.3	24.8	24.1	23.1	24.0
Rainfall (mm)	18	16	14	27	100	83	40	81	107	167	61	31	62.1
No. of rain days	4	4	3	5	5	6	4	6	8	10	6	4	5.4
Rel. Hum. 7am (%)	80	78	77	77	76	73	76	76	78	80	79	78	77.3
Rel. Hum. 1pm (%)	61	62	64	60	66	65	65	68	68	65	65	64	64.4
Sunshine (Hours)	8.3	8.6	8.5	8.7	8.2	7.7	8.2	8	7.2	7.4	7.8	7.8	8.0

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

The dominant winds over Jamaica are the northeast trade winds whose strength is governed by the strength and location of the Azores-Bermuda sub tropic high-pressure cell. During the summer months the high-pressure cell is weaker and farther north (than in summer) and consequently the trade winds are broad, persistent and extend further south. In the winter months, the central pressure of the cell is higher and further south and the winter trade winds are weaker and have a more northerly component.

The wind data for the period 1981 to 1990 show that the most predominant wind directions are from the east and east-southeast, (Table 4.2, Figure 4.1 and Figure 4.2). These are the prevailing sea-breeze directions and reflect the effects of the mountains that lie along an east-west axis. The mountains deflect the dominant northeasterly trade winds and provide the easterly component to the winds. The mean wind speed over the period was 10.3 knots (19.1 km/h). Winds from the south had the highest wind speeds (19.5 knots (kt)) followed by the south-southwest. Winds from the ESE had the lowest average wind speeds. Calm winds were reported 14.7% of the time and wind speeds of 1 to 3 kt were reported 4.2% of the time.

For the 2002 NMIA wind data (see Figure 4.2), it was revealed that the predominant wind direction was from the southeast, followed by the south-south-easterly winds. This is consistent with the historic patterns as reported.

	WIND DIRECTION																
Wind speed (Knots)	**NNE 020-030**	**NE 040-050**	**ENE 060–070**	**E 080–100**	**ESE 110-120**	**SE 130-140**	**SSE 150-160**	**S 170-190**	**SSW 200-210**	**SW 220-230**	**WSW 240-250**	**W 260-280**	**WNW 290-300**	**NW 310-320**	**NNW 330-340**	**N 350-010**	**All DIR**
0																	12792
1 – 3	102	47	61	151	66	60	85	143	88	84	64	290	556	644	798	438	3677
4 – 6	373	194	346	796	431	371	545	1035	457	297	281	697	1435	2253	3486	2104	15101
7 – 10	536	311	857	2470	1434	1027	1093	1429	578	279	216	545	866	1801	3787	3020	20249
11 - 16	169	121	868	5520	3675	1714	751	257	87	59	31	79	96	255	809	930	15421
17 - 21	35	14	265	3734	3322	1475	327	45	10	4	2	6	8	53	108	97	9505
22 - 27	15	0	59	2786	3254	1509	238	12	3	1	1	3	5	54	51	70	8061
28 - 33	7	0	8	594	520	224	19	7	1	0	1	0	5	24	31	52	1493
34 - 40	0	0	0	7	8	10	3	3	0	0	1	0	1	15	0	13	61
41 - 47	0	0	1	1	0	1	4	0	0	0	0	0	0	0	0	0	7
48 - 55	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
56 - 63	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	3
>63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Average Speed	18.54	19.09	18.29	14.80	13.67	14.32	17.74	19.46	19.16	18.11	18.03	16.99	16.59	17.54	18.54	18.89	13.94

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

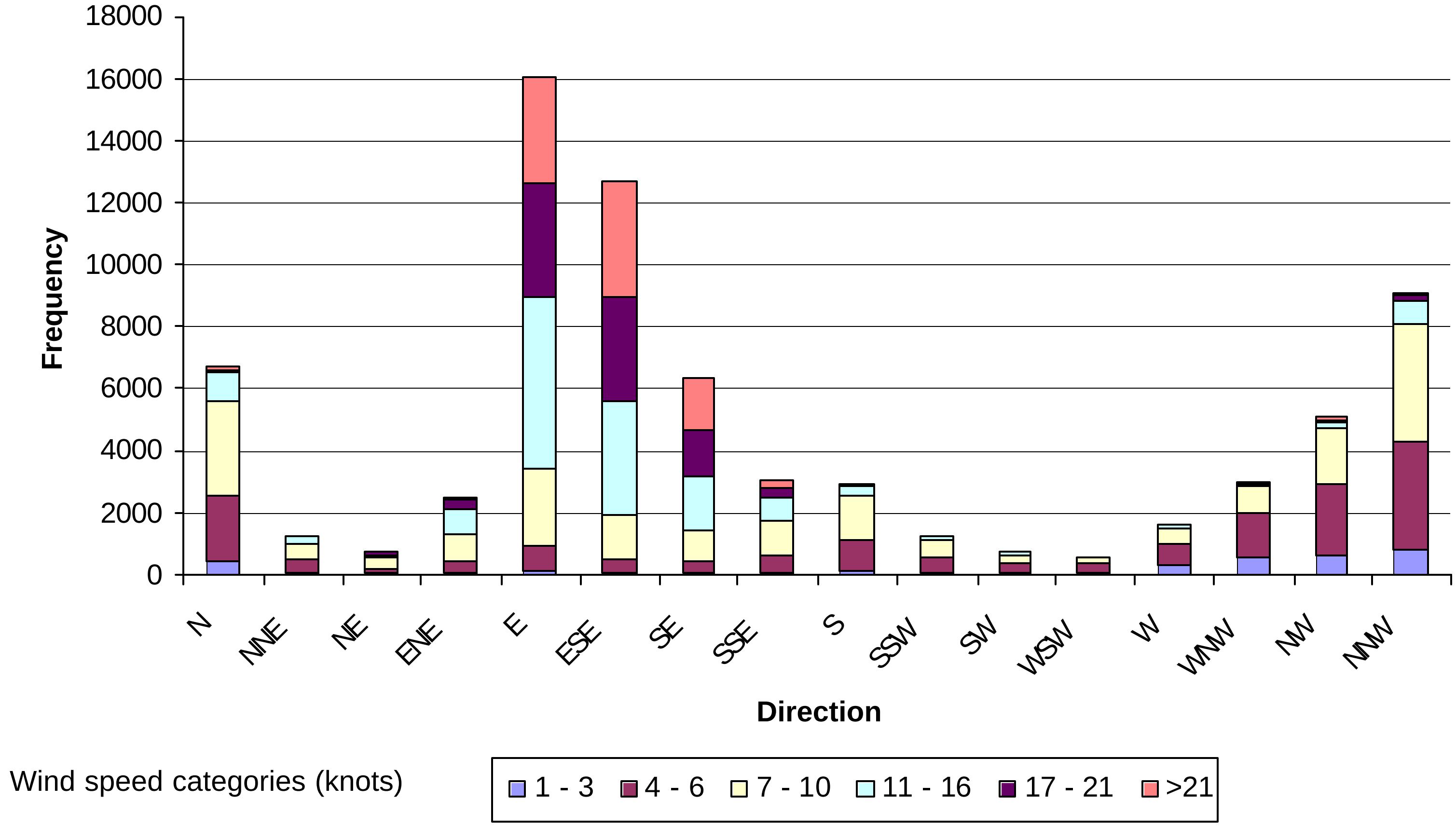

Figure 4.1 Wind Speed and Wind Direction Frequencies at Norman Manley International Airport, 1981 – 1990

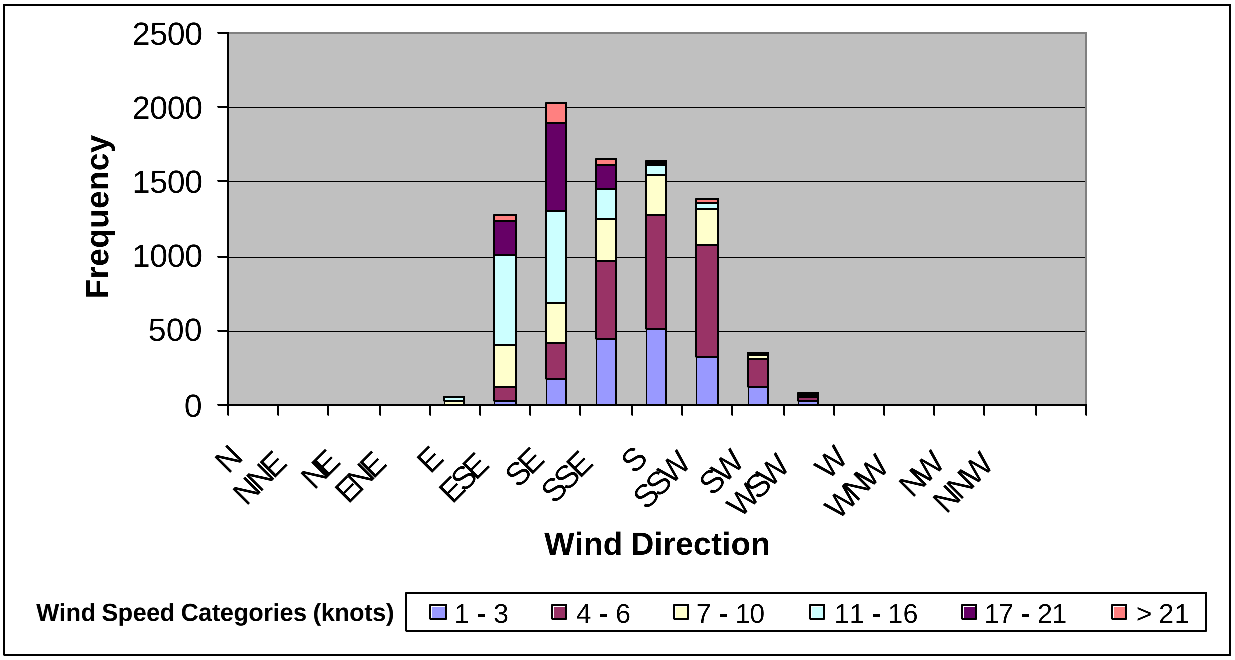

Figure 4.2 Wind Rose: 2002 Norman Manley International Airport Data

4.1.2 Topography and Drainage

The cement factory is located on a narrow coastal strip towards the northeastern segment of Kingston Harbour (Figure 1.2) The low-lying flat coastal strip lies at the base of Long Mountain, which rises sharply to an altitude of 343 meters north of the factory (Figure 4.3). This mountain runs parallel to the coastline in a NW-SE direction.

The main factory compound lies to the north of the main road (Plate 4.1) while support and shipping facilities are located south of the main road along the coastline (Plate 4.2). The coastal strip on which the factory is located is flat with very little relief with maximum altitude between 1–2 meters. The eastern portion of the site is slightly higher with an altitude of 4 meters and the mountain rises abruptly with a uniform slope of greater than 70 degrees.

Jamaica Government, 1983

Figure 4.3 Topography of the Carib Cement Site

Plate 4.1 View of Factory Looking Northwest

Plate 4.2 Factory and Shipping Facilities Looking Northwest

4.1.3 Geology

The coastal strip on which the Carib Cement is located is covered by colluvial soils at the foothills of the Long Mountain (Plate 4.3) and engineered fill mainly on the south side of the main road. The colluvial soils consist of gravelly sand that is in the order of 2 meters thick. The compacted fill along the coastline is protected by rock armour (Plate 4.4).

The underlying limestone belongs to the 'Coastal Group' that refers to a set of impure clastic limestones of late Miocene to Quaternary age (Plate 4.5). These rocks consist of a wide range of carbonate deposits including shallow water limestones, marls, conglomerates, and reef rock with minor interbedded lava flows. This limestone is used by the cement factory as a raw material and is extracted from a quarry located north of the plant (Figure 4.5).

Plate 4.3 View of the Long Mountain behind the factory showing the soils of the coastal strip and the form of limestone on the hill slopes.

Plate 4.4 View of shoreline showing protective rock armour

Plate 4.5 Quarry face north of the factory illustrating the lithology of the Coastal Group of limestones

4.1.4 Hydrology

On Long Mountain, behind the Carib Cement facility, rainfall infiltrates into the limestone bedrock and flows as through flow and groundwater flow. Groundwater emerges as springs at the base of Long Mountain, flow under the road and into the sea. One such spring, Rock Spring, east of Carib Cement, is used by the NWC. A fresh water production well is also used by to provide water for the facility to the factory. The well is licensed to provide a maximum of 150,000 gallons per day. A warm salt-water spring is located to the west of the factory around which a spa is built.

During heavy rainfall events, surface flow may occur on Long Mountain, and becomes channelled though small, shallow dry valleys. Together with the springflow, these cause temporary flooding. There are no well-developed drainage lines on the narrow coastal strip. The factory compound is drained by four storm-water drains that pass through culverts under the main road into the sea.

4.1.5 Landscape and Aesthetics

At present, the Carib Cement facility presents a negative impact on the visual aesthetics. One of the first views of Kingston offered to visitors is that of the industrial zone of the Kingston Harbour, with the dust-shrouded Carib Cement facility prominent in the landscape at the base of Long Mountain. This expansion project, which also aims to reduce dust emissions, will improve this situation.

4.2 AIR AND WATER QUALITY

4.2.1 General Description of the Airshed

Carib Cement is located in an area that is bounded on the north by a NW-SE trending range (Long Mountain) with an elevation of approximately 343 metres. The Kingston Harbour lies to the south and the Palisadoes peninsula marks the southern boundary of the harbour at a distance of about 3 km. To the west and southwest of the harbour at a distance of about 20 km lies the municipality of Portmore. The Rockfort Mineral Spa lies immediately west of the plant, and further west other industrial and commercial enterprises and some residential communities mark the landscape. East of the plant other commercial and more substantial residential communities, such as Harbour View (Figure 4.3) characterise the area.

The mountains form a natural barrier against which the prevailing east and east-southeast winds (sea breezes) carry emissions towards the mountains (Figure 4.4). Land breezes, which occur at night, will transport emissions in a southerly direction towards the sea. The airshed and model domain have therefore been defined as a 21 km by 20 km area with the new dry production line near the centre.

The air discharges from Carib Cement occur from several point and area sources. The point sources are stacks and vents designed specifically for the release of air streams after processing through air pollution control systems, such as electrostatic precipitator or a fabric filter. The discharges from these point sources consist mainly of particulates.

Nitrogen oxides (NOx) and sulphur dioxide (SO_2) are emitted from combustion sources, such as the kiln systems. The area sources include an existing quarry, the clinker storage yard, the shale and gypsum yard, a hot dust dump, the areas where raw materials are crushed, the coal storage area, as well as the packing area. The main emission from these area sources is fugitive particulates.

Figure 4.4 shows the location of the Carib Cement emission sources, as well as the topographical data that was used in the modelling of the facility. Table 4.3 contains the location data for sources at the Carib Cement facility. Figure 4.5 shows the location of buildings that were modelled and input into the Building Profile Input Programme (BPIP) to simulate the building downwash. The other significant air pollution point sources in the Kingston airshed are summarized in Table 4.4

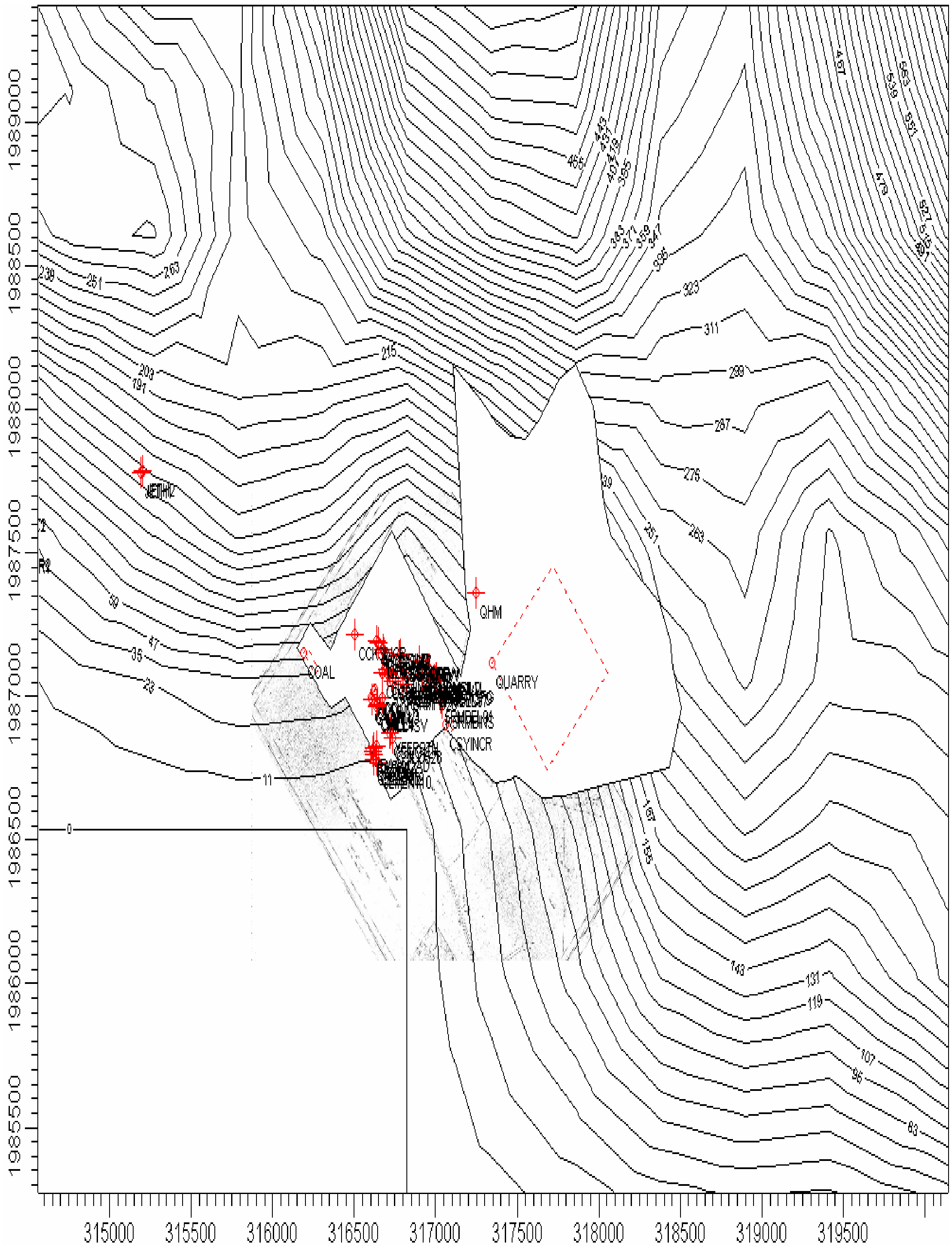

Figure 4.4 Carib Cement Plant with Terrain Contours

Table 4.3 Stack Data for Existing and Future Carib Cement Emission Sources

Plant	Stack ID	UTME m	UTMN m	Elev. m	Stack Height m	Stack Dia. m	Stack Vel. m/s	Stack Temp. K
Quarry Hammer Mill	QHM	316,695	1,987,479	200.0	15.0	2.26	0.1	303
Coal Mill A	COALA	316,691	1,987,304	6.3	2.4	0.91	11.6	363
Coal Mill B	COALB	316,691	1,987,290	6.3	2.4	0.91	11.6	363
Kiln 3 main stack	CCK3	316,433	1,987,235	40.0	44.0	2.60	9.4	433
Kiln 3 clinker cooler vent	CLC3	316,629	1,987,263	6.2	24.4	2.17	20.4	443
kiln 4 main EP	CCK4	316,592	1,987,318	15.0	44.0	2.60	13	363
Main EP discharge	K4EPDIS	316,580	1,987,317	15.0	39.6	0.34	25	303
Kiln 4 clinker cooler vent	CLC4	316,637	1,987,289	6.3	24.4	2.17	20	478
Homogenizing silo vent	4HOMSILV	316,549	1,987,313	15.2	26.0	0.91	33	303
Homogenizing silo discharge	4HOMSILD	316,533	1,987,307	15.2	4.5	0.34	21	303
Clinker silo belts	CSBELTS	316,657	1,987,285	6.1	14.0	1.38	3.2	303
Clinker storage silos (top)	CSSTOP	316,660	1,987,376	22.0	41.0	1.38	2.2	303
Gypsum Hammer crusher	GYPHM	316,647	1,987,161	4.0	2.0	0.20	12	303
Clinker storage silos (bottom belts)	CSSBOTM	316,660	1,987,369	22.0	12.5	0.20	13	303
Cement mill vent	CMILL3	316,688	1,987,208	4.6	10.7	1.38	6	363
Cement mill 4 vent	CMILL4	316,681	1,987,172	4.8	20.0	1.38	7	363
Cement mill 4 separator vent	CMILL4SV	316,681	1,987,166	3.4	16.8	1.38	5	333
Cement silo 1 – 4	CSILO124	316,793	1,987,165	9	36.5	1.03	3	303
Cement silo 5 – 8	CSILO528	316,812	1,987,165	9	36.5	1.03	3	303
Cement silo 9 vent (bags 6X101")	CEMENT9	316,801	1,987,052	2.3	36.5	1.03	3	303
Cement silo 10 vent (bags 6X101")	CEMENT10	316,819	1,987,051	2.3	36.5	1.03	3	303
Distribution bin	DISTBIN	316,783	1,987,049	2.3	36.5	1.03	3	303
Transfer station	XFERSTN	316,793	1,987,175	9	36.5	1.03	3	303
Big bag loading (bags 6X99")	BAGLOAD	316,772	1,987,079	2.8	10.5	1.03	5	303
Packer 4 (bags 6X99")	PACK4	316,765	1,987,066	2.3	10.5	0.91	5	303
Packer 5 (bags 6X129")	PACK5	316,764	1,987,054	2.5	10.5	0.91	5	303
Cement silo 9 and 10 discharge	CS9&10D	316,790	1,987,044	2.4	10.5	0.91	5	333
Raw mill bin feed belt	K5RMFB20	316,737	1,987,325	19.3	3.0	0.25	14	303
Raw mill bin feed belt	K5RMFB30	316,737	1,987,356	21.3	10.0	0.25	14	303
Raw mill bins	K5RMBINS	316,933	1,987,448	39.4	30.0	0.40	15	303
Raw mill feed belt	5RMBEL91	316,920	1,987,450	38.0	10.0	0.40	14	303
Raw mill feed belt	5RMBEL97	316,859	1,987,460	38.0	24.0	0.30	17	303
Raw mill system fugitive	5RMSYSFG	316,853	1,987,474	38.0	10.0	0.40	14	303
Raw mill cyclone fugitive	5RMCYCFG	316,834	1,987,462	38.0	10.0	0.30	16	303
Homogenizing silo vent	5HOMSILV	316,807	1,987,460	38.0	34.0	0.45	15	303
Homogenizing silo discharge	5HOMSILD	316,809	1,987,466	38.0	10.0	0.45	15	303
Kiln feed vent	K5FEEDV	316,809	1,987,466	38.0	95.0	0.40	14	303
Clinker cooler vent	CLC5	316,751	1,987,438	34.0	29.0	1.80	13	394
Kiln 5 main fabric filter	CCK5	316,790	1,987,425	38.0	117.5	2.60	17	381

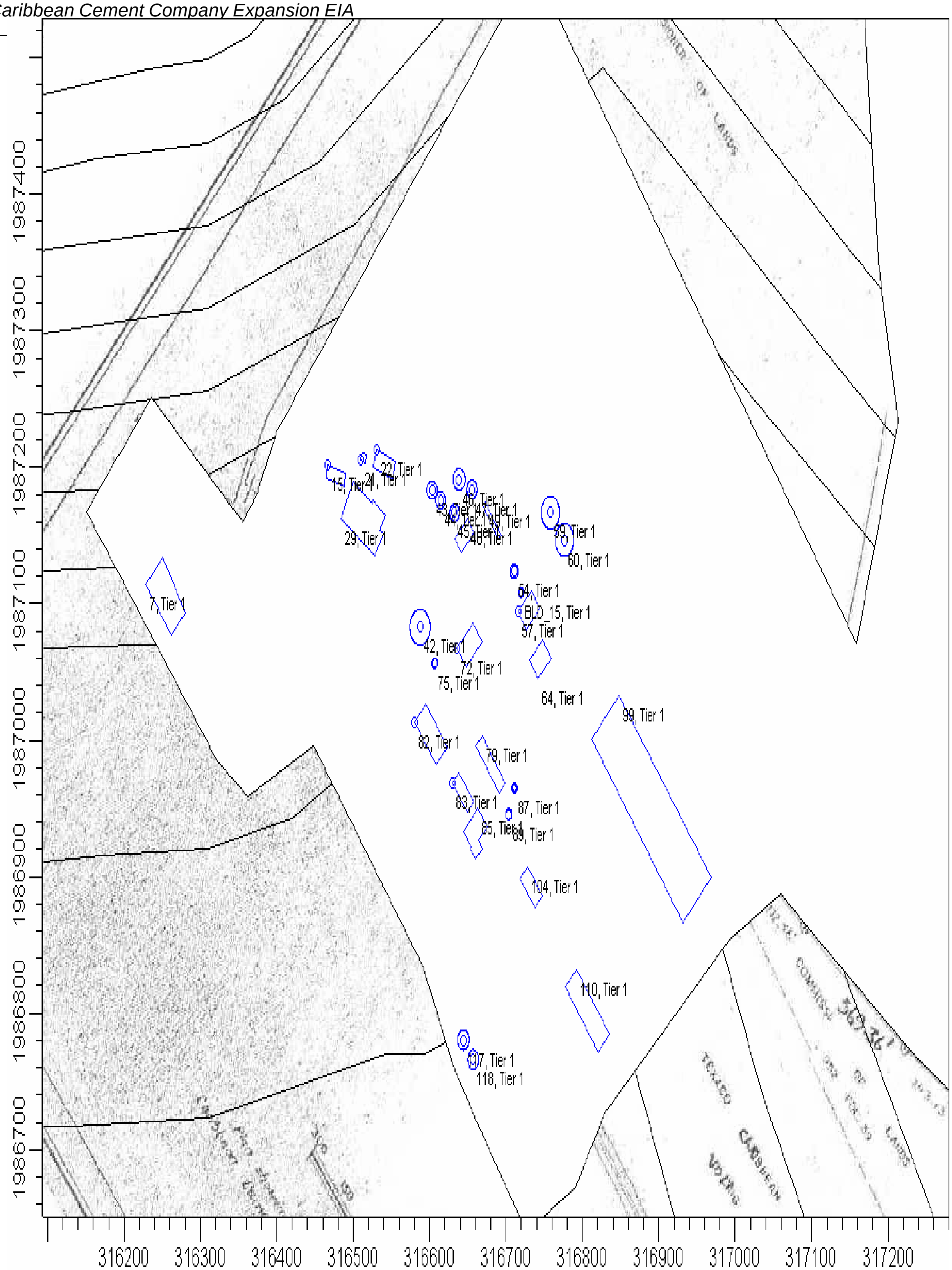

Figure 4.5 Map of Carib Cement Buildings Modelled for Use with BPIP programme

Plant	Stack ID	UTME	UTME	Elev	SO2	NO2	PM	Stack Height	Stack Dia.	Stack Vel.	Stack Temp
		M	M	m	g/s	g/s	g/s	m	m	m/s	K
Jamaica Ethanol Processing Ltd	Jeth2	315,204	1,987,782	20	6.43	0.64	0.43	6.2	0.60	9.81	458
JPS Hunts Bay B6	JPHB6	308,212	1,987,859	1	251.3	26.10	9.90	45.7	2.90	23.90	439
JPS Hunts Bay GT10	JPSGT10	308,300	1,987,871	1	27.5	38.34	3.35	9.5	4.20	15.80	689
JPS Hunts Bay GT5	JPSGT5	308,392	1,988,081	1	18.2	25.36	2.22	12.0	10.10	8.30	766
JPS-Rockfort	JPSR1	314,442	1,987,512	1	100.9	55.70	2.80	38.8	1.76	26.20	645
JPS-Rockfort	JPSR2	314,442	1,987,522	1	117.3	47.10	2.90	38.8	1.76	30.80	666
0JPPC Engine 1	JPPC1	314,414	1,987,661	1	83.1	157.20	8.90	65.0	1.80	45.90	572
JPPC Engine 2	JPPC1	314,414	1,987,661	1	83.1	134.50	9.70	65.0	1.80	45.90	572
PJAM Pipestill heater	PJAMF-1	307,439	1,988,147	1	45.8	5.28	3.46	69.4	3.05	4.19	650
PJAM Powerformer Feed Preheater	PJAMF-2	307,448	1,988,156	1	9.4	0.79	0.02	45.7	2.90	1.66	811
PJAM No.1 Reheat coils F-3	PJAMF-3-4	307,447	1,988,162	1	3.1	0.26	0.006	45.7	2.90	0.81	811
PJAM No.2 Reheat coils F-4	PJAMF-3-4	307,447	1,988,162	1	1.5	0.12	0.003	45.7	2.90	0.81	811
PJAM Vacuum Furnace	PJAMF201	307,452	1,988,162	1	2.5	0.21	0.005	20.8	0.69	3.71	674
PJAM GTG High & Low Temp Coils	PJAMF6	307,464	1,988,146	1	1.4	4.96	0.43	18.3	1.83	32.06	673
PJAM Foster Wheeler Boiler	FWB	307,450	1,988,135	1	21.7	2.50	1.63	16.2	0.80	24.90	623

Plant	Stack ID	UTME	UTME	Elev	SO2	NO2	PM	Stack Height	Stack Dia.	Stack Vel.	Stack Temp
		M	M	m	g/s	g/s	g/s	m	m	m/s	K
PJAM Cleaver Brooks Boiler (Standby)	CBB	307,462	1,988,123	1	38.5	4.50	2.91	16.2	0.80	44.30	623
PJAM Hurst Boiler (Standby)	F-1	307,439	1,988,147	1	1.7	0.58	0.05	69.4	3.05	0.58	650
PJAM Volcano Boiler (Standby)	F-1	307,439	1,988,147	1	1.4	0.47	0.04	69.4	3.05	0.47	650
PJAM Flare	FLR	307,330	1,988,172	1	0.3	0.03	0.001	45.7	0.20	Na	na
PJAM F-401	F-400	307,544	1,988,096	1	1.6	0.14	0.003	45.7	2.90	0.37	483
PJAM Platformer Charge Heater F-411	F-400	307,544	1,988,096	1	3.6	0.30	0.01	45.7	2.90	0.81	483
PJAM No.1 Interheater F-412	F-400	307,544	1,988,096	1	4.6	0.39	0.01	45.7	2.90	1.03	483
PJAM No.2 Interheater F-412	F-400	307,544	1,988,096	1	2.8	0.24	0.01	45.7	2.90	0.63	483

(Source: Internal CCL reports)

Table 4.4 Summary Air Pollution Point Sources in the Kingston Airshed

5.3% existing SO_2 emissions, 11.6% of existing NOx emissions and 31.2% of existing particulate emissions.

The Jamaica Private Power Company is a slow speed diesel generating station and is the major point source in the airshed for NO_2 (50.1%) and particulate (30.7%) emissions. Other major point sources are the JPS electricity generating station at Rockfort and the Petrojam refinery. The remaining point sources are facilities with industrial boilers. All sources use up to 3% heavy fuel oil except for the JPPC plant that is permitted to burn up to 2.2% sulphur oil.

Motor vehicles are the other major source of nitrogen oxides and particulate matter. Current emission rates for these sources are not available and hence were not considered explicitly in the modelling analysis. Instead the background air quality levels for NOx and PM (that will be added in order to achieve the highest potential impact) are assumed to include the contribution from all sources other than those listed in Table 4.4.

4.2.2 Existing Air Quality

Ambient air quality monitoring data for the Kingston area are limited. The consultants conducted ambient respirable particulate measurements at four Carib Cement sites and five communities in proximity to the Carib Cement plant. Additionally, carbon monoxide, hydrogen sulphide, combustibles and SO_2 gases were measured using direct reading instruments.

Table 4.5 shows the results of the respirable particulate analyses while Table 4.6 presents the results of the other ambient gaseous emission measurements. It should be noted that within the project area there are other significant contributors to the quality of the airshed. Hence, the results obtained for the community sites should not be interpreted to read that Carib Cement is the sole contributor.

LOCATION	**Results (24 hrs of sampling) /mg/m^3**	**NEPA Ambient 24 Hr Standard mg/m^3**
Hot Dust Dump	323.3	150
August Town Quarry	187.5	
Sales at Carib Cement	312.3	
Below Coal Wharf	167.9	
Rennock Lodge Primary	318.3	
Caribbean Terrace	166.6	
Harbour Drive	196.2	
Mineral Spa	405.2	
Control – Maritime Inst.	41.99	

Particulate matter includes dust, dirt, soot, smoke and liquid droplets.
Respirable particulates are particles with diameter less than 10 microns (PM10).

Table 4.5 Current Ambient Respirable Particulate Levels

PARAMETERS	**SAMPLE SITES**		**NEPA Ambient Air Quality Standards /µg/m^3**
	Kiln #3	**Coal Mill**	
Carbon Monoxide (ppm)	0.0	0.0	40,000
Hydrogen Sulphide (ppm)	0.0	0.0	
Combustibles (%)	0.0	0.0	
Sulphur dioxide (ppm)	<0.4	<0.4	700

Table 4.6 Ambient Gaseous Emissions

The data show that emissions at the Carib Cement plant on the day of sampling were well within the NEPA ambient air quality standards.

4.2.2.1 Carib Cement Plant Sites

The data show that ambient respirable particulate levels at some of the Carib Cement sites are currently exceeding the NEPA ambient respirable particulate standard of 150 µg/m^3. The results are however well within the Occupational Health and Safety Administration (OSHA) standard of 10 mg/$m^{3.}$ The expansion work will include the removal of this hot dust dump, which will improve the air quality at this site.

4.2.2.2 Community Sites

Highest respirable particulate levels in surrounding communities were measured at the mineral spa and the Rennock Lodge School (405.2 and 318.3µg/m^3 respectively). These concentrations are elevated. Respirable particulate levels in the Harbour View and Caribbean Terrace communities are slightly above the 24-hour standard. Respirable particulates occur from a number of sources including roadside dust, wind blown particulates from open lots, vehicular activities, industrial activities, sea spray, and etcetera. Carib Cement is only one of several industrial facilities in the Rockfort area that contribute to the PM10 levels.

With the proposed expansion and the use of improved dust control devices the concentration of ambient particulates emitted from the Carib Cement's operations will be significantly reduced. The results from the dispersion model show that the PM data from the new configuration will be only slightly out of compliance with the NEPA standard.

4.2.3 Water Quality – Coastal Zone

The surface water quality component of the assessment is intended to provide essential baseline data on the quality of the surface waters in the project area. The primary consideration is the nature and extent of the present impacts from the operations of the cement company on coastal water quality. The stations were chosen based on their location relative to the main surface water drainage channels exiting Carib Cement (Figure 1.1).

It must be stated for the record that the following discussion is based on data generated from only one sampling exercise, the results of which are presented in Table 4.7. Therefore, no conclusive inferences can be drawn from the limited data although it does provide an indication of the current water quality status in the coastal zone.

PARAMETER PARAMETERS	SAMPLES				
	RF # 1	RF # 2	RF # 3	RF # 4	NEPA Marine Standards
PH	8.2	8.2	8.2	8.2	8.0-8.44
Salinity (ppt)	34.7	33.4	33.9	34.2	-
Dissolved Oxygen (mg/L)	7.0	8.6	7.3	7.7	4.5-6.8
BOD (mg/L)	14.0	16.0	4.0	8.0	0.57-1.16
TSS (mg/L)	38.3	27.7	10.0	16.7	-
Marine Nitrate (mg/L)	0.1	4.8	4.3	0.8	0.001-0.081
Phosphate (mg/L)	0.3	1.1	0.2	0.1	0.001-0.055
Total Coliform (MPN/100ml)	<3	150.0	93.0	240.0	48-256
Faecal Coliform (MPN/100ml)	<3	93.0	43.0	3.0	<2-13
Oil & Grease (mg/L)	1.1	0.7	1.6	2.4	-

Table 4.7 Water Quality Data for Samples collected in the Coastal Zone off Carib Cement, October 14, 2004

However, the current data is supplemented by the data from Carib Cement's ongoing wastewater monitoring programme for the three main drainage channels which discharge wastewater to the marine environment (East, Central and West Drains). These drains take plant wash down (slurry tank cleaning, vehicle washing, etc), process cooling water, final effluent from the sewage treatment plant and storm water (runoff and leakage from storage piles).

At most cement manufacturing plants effluents requiring treatment result from cooling operations or from storm water runoff. The parameters of importance with respect to cooling water effluent are pH and temperature. Treated effluent discharges should have a pH in the range of 6-9. Cooling waters should preferably be recycled. If this is not economical, then the effluent should not increase the temperature of the receiving waters at the edge of mixing zone (or 100 meters where the mixing zone is not defined) by more than 3 degrees Celsius. At Carib Cement investigations indicate that pH is within the required range according to NEPA standards and cooling water temperatures are generally at ambient levels.

Stormwater or other surface runoff at cement plants may have high total suspended solids. If the suspended solid loading is high in relation to the receiving waters, treatment may be required to reduce levels in the effluent to meet the NEPA guideline of (30/150 milligrams per litre (mg/L)). The proposed replacement of the wet process with a new dry line will significantly improve the quality of the wastewater at Carib Cement. Removal of the wet process will effectively reduce the sediment loads to the drains.

Carib Cement has recently upgraded its sewage treatment system; this has resulted in reduced bacterial and nutrient loads to the drains. Faecal Coliform and suspended solids from the sewage plant are normally well within the national standard. The data for the coastal water quality survey show that pH, dissolved oxygen, oil and grease, and bacterial concentrations are within the national guidelines. The parameters that are currently out of compliance will be discussed as follows:

4.2.3.1 Biochemical Oxygen Demand

BOD for surface waters in excess of 2.0 mg/l indicates elevated organic loading. BOD levels were elevated at all four stations ranging between 4 and 16 mg/l.

4.2.3.2 Nitrates

Nitrate levels are also used as an indicator of contamination by wastewater from sewage and/or fertilisers from agriculture. Nitrate levels in coastal waters higher than 1 micro-mole (µM) or 0.65 mg/l NO_3 usually indicate nutrient enrichment from one or both sources.

Nitrate concentrations exceeded 1.0 µM at all stations sampled, with a maximum of 73.0µM (4.8 mg/l) measured at Station RF#2. High nitrate levels were also recorded at Station RF#3. The data show considerable nitrate enrichment in the coastal zone. The groundwater in the Rockfort area reportedly has high nitrate levels and it is likely that the high nitrate concentration in the coastal waters is influenced by groundwater and other nitrate rich surface waters in the project area.

4.2.3.3 Phosphates

The phosphate concentration at all four stations was high, particularly at Station RF#2.

4.2.3.4 Total Suspended Solids

The Massachusetts Department of Environment (MDE) 2002 Integrated List of Water Standards recommend maximum suspended solids concentration of 25 mg/l to prevent damage to aquatic life [Massachusetts Department in Smith-Shirley, 2004]. Total suspended solids at RF#1 and RF#2 are currently exceeding this guideline. NEPA does not currently have an ambient guideline for suspended solids. Using the trade effluent guideline of 30 mg/l, Station RF#1 would remain out of compliance.

The water quality at the stations surveyed appeared to be impacted by shore-side activities. The proposed expansion will likely effect an improvement in the effluent quality discharged to the coastal zone. The 'dry-process' technology generates cooling water as the primary liquid effluent, and indications above suggest no major impact.

4.2.3.5 ONGOING ENVIRONMENTAL MONITORING PROGRAMS

Carib Cement currently monitors the following sources of pollution at its Rockfort plant:

- Wastewater monitoring in satisfaction of the NRCA Section 17 pollution control requirement is conducted bimonthly at the three main discharge drains and the sewage treatment plant. This sampling programme is ongoing. Appendix 2 presents the water quality monitoring data for 2004.
- Dust fall, total suspended particulate monitoring is conducted monthly at eight sites, August Town quarry, Carib Cement main gate, Mineral Spa, Carib Cement sales Office, Caribbean Terrace and Harbour Drive in Harbour View, the hot dust dump and Rockfort.

Carib Cement is currently in an advanced state of discussions with a team from General Electric Company with the object of purchasing state of the art dust control equipment. While the Carib Cement has not achieved compliance with all the parameters that are being measured, it is making steady progress with its environmental programme.

4.2.4 Noise Levels

In cement plants, noise is generated by various pieces of machinery, such as; crushers, grinding mills, fans, blowers, compressors and conveyors. The noise levels emitted in cement plants is known to vary between 70 and 118 decibels. Noise abatement measures should achieve the guideline established by NEPA or a maximum increase in background levels of 3 dBA.

Noise measurements were taken at noise receptors located inside the plant and at the plant boundary (Table 4.8).

LOCATIONS	READINGS (dbA)	NEPA GUIDE LINES (dbA)
Main Gate	76.4	75
Weighing Bridge at Sales	86.0	

Table 4.8 Noise measurements data for Carib Cement

Perimeter noise level is somewhat above the recommended guideline at Sales. The noise level at Sales is of short duration and is likely due to the impact of the haulage trucks (startup/horn blowing). Both sites are influenced significantly by vehicular noise from the main road.

4.3 NATURAL HAZARD VULNERABILITY

The project site is exposed to three of the main natural hazards that affect Jamaica, viz. earthquakes, coastal flooding and hurricanes.

4.3.1 Seismic Activity

Earthquake hazard zones for Jamaica were determined over the period from 1692 to the present time and shows that the Kingston area lies within the zone of highest probability of high intensity earthquakes in Jamaica (Figure 4.7). Data from the Earthquake Unit at the University of the West Indies indicate that for Modified Mercalli Intensities (MMI) the Kingston area has an average exposure rate of 7 occurrences per century. MMI is the threshold for damage to ordinary but well-built structures.

Strong motion studies of earthquakes and the response of underlying materials undertaken by the Caribbean Disaster Mitigation Project (CDMP, 1999) produced a strong motion earthquake hazard map for Kingston Metropolitan Area. This map (Figure 4.8) shows the horizontal ground motion expected as a percentage of gravitational acceleration in areas of differing underlying substrate.

The acceleration rates represent the site-corrected earthquake ground motion that has a 10% chance of being exceeded in 50 years. The map indicates that the proposed project site lies in an area that requires a site specific ground motion study to determine the likely behaviour of the existing soils to ground motion induced by earthquakes. Alluvium and engineered soils that exist at the project site are highly susceptible to ground shaking and tend to amplify the effects of ground motion through earthquakes.

To reduce the earthquake hazard, Carib Cement's facility will be designed to withstand the ground motions expected. This will involve detailed site investigations and modelling.

In addition to extensive geotechnical surveys already completed, the company is presently conducting a Wave Propagation Test for inclusion in the engineering data set for its plant design.

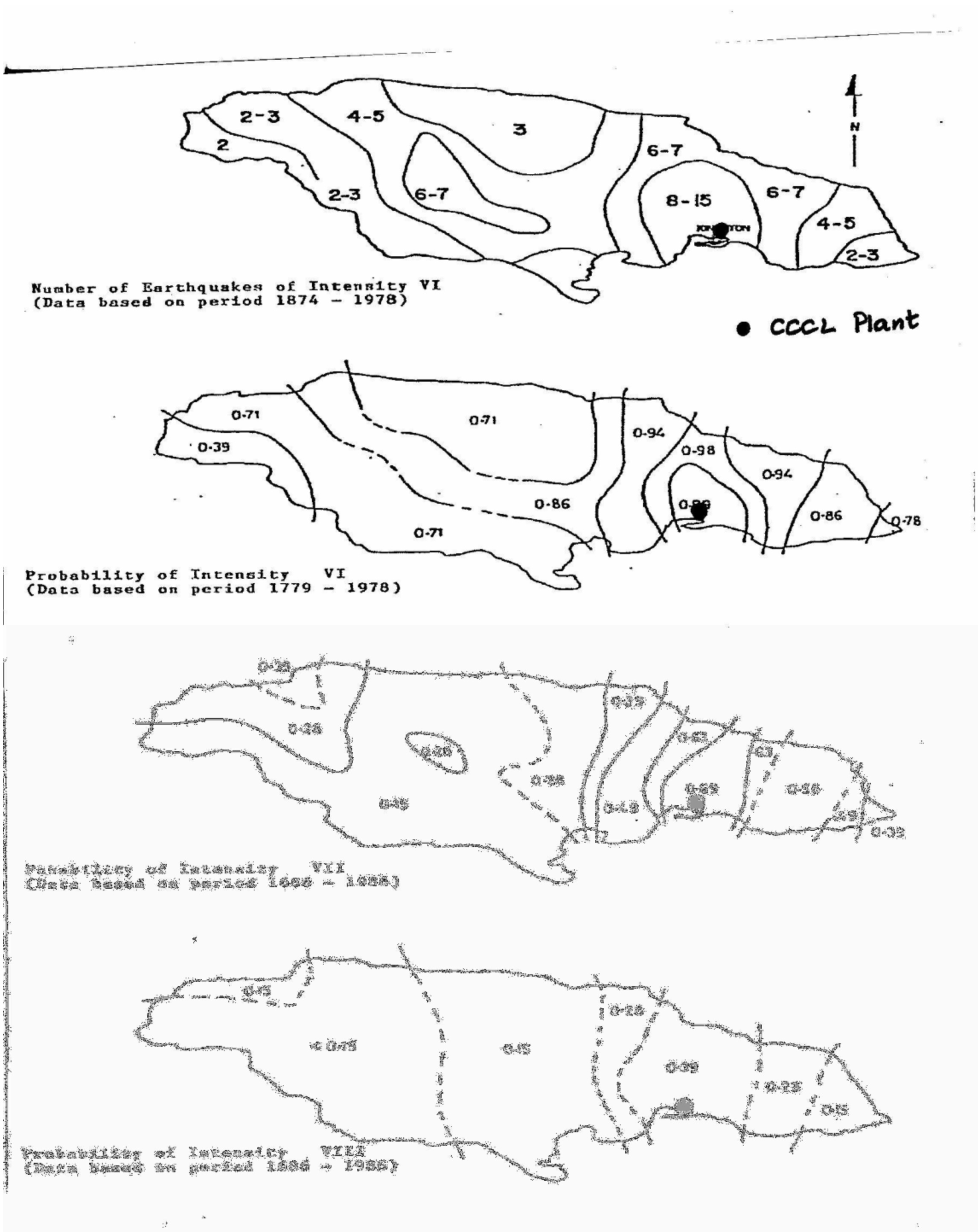

Figure 4.7 Earthquake Hazard Zonation of Jamaica.

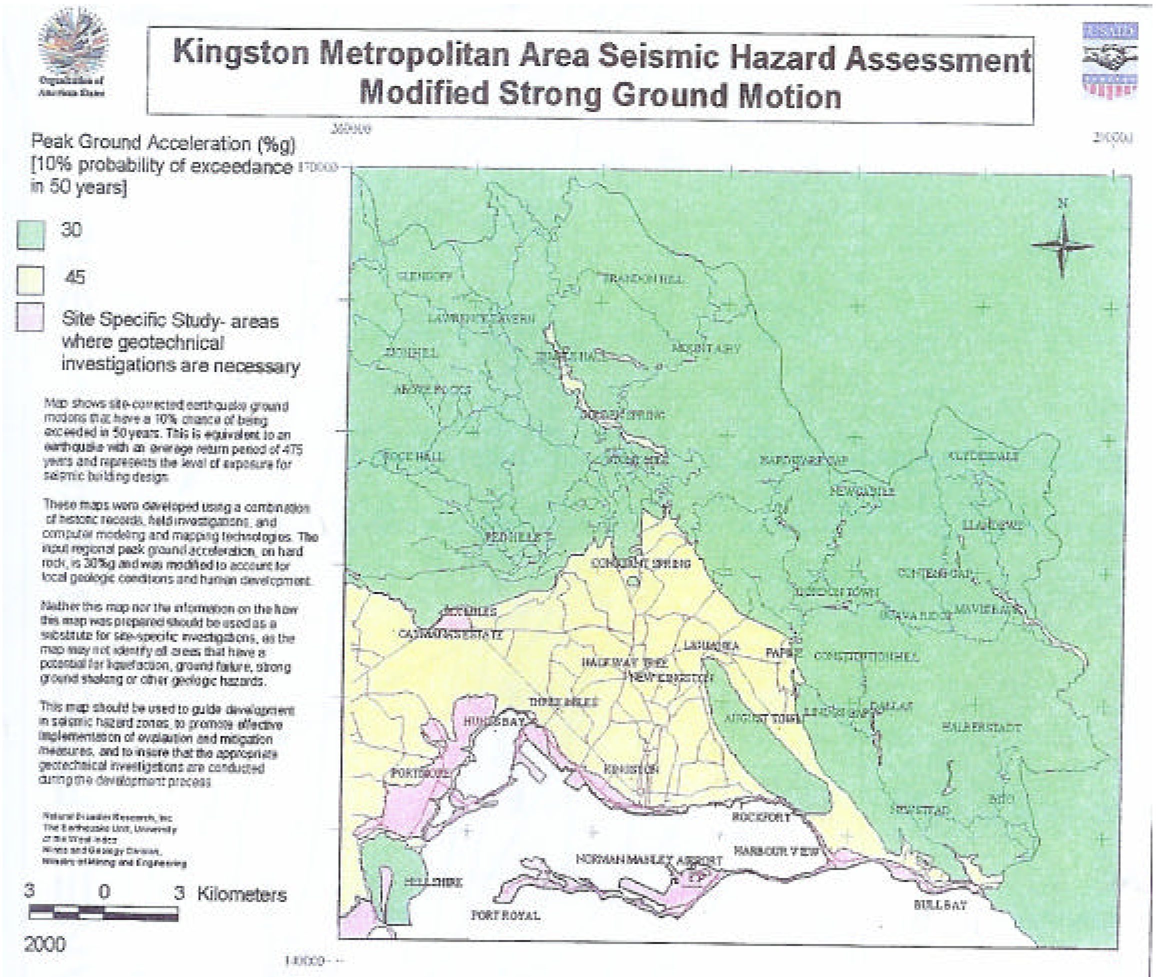

Figure 4.8 Strong Motion Seismic Hazard for the Kingston Metropolitan Area

4.3.2 Hurricanes

Hurricanes produce heavy rainfall, high winds, and storm surge, all of which have the potential to cause damage and dislocation at the Carib Cement plant. The high velocity winds can cause structural damage. Hurricane Ivan in 2004 caused damage to the cladding on numerous parts of the Carib Cement buildings. Carib Cement has since implemented a maintenance programme for its structures, to ensure that they can.

4.3.3 Coastal Flooding

The site is located on a low-lying coastal strip that is susceptible to storm surge produced by hurricanes that have the potential to cause severe coastal erosion and inundation. The experience of the last two major hurricanes that affected Jamaica, Gilbert in 1988 and Ivan in

2004 suggests that the Palisadoes peninsula reduces the build-up of storm surge within the Kingston Harbour. This minimizes the potential threat to the coastline in the north and northeast sections of the harbour on where the plant is located.

4.4 BIOLOGICAL ENVIRONMENT

4.4.1 Flora

Carib Cement situated on the Windward Road is within a highly industrialized area with other major industrial type business in the area including the Jamaica Flour Mills, Shell Company of the West Indies, Tropigas S.A. Texaco Limited and the Jamaica Ethanol Plant. These businesses generate a high level of activity in the area and include transportation of goods and services, factory operations, commuter traffic and shipping facilities.

To the north west of Carib Cement is the Long Mountain range, and behind the facility to the northeast is the Dallas Mountain. Vegetative communities within the area are dominated by these mountain ranges behind the facilities, and in closer proximity, south of the factory and south of the main road, are roadside fringes of trees mixed with open grey areas and scrubland (Plate 4.6).

Plate 4.6 Vegetation around the Carib Cement plant

Based on Grossman *et al* (1991), the vegetation along the Windward Road in the proximity of Carib Cement can be classified as modified secondary communities, particularly scrubland. The species composition is consistent with coastal vegetation including Button Mangrove, Seaside Mahoe and Almond; and vegetation associated with open waste places including Oleander, Duppy Cherry, and Crab With. A list of the plants previously reported from this area, by ESL in 2001, is given in Tables 4.9a-c. The quarry located behind the main plant is south of the Long Mountain Range, which is characterised by dry limestone forest. This quarry is dominated by scrubland and bare surfaces, resulting from the quarry operations.

There are no rare, threatened or endangered plants or animals reported from the area extending from Rennock Lodge in the west to the Harbour View round about in the east.

Monocotyledons		
FAMILY	**BOTANICAL NAME**	**COMMON NAME**
Poaceae	Andropogon pertusus	Seymour Grass
Poaceae	Dactyloctenium aegyptium	
Dicotyledons		
Amaranthaceae	Alternanthera ficoides	Crab With
Apocynaceae	Nerium oleander	Oleander
Bignoniaceae	Tabebouia sp1	
Bignoniaceae	Tabebouia sp2	
Caesalpiniacea	Delonix regia	Poinciana
Caeasalpiniaceae	Parkinsonia aculeate	Jerusalem Thorn
Caeasalpiniaceae	Peltopphorum pterocarpum	
Combretaceae	Peltophorum pterocarpum	
Combretaceae	Conocarpus erectus	Button Mangrove
Combretaceae	Terminalia catappa	Almond
Fabaceae	Melletia thonningii	
Mimosaceae	Leucaena leucocephala	Lead Tree
Mimosaceae	Prosopis juliflora	Cashaw
Nyctaginaceae	Bougainvillea sp.	Bougainvillea
Polygonaceae	Antigonon leptopus	Coralita
Sterculiaceae	Waltheria	Raichie

ESL, 2001

Table 4.9a Dominant Flora identified in the vicinity of Rockfort Mineral Baths

Dicotyledons		
FAMILY	**BOTANICAL NAME**	**COMMON NAME**
Amaranthaceae	Alternanthera ficoides	Crab With
Apocynaceae	Nerium oleander	Oleander
Combretaceae	Conocarpus erectus	Button Mangrove
Convolvulaceae	Ipomoea sp.	
Mimosaceae	Albizia lebbeck	Woman Tongue Tree
Mimosaceae	Leucaena leucocephala	Lead Tree
Polygonaceae	Antigonon leptopus	Coralita
Rhamnaceae	Ziziphus mauritian	Coolie Plum

ESL, 2001

Table 4.9b List of Dominant Flora identified in vicinity of Jamaica Flour Mills

Dicotyledons		
FAMILY	**BOTANICAL NAME**	**COMMON NAME**
Amaranthaceae	Alternanthera ficoides	Crab With
Apocynaceae	Nerium oleander	Oleander
Combretaceae	Conocarpus erectus	Button Mangrove
Convolvulaceae	Ipomoea sp.	
Mimosaceae	Albizia lebbeck	Woman Tongue Tree
Mimosaceae	Leucaena leucocephala	Lead Tree
Polygonaceae	Antigonon leptopus	Coralita
Rhamnaceae	Ziziphus mauritian	Coolie Plum

ESL, 2001

Table 4.9c List of Dominant Flora identified in vicinity of Shell /Esso facility

Monocotyledons		
FAMILY	**BOTANICAL NAME**	**COMMON NAME**
Poaceae	Andropogon pertusus	Seymour Grass
Poaceae		
Dicotyledons		
Amaranthaceae	Alternanthera ficoides	Crab With
Asclepiadaceae	Calotropis procera	French Cotton
Avicenniaceae	Avicennia germinans	Black Mangrove
Bignoniaceae	Tabebouia sp1	
Boraginaceae	Cordia alba	Duppy Cherry
Boraginaceae	Heliotropiumangiospermum	Dogstail
Caeasalpiniaceae	Parkinsonia aculeate	Jerusalem Thorn
Fabaceae	Canavalia maritima	Seaside Bean
Fabaceae	Desmodium sp.	
Malvaceae	Herissantia srispa	
Malvaceae	Thespesia populnea	Seaside Mahoe
Mimosaceae	Acacia tortusosa	Wild Popanox
Mimosaceae	Leucaena leucocephala	Lead Tree
Polygonaceae	Antigonon leptopus	Coralita
Rhamnaceae	Ziziphus mauritiana	Coolie Plum
Scrphulariaceae	Capraria biflora	Goatweed
Sterculiaceae	Waltheria indica	Raichie

ESL, 2001

Table 4.9d List of Dominant Flora identified to the east of the Carib Cement plant

4.4.2 Fauna

The American Crocodile (*Crocodylous acutus*), protected by national and international law, has been reported as present in the Kingston Harbour. Although there have been no recent reports of sightings from the area of Rockfort, the Kingston Harbour and associated coastal environment must be recognized as a habitat for this species.

Several species of butterfly were observed on the Windward Road and at the JGQ quarry. These included Sulphurs (*Phoebis* spp.), which are commonly found in open land, trees, shrubs and dry coastal areas; and the Flambeaus (*Dryas* sp.) which are found in lowland areas. Species of butterfly previously reported from the Windward Road environs is given in Table 4.10. No threatened or endangered butterflies exist in the Rockfort area.

Scientific Name	Common Name	Range	Habitat
Phoebis spp.	Sulfurs	Throughout the Caribbean, South America and southern USA.	Open land, trees and shrubs and dry coastal areas.
Appias drusilla jacksoni	Florida Whites	South Florida to Brazil (endemic sub- species)	Coastal areas.
Ascia monuste monuste	Great Whites	Gulf coast states of the US, Caribbean and south America (endemic sub-species)	Numerous towards dry coastal areas.
Eurema lisa euterpe	Yellows	Southern USA to Costa Rica and Throughout the Caribbean (endemic sub- species)	Dry coastal areas.
Hermiargus hanno	Hanno Blue	Widespread in Florida and the Caribbean	Open roadsides, gardens, meadows and flowery margins of woods. Host plants include legumes such as Crotalaria
Dione vanillae isnularis	Silverspot	Central and south America and the Caribbean (endemic sub-species)	Lowland flowers gardens.
Precis evarete zonalis (Junonia evarete)	Buckeye	Central America and the Caribbean	Coastal range associated with mangrove habitat. Host plant includes black mangrove (Avicennia germinans) and blue Porterwood (Stachytarpheta jamaicensis).
Dryas iulia delila	Flambeau	Common throughout the Caribbean (endemic sub-species)	Found in lowlands. Host plants include Bougainvillea, Poinsettia, lantana, Zinnia and Bidens.
Anartia jatrophae jamaicensis	White peacock	Central and South America, Greater and Lesser Antilles, Southern USA (endemic sub-species)	Common in open country, roadsides, beaches, wastelands often in ass. with species such as the Buckeye. Host plants include water hyssop.
Colobura dirce avinoffi	Mosaic	Mexico to Paraguay and Greater Antilles	Mostly found in shade of forests or plantations.
Polygonus-leohagar	Skipper	Endemic Sub- species	Common from gardens to meadows.
Danaus sp.	Monarchs	Native. South east USA, Caribbean, Central and S America	Open land including meadows and marshes.

Table 4.10 Butterfly Species Identified at all Three Vegetated Areas on south side of Windward Road (ESL, 2001)

4.4.3 Coastal Environment

The coastal area adjacent to the Cement Company pier and operations is mostly shallow with the bed consisting mainly of sand, muddy substrate and some patches of Seagrasses (Plate 4.10) .

Plate 4.7 Coastal Area Adjacent to Wharf Facilities

4.5 SOCIAL SETTING

Analysis of the socio-economic environment will be grouped under communities, land use patterns, population and demography, health, transportation and water. These reflect the issues of interest in the human environment relating to the project. The perception of current Carib Cement operations and the proposed expansion by communities located close to the plant was also examined for this section of the report.

4.5.1 The Communities

The residential communities surveyed comprise a mix of low income and middle-income housing stock, with one or two instances of wealthy hillside homes. The communities can be characterized as mainly low income, with pockets of squatter elements.

A corridor of industrial plants runs adjacent to the Kingston Harbour (Industrial Corridor, Figure 4.9). The largest of these facilities are the Jamaica Flour Mill, Shell Company West Indies Ltd, Texaco Caribbean, Jamaica Public Service and Jamaica Private Power Company.

Starting west of the Carib Cement plant and proceeding eastwards, the communities (Figure 4.9) from which data were collected included:

- Springfield
- Norman Gardens
- Johnson Town
- Rennock Lodge
- The Industrial Corridor
- Bayshore Park (Harbour Heights)
- Harbour View
- Harbour Head Fishing Beach
- Number 1 Palisadoes
- St. Benedicts
- Shooters Hill
- Rest Haven & Copacabana
- Seven Miles
- Bay View
- Ten Miles

4.5.2 Land Use

4.5.2.1 Residential Land Use

Within the project area, relatively large land areas are devoted to human habitation, mainly residential. Although exact hectares utilized by housing have not been estimated, from observation this exceeds any other competing land use. STATIN 2001 census data puts the number of dwellings in these communities at 9,692 (2001 Census STATIN).

At the time of its original construction, the plant was an isolated operation, with no residential and only one or two industrial neighbours. Over the years this has changed. The nearest residential communities now border the plant at Bayshore in the east (Figure 4.9), with a very small element of the community actually squatting on the company's land, and on the flanks of the Hope River Valley close to the Rockfort Mines. To the west, about 2 miles, in a line of sight, is Rennock Lodge, one of the larger communities in a cluster collectively referred to as Rockfort.

Figure 4.9 Communities Within the Socio Economic Survey

The eastward expansion of the urban sprawl that characterizes parts of East Kingston was halted only by the commercialisation of the land east of the Flour Mill. In recent years this pressure for residential land saw settlers moving into the foothills behind the Flour Mill, but steps have been taken to control this.

Table 4.11 presents residential indicators for the Project area. For convenience the communities above have been collapsed into three general areas three areas generally conforming to STATIN's classification of these areas.

Area	Number of Dwellings	Percentage of Total
Rockfort – Springfield to the Industrial Corridor	3,633	37
Harbour View – Harbour View to Shooters Hill	2,212	22
Bull Bay – Rest Haven to Ten Miles	3,847	40
Total	**9,692**	**100**

Table 4.11 Residential Land Use - Housing

4.5.2.2 Industrial Land Use

Within the project area, the main land use in economic terms is industrial followed by quarrying (Table 1.12). The industrial corridor comprises the following main enterprises, and gross revenue generation is estimated to be closely competitive with the Spanish Town Road industrial commercial corridor, but less so with the Newport East/West industrial commercial zone.

COMPANY NAME	TYPE OF BUSINESS
Jamaica Private Power Co. Ltd.	Power Generation
Jamaica Public Service Company LTD's.	Power Generation
Jamaica Flour Mills Ltd.	Milling
Jamaica Ethanol Processing Ltd.	Fuel Processing
Shell Chemicals (JA) Ltd.	Fuel & Chemicals
Texaco Caribbean Inc.	Lubricant manufacture
Rockfort Mineral Baths	Heath spa
Caribbean Cement Co. Ltd.	Cement manufacture.
Caribbean Construction Co. Ltd.	Construction
New Kingston Dry-Dock Ltd.	Boat repair
Jamaica Gypsum & Quarries	Gypsum & Aggregates

Table 4.12 Rockfort Industrial Corridor

An important land use is quarrying, which takes place in the coastal foothills of the Long Mountain, Dallas Mountain and Port Royal Mountains. Quarrying activities stretch eastwards from behind the cement plant, intermittently to the Yallahs Valley (Table 4.13). A total of 14 mining licenses have been granted in this area and are held by 10 licensees. The main materials mined by volume are sand and gravel, limestone, gypsum and shale in that order (Table 4.14).

Operators	Location	No. of Licenses	Materials Quarried	Area (ha)	2004 Production (Est) Tonnes.
Caribbean. Cement	Rockfort	1	Limestone	27.44	775,537
Caribbean Cement	Cambridge Hill	1	Shale	1.40	141,264
Jamaica Gypsum	Bito	1	Gypsum	14.10	202,219
Michael Black	Cane River (Bull Bay)	1	Limestone	21.20	86,604
Howard McKenzie	Cane River (Bull Bay)	1	Limestone	12.38	15,192
Warren Shaw	Cane River (Bull Bay)	1	Limestone	6.03	14,000
Warren Shaw	Cane River (Bull Bay)	1	Sand & Gravel	2.70	Nil
Ludlow Rennicks	Yallahs (River)	1	Sand & Gravel	2.50	7,500
Felicity Lightbourne	Yallahs (River)	1	Sand & Gravel	2.80	113,358
Alvin Nicholas	Yallahs (River)	1	Sand & Gravel	1.60	4,000
Caribbean Aggregates	Yallahs (River)	1	Sand & Gravel	12.00	158,320
Ja. Premix	Yallahs (River) 3 locations	3	Sand & Gravel	19.20	728,779
Total		14		118.35	2,246,773

Source. Mines & Geology Division Ministry of Land & Environment.

Table 4.13 Mining Activities by Operators, Material and Production

Materials Quarried	2004 Production	
	Tonnes	**%**
Limestone	891,333	40
Gypsum	202,219	9
Shale	141,264	6
Total	2,246,773	100

Table 4.14 Annual Quarry Production by Type of Material (MT)

Note. Production figures are those reported by operators. These are, on average, consistent with previous years figures.

At several locations, quarrying is a major air pollution concern in surrounding communities. The pollution arises from the operations at the quarries, or during the transportation of the material. The concerns of the affected communities are reported below.

Mining licenses impose specific mitigation measures on licensees. For hillside mining these measures are mainly concerned with issues of aesthetics and safety. Non-observance of these requirements creates negative impacts both during and after mining has taken place. The Mines and Geology Division regards the Cement Company as being one of the more compliant operators.

Agriculture, outside of backyard farming and small hillside cultivating is not a land use activity in the area. Public recreational activities are mainly centred on the various sports facilities that schools and larger communities offer, and on the beaches, mainly at Seven Miles, that are popular.

The project will not alter the general land use characteristics in the project area and does not affect the land use as currently identified.

4.5.3 Population & Demographics

The 2001 Census data puts the population of the communities lying within the project area at about 41,000. Table 4.15 below illustrates the distribution.

Community	Total Population (2001)	% Increase over 1991	% Male	% Female	% 0-39 yrs	% 40+ yrs
Springfield	1,693	9.9	45.5	54.5	68	32
Rennock Lodge/D'Aguilar Town	8,396	55	49.5	50.5	79	21
Johnson Town	2,559	-28.48	47.0	53.0	79	21
Norman Gardens	2,337	5	46.0	54.0	72	28
Harbour View	8,386	7.60	43.0	57.0	68	32
Bull Bay	17,788	104	44.0	56.0	74	26
Total	41,159					
Averages		26	46	54	73	26

Table 4.15 Community Population

As is typically the case in urban high density communities, the boundaries of communities are people defined and seldom accord with strict local government dellniations. A good example of this is that the area commonly referred to locally as "Rockfort" includes all the communities listed from Springfield through Norman Gardens above, and also some abounding and near to them, as well as sections of the Industrial corridor.

From inference and observation this figure is an understatement of the current population, which over the period 1991-2001 grew by 2.6% per annum on average. Bull Bay (17,800) Rennock

Lodge/D'Aguilar Town (8,400) and Harbour View (8,386) account for 81% of the total population. Harbour View is a lower middle- income housing development. Using this scheme as a point of comparison, about 75% of the population in the project area can be placed in the lower income groups. Females are the majority gender (54%). In addition, all communities have relatively young populations. On average 7.3 out of every 10 members are less than 40 years of age. In the larger sprawl communities, Rennock Lodge/D'Aguilar Town and Bull Bay this ratio is even higher. Where large populations in low-income communities coexist with young female led households, dependency ratios are high. Although not calculated for the Project area, when related to other similar populations for which figures are available, it is likely to be in the order of 70%, the assumption being that about 7of every 10 persons are dependents of others.

This population profile, juxtaposed with a capital intensive, high skill level, industrial corridor, has several implications. Firstly, employment opportunities for community members bordering this economic zone are extremely limited. One consequence is that almost any project will find community acceptance providing it offers an employment opportunity. The current project is no exception. The most frequently sought after information from the consultants during community based interviewing was related to job opportunities.

In this respect the Cement Company has initiated a skills training programme targeting the construction phase of the project. This it has undertaken, to ensure participation for these communities in project employment benefits. Some ambivalence existed in the attitude of respondents. Many welcomed the project for potential economic gains, while still expressing concerns that expansion meant more air pollution. Demands are also made on the industrial entities to provide social infrastructure support within the communities, often within committed long-term programs. In this respect the Cement Company has several out reach programs.

Notwithstanding corporate participation and support within the industrial corridor, these communities are still affected by emissions associated with some of these companies. Support for this comes from the consistency with which air pollution is the 'top of mind' health issue for community members. It is in relation to these health issues that the socio demographic profiles of the communities assume importance in the project. One positive benefit from the project is the expected improvements in the quality of air emissions.

Community members within the project area, in keeping with the dormitory relationship of these communities with Kingston, present a mix of occupations. However, these occupations tend to reflect the income status of most of these communities. Labouring, construction, domestic, factory employment and hustling occupations predominate in most communities. Rapid appraisal community based assessments support this as indicated for these communities, but also this characterisation is reasonably typical of low income urban occupations.

The project is highly capital intensive, and other than at the construction phase, will not offer significant direct employment opportunities after the construction phase is completed. However its longer-term indirect contribution to employment via the construction industry must be considered significant.

The population of the project area also includes persons working but not residing in the area. This is applicable to the industrial corridor. Total employment figures however, were unavailable for inclusion in this report.

4.5.4 Health

In probing the perception of the communities regarding air pollution, the standard approach was to enquire of respondents, whether air quality was an important issue for the community. Where the response was affirmative, specific issues were probed and respondents were asked to support their statements with evidence, based on personal or household experience. Table 4.16 provides a ranking by respondents interviewed, of the perceived main sources of the air pollution.

Area	**Ranked 1st**	**Ranked 2nd**	**Ranked 3rd**
Springfield	JPPC	Carib Cement	JFM
Rennock Lodge	Ethanol	Carib Cement	JFM
Johnson Town	Ethanol	JFM	Carib Cement
Norman Gardens	Ethanol	JPS Barge	Carib Cement
Bayshore/Harbour Heights	Carib Cement	Ja.Ethanol	-
Harbour View	Carib Cement	Gypsum Plant	JFM
#1 Palisadoes	Gypsum Plant	N/A	N/A
St. Benedicts	Carib Cement	N/A	N/A
Shooters Hill	Not considered a problem		
Resthaven	Not considered a problem		
Copocabana	Not considered a problem		
Bay View	Carib Cement	N/A	N/A
8-10 Miles	Block Factory	Barba Green Plant	Associated quarries and trucking of gypsum

Table 4.16 Respondents Ranking Of Perceived Main Polluter. (1=Main Polluter)

In summary, the Carib Cement was identified most frequently as the “worst polluter”, based on the number of occasions it was ranked first. The perception of the majority of respondents is that air quality has not been improving over time, but this view was not shared by all respondents, who ranked the Carib Cement as the main polluter.

The general perception received from respondents in the communities is that those communities closest to the Carib Cement are the ones mostly affected by the plant. This seems substantiated by the consistency of complaints found in Rennock Lodge to the west of the plant and Bayshore to the east, and supported by the air quality sampling conducted in these two communities.

In conducting the survey, women were observed to be the gender most impacted by cement dust, as they carried the burden of both maintaining household cleanliness and providing care to family ailments they attribute to poor air quality.

Data was collected mainly from community individuals and groups, but key informants were also canvassed. These were heads of local citizen's association, principals of schools and persons identified as community leaders. As a group there was less unanimity in relation to cause and effect of air pollution on the communities.

A survey was also conducted among the firms in the industrial corridor where an important segment of the work force find employment. The responses received are summarized in Table 4.17. Only members of senior management, who could offer an opinion on behalf of the firms, were interviewed.

Industrial Firm	**Comment**
Jamaica Private Power Co. Ltd.	Not a problem as far as can be determined.
Jamaica Public Service Company Ltd. (Barge)	Not a problem
Jamaica Flour Mills Ltd.	A problem that has not improved over the years.
Jamaica Ethanol Processing Ltd.	A major problem
Shell Chemicals (JA) Ltd.	Remains a problem but has improved in recent years.
Texaco Caribbean Inc.	A problem that has not changed over time.
Rockfort Mineral Baths	Not a problem
Caribbean Construction Co. Ltd.	Not a problem
Mineral Bath	Not a problem

Table 4.17 Summary of Responses Concerning Dust Nuisance among Industrial Firms

Responses were almost evenly balanced between perceiving cement dust to be a problem and not. While the question remains as to whether the pollution experienced is in fact cement dust, the perception of respondents is firm on this point. To the extent that distinctions were probed, most respondents were confident that they knew and could recognize the origins of the dust nuisance they were experiencing.

A senior health official at the Type 3 Norman Gardens Health Clinic was of the opinion that the incidence of Upper Respiratory Infection was not abnormal in relation to other Kingston clinics. The Chief Medical Officer, Ministry of Health was unaware of any publicly funded studies on the impact of cement dust on the health of neighbouring communities. His recall went back to the 1980's. It was pointed out by him, that private research such as conducted at tertiary institutions would not necessarily find its way into public agencies.

4.5.5 Transportation

Traffic counting was undertaken on Monday 17th January 2005, to provide an indication of flows past the plant. Counts were conducted over the six hour period 6AM – 12 Noon. The results were then extrapolated for the 12-hour period to 6PM (Tables 4.18 and 4.19).

The survey revealed that traffic flows were heavy and continuous over the period. Extrapolated, some 18,000 vehicles and 46,200 passengers probably pass the plant daily between 6AM and 6 PM. Of these 70% are motorcars and 14.5% buses.

TIME	EAST BOUND	WEST BOUND	ACTUAL FOR 6 HOUR COUNT	ESTIMATED FLOWS OVER 12hrs	% OF TOTAL
6:00 – 7:59	1083	1923	3006	6012	33%
8:00 – 9:59	1454	1623	3077	6154	34%
10:00 – 12:00	1531	1488	3019	6038	33%
TOTALS	**4068**	**5034**	**9102**	**18204**	**100%**

Table 4.18 Traffic Counts; Summary of Vehicles by Time Period

TYPE OF VEHICLE	EAST BOUND	WEST BOUND	TOTAL FOR 6 HOUR COUNT	ESTIMATED FLOWS OVER 12 HOURS	% OF TOTAL

MOTOR CAR	2815	3581	6396	12792	70%
VAN	314	367	681	1362	7.50%
TRUCK	286	287	573	1146	6%
TRAILER	49	44	93	186	1%
LARGE BUS	249	263	512	1024	6%
MINI BUS	340	433	773	1546	8.50%
MOTOR BIKE	15	59	74	148	1%
TOTALS	4068	5034	9102	18204	100 %

Table 4.19 Traffic Counts. Summary of Vehicles

Traffic access into the plant occurs at five points (Figure 4.10). At the main gate, staff vehicles entering number about 160, which implies about 350 to 400 movements through the gate in any 12-hour period. At the Packaging Plant, about 75 trailers enter to collect bag and bulk purchases. Only intermittent use is made of the East Gate, located east of the main gate, by trucks delivering shale and gypsum to maintain inventories. A small number of vehicles enter the Sales Office, which adjoins the Packaging Plant and even fewer, the Coal Wharf. Internally, about 8 heavy-duty vehicles from the mining area are parked overnight at the plant. With the exception of a front-end loader, these vehicles do not access the main road.

The construction of the foreshore highway from east Harbour Street to the Windward Road intersection has considerably reduced the traffic congestion once experienced, from particularly westbound vehicles on leaving the plant.

It is not expected that traffic flows past the plant will be impacted to any noticeable extent by the project and the mitigation measures recommended during the construction, will minimise any disturbance to flows during this phase.

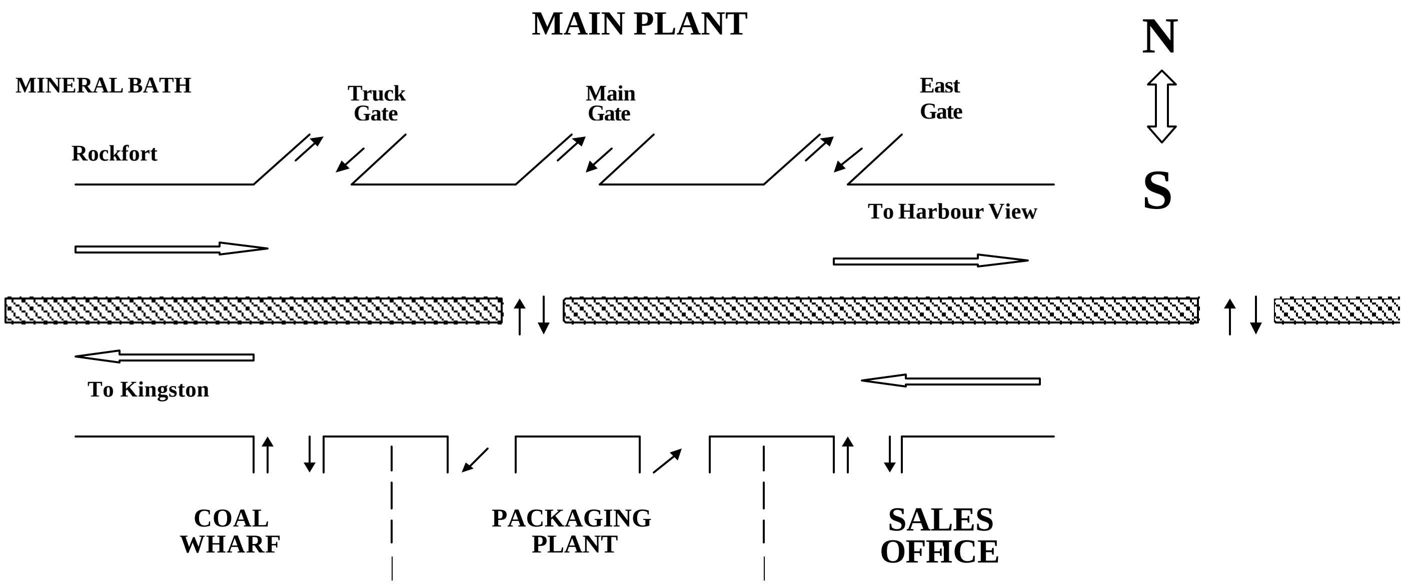

Figure 4.10 Traffic Patterns in Vicinity of Plant

4.5.6 Water & Electricity

Although exact values are not final, the consumption of both water and electricity by the project will be lower than presently consumed. This is because of the switch from a wet kiln cement process to a dry process. For water consumption, the company has projected that the project will save 224 Million litres of water currently consumed in clinker production. Reduction in electricity consumption is a major rationale for the new kiln technology selection although absolute values in savings are not available for this report. Over the life of the project, which has as a main rationale, increased production levels of close to 40%, input requirements of electricity may or may not increase absolutely, but proportionally these inputs will still be more efficiently absorbed by production than they are currently. New utilities will not be needed.

4.5.7 Archaeological Heritage

Rockfort, which lies to the west but within the plant environs, dates from 1729. The Fort formed part of the island's British colonial military history and has been "preserved" as part of the archaeological heritage. A warm spring emerges from Long Mountain and was captured in a 'mineral spa' on the Rockfort grounds from the 1950's. This spa has been upgraded and is maintained by the Carib Cement.

Overall the project will impact positively on heritage assets within the plant environs, since the targeted reduction in stack emissions will reduce one important corrosive element at work, cement dust. Recommendations for the mitigation of dust nuisance during construction phase have also been made.

5.0 SIGNIFICANT ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 AIR QUALITY ASSESSMENT

The cement manufacturing process is very energy-intensive and there are strong incentives for energy conservation. The dry process is both economically and environmentally preferable to the wet process because the energy consumption is approximately half of that for the wet process. The dry process technology also has some environmental challenges, namely the handling of huge volumes of dry powdered materials such as limestone and shale that can lead to greater fugitive dust levels. However, advances in dust control technology such as the Electrostatic Precipitators (ESP) and Fabric Filters should allow Carib Cement to successfully mitigate this impact from particulate emissions, on the one hand, and through increased efficiency of production resulting from conversion of waste emissions (which are added to the cement output).

Air Quality impacts during operations were assessed by looking at the air pollutant emissions from the Carib Cement sources alone and also in relation to the emissions from other point sources in the Kingston airshed. The potential air quality impacts were determined by modelling the dispersion of the air pollutants from existing sources as well as after the proposed production expansion at Carib Cement. In order to get more accurate results for impacts from the Carib Cement facility, the decommissioned point and area sources were left out of the future plant models that include the expansion project.

5.1.2 Air Pollution Sources

Air discharges occur from several point and area sources at Carib Cement. The point sources are stacks and vents designed specifically for the release of air streams after processing by air pollution control systems, such as electrostatic precipitator or a fabric filter. The discharges from the point sources consist mainly of PM. Nitrogen oxides (NOx) and sulphur dioxide (SO_2)are emitted from combustion sources, such as kiln systems.

The area sources consist of a wide variety that can be categorized as storage piles, transfer stations on conveyor belts, dump sites and open yard areas. PM is the main pollutant emitted from these area sources.

A critical step for conducting air dispersion modelling is to quantify emissions from the various sources at the Carib Cement facility and other nearby sources. The Air Quality Guideline Document (Davis, 1999) indicates that surrounding sources that will “significantly” contribute to the impact of the source or sources under consideration (termed the subject source) must be included in the modelling analysis. The document further states, "all major point and area sources located within 10 km and all significant point sources within 5 km of the subject source should be included in the modelling analysis."

An attempt was made to determine the emission rates from such point and area sources in the vicinity of the Carib Cement facility. The emission rates from these sources were estimated in accordance with the recommendation outlined in the Ambient Air Quality Guideline Document. According to Davis & Associates (1999), emission rates are estimated in the following order of preference:

- Stack Emission Testing
- Manufacturer's emission data
- Mass balance calculations
- Emission factors
- Engineering calculations

Table 5.1 shows the data found for point and area sources in the vicinity of the Carib Cement facility.

For the new sources at the Carib Cement facility, manufacturer's emission data were supplied for kiln 5 production units. For existing Carib Cement sources, including the existing dry process (kiln 4), the wet process (kiln 3), the two existing clinker coolers, the various point sources associated with the dust collectors on the plant, as well as area sources throughout the plant complex, the emission factor estimation method was utilized. Regarding the other existing point sources within 10 km of the Carib Cement facility, the emission factor methodology was utilized to determine emission rates, except for JPS and JPPC sources. Stack emission test data were available for JPS sources (2001) and JPPC (1999).

Table 5.1.1 shows emission rates calculated using two different methods for all Carib Cement sources that contribute to PM modelling. Method A uses US AP-42 emission factors multiplied by the production rate to give the emission rate. Method B uses mass loading factors given by the manufacturer multiplied by the flow rate to give the emission rate.

Plant	Stack ID	UTME (m)	UTMN (m)	Elev (m)	SO_2 (g/s)	NO_2 (g/s)	PM (g/s)	Stack Height (m)	Stack Dia. (m)	Stack Vel. (m/s)	Stack Temp. (K)
Jamaica Ethanol Processing Ltd	Jeth1	315,194	1,987,775	20	9.65	0.963	0.637	6.1	0.6	15.8	493
Jamaica Ethanol Processing Ltd	Jeth2	315,204	1,987,782	20	6.43	0.642	0.425	6.2	0.6	9.81	458
JPS Hunts Bay B6	JPHB6	308,212	1,987,859	1	251.3	26.1	9.9	45.7	2.9	23.9	439
JPS Hunts Bay GT10	JPSGT10	308,300	1,987,871	1	27.5	38.34	3.35	9.5	4.2	15.8	689
JPS Hunts Bay GT5	JPSGT5	308,392	1,988,081	1	18.2	25.36	2.22	12.04	10.1	8.3	766
JPS-Rockfort	JPSR1	314,442	1,987,512	1	100.9	55.7	2.8	38.8	1.76	26.2	645
JPS-Rockfort	JPSR2	314,442	1,987,522	1	117.3	47.1	2.9	38.8	1.76	30.8	666
JPPC Engine 1	JPPC1	314,414	1,987,661	1	83.1	157.2	8.9	65	1.8	45.9	572
JPPC Engine 2	JPPC1	314,414	1,987,661	1	83.1	134.5	9.7	65	1.8	45.9	572
PJAM Pipestill heater	PJAMF-1	307,439	1,988,147	1	45.8	5.28	3.46	69.4	3.05	4.19	650
PJAM Powerformer Feed Preheater	PJAMF-2	307,448	1,988,156	1	9.35	0.79	0.0168	45.7	2.9	1.66	811
PJAM No.1 Reheat coils F-3	PJAMF-3-4	307,447	1,988,162	1	3.12	0.26	0.00561	45.7	2.9	0.81	811
PJAM No.2 Reheat coils F-4	PJAMF-3-4	307,447	1,988,162	1	1.46	0.12	0.00262	45.7	2.9	0.81	811
PJAM Vacuum Furnace	PJAMF201	307,452	1,988,162	1	2.52	0.21	0.00454	20.8	0.69	3.71	674
PJAM GTG High & Low Temp Coils	PJAMF6	307,464	1,988,146	1	1.42	4.959	0.433	18.3	1.83	32.06	673
PJAM Foster Wheeler Boiler	FWB	307,450	1,988,135	1	21.7	2.5	1.63	16.2	0.8	24.9	623
PJAM Cleaver Brooks Boiler (Standby)	CBB	307,462	1,988,123	1	38.5	4.5	2.91	16.2	0.8	44.3	623
PJAM Hurst Boiler (Standby)	F-1	307,439	1,988,147	1	1.72	0.583	0.049	69.4	3.05	0.58	650
PJAM Volcano Boiler (Standby)	F-1	307,439	1,988,147	1	1.39	0.468	0.039	69.4	3.05	0.47	650
PJAM Flare	FLR	307,330	1,988,172	1	0.32	0.03	0.0006	45.7	0.2	na	na

Table 5.1 Emission Rates Calculated for Carib Cement Sources Using Two Different Methods

Description	Model Ref	Status		PM Emissions (g/s)		Method
		Present	Future	Present	Future	
Quarry Activities	QUARRY	X	X	5.2954	5.2954	A
Quarry Hammer Mill	QHM	X	X	0.0033	0.0033	A
Coal Mill A	COALA	X	X	0.0003	0.0003	A
Coal Mill B	COALB	X	X	0.0003	0.0003	A
Coal Yard	COAL	X	X	0.0028	0.0028	A
Kiln 3 main stack	CCK3	X		2.3692		A
Kiln 3 clinker cooler vent	CLC3	X		0.7005		A
Hot Clinker dump storage pile	HDD	X		1.006		A
Clinker storage yard	CSY	X		4.75		A
Kiln 4 main EP	CCK4	X	X	2.1065	1.6204	A
Main EP discharge	K4EPDIS	X	X	0.1066	0.0853	B
Kiln 4 clinker cooler vent	CLC4	X	X	1.1019	1.1019	A
Homogenizing silo vent	4HOMSILV	X	X	0.3401	0.2721	B
Homogenizing silo discharge	4HOMSILD	X	X	0.0743	0.0595	B
Raw mill bin feed belt	K5RMFB20		X		0.0255	B
Raw mill bin feed belt	K5RMFB30		X		0.0255	B
Raw mill bins	K5RMBINS		X		0.0664	B
Raw mill feed belt	5RMBEL91		X		0.0638	B
Raw mill feed belt	5RMBEL97		X		0.0426	B
Raw mill system fugitive	5RMSYSFG		X		0.0630	B
Raw mill cyclone fugitive	5RMCYCFG		X		0.0409	B
Homogenizing silo vent	5HOMSILV		X		0.0851	B
Homogenizing silo discharge	5HOMSILD		X		0.0851	B
Kiln feed vent	K5FEEDV		X		0.0654	B
Clinker cooler vent	CLC5		X		0.9368	B
Kiln 5 main fabric filter	CCK5		X		2.7200	B
Clinker silo belts	CSBELTS	X	X	0.0318	0.0583	A
Clinker storage silos (top)	CSSTOP	X	X	0.1246	0.2285	A
Gypsum Hammer crusher	GYPHM	X	X	0.0009	0.0009	A
Clinker storage silos (bottom belts)	CSSBOTM	X	X	0.0318	0.0583	A
Gypsum storage yard	GY	X	X	0.0235	0.0235	A
Cement mill vent	CMILL3	X	X	0.2502	0.2502	B
Cement mill 4 vent	CMILL4	X	X	0.1327	0.1327	A
Cement mill 4 separator vent	CMILL4SV	X	X	0.4861	0.4861	A
Cement silo 1 - 4	CSILO124	X	X	0.1371	0.1371	A
Cement silo 5 - 8	CSILO528	X	X	0.1384	0.1384	A
Cement silo 9 vent (bags 6X101")	CEMENT9	X	X	0.1632	0.1632	A
Cement silo 10 vent (bags 6X101")	CEMENT10	X	X	0.1632	0.1632	A
Distribution bin	DISTBIN	X	X	0.5222	0.5222	A
Transfer station	XFERSTN	X	X	0.1306	0.1306	A
Big bag loading (bags 6X99")	BAGLOAD	X	X	0.1306	0.1306	A
Packer 4 (bags 6X99")	PACK4	X	X	0.1306	0.1306	A
Packer 5 (bags 6X129")	PACK5	X	X	0.1306	0.1306	A
Cement silo 9 and 10 discharge	CS9&10D	X	X	0.1667	0.1667	B

Table 5.2 Present and Future PM Emissions of the Carib CementPlant

Regarding the area sources utilized in the modelling analysis, Table 5.1.2 provides the various area source parameters. Calculations for the emissions use AP-42 emission factors.

Source	I.D.	UTME (m)	UTMN (m)	Elevation (m)	Release Height (m)	PM Emissions (g/s)	Area (m^2)
Clinker Storage Yard	CSY	316,654	1,988,137	50	4	4.74757	1600
Gypsum Storage Yard	GSY	316,550	1,988,240	5	4	0.023515	100
Hot Dust Dump	HDD	316,553	1,988,065	4	4	1.006033	100
Coal Storage Yard	Coal	316,195	1,987,147	1	4	0.00278	3000
Quarry	Quarry	317,350	1,987,115	200	4	5.295436	250000

Table 5.3 Area Source Locations and Emissions for the Carib Cement Plant

The kilns release other criteria pollutants. Table 5.1.3 shows the emission rates of kiln 3, kiln 4 and kiln 5 for NO_x, SO_2, lead, ozone as VOC and carbon monoxide. These emission rates were calculated using AP-42 emission factors.

Description	Model Ref	NO_x g/s	SO_2 g/s	CO g/s	Lead g/s	Ozone g/s
Kiln 3	CCK3	38.11	42.23	0.06	3.90E-07	0.00028843
Kiln 4	CCK4	28.03	4.38	7.94	5.83E-06	0.00291667
Kiln 5	CCK5	43.42	28.95	58.33	1.23E-06	0.00388889

Table 5.4 Other Emission Rates of Kilns in the Carib CementPlant

Having quantified the emissions, it was determined that no regulatory draft standards were exceeded for either the existing or the proposed project (see Table 5.1.4).

Source	Capacity (t/d)	Flowrate (m3/s)	PM (g/s)	PM (mg/m^3)	PM Target (mg/m^3)	PM Standard (mg/m^3)
Kiln 3	890		2.3692	230.00		
Clinker Cooler 3	890		0.7005	68.00	300	
Kiln 4	1400		2.1065	130.00	800	
Clinker Cooler 4	1400		1.1019	68.00	300	
Kiln 5	2800	94.9	2.72	28.66		50
Kiln 5 Clinker Cooler	2800	33.8	0.9368	27.72		100

Davis, 1999

Table 5.5 Emission Comparison with Draft Regulatory Limits

5.2 DISPERSION MODEL RESULTS

Tables 5.6 and 5.7 summarize the maximum predicted concentrations for before and after the kiln expansion programme and their comparison with the respective ambient air quality standard or guideline. For the "all existing sources" model run, the results revealed that the maximum predicted concentrations for pollutants exceeded the comparable standards for averaging periods. With regard to the "existing Carib Cement sources" model run, it was shown that applicable averaging periods for NO_x, SO_2, and PM had predicted maximum concentrations that exceeded the JAAQS.

Pollutant	Regulation	Avg. Period	Background ($\mu g/m^3$)	Standard ($\mu g/m^3$)	Existing Carib Cement Sources: Max Conc ($\mu g/m^3$)	Existing Carib Cement Sources: UTME (m)	Existing Carib Cement Sources: UTMN (m)	All Existing Sources: Max Conc ($\mu g/m^3$)	All Existing Sources: UTME (m)	All Existing Sources: UTMN (m)
TSP/PM_{10}	NAAQS	24-hr	60	150	1600	317127	1987107	1600	317127	1987107
		Annual	15	50	449	317158	1987070	449	317158	1987070
NO_x	NAAQS	1-h	0	400	9170	316454	1987306	16300	314564	1988161
		Annual	0	100	660.0	316471	1987323	1184	314563	1988061
SO_2	NAAQS	1-hr	0	700	10145	316454	1987306	34925	314463	1987561
		24-hr	0	280	2312	316437	1987288	6941	314463	1987561
		Annual	0	60	649	316470	1987323	1260	315163	1987861
CO	NAAQS	1-hr	0	40000	14.4	316454	1987306	na	na	na
		8-hr	0	10000	5.74	316470	1987323	na	na	na
Ozone (VOC)	NAAQS	1-hr	0	235	0.07	316454	1987306	na	na	na
Lead	NAAQS	Quarterly	0	2	0	316470	1987323	na	na	na

Table 5.6 Results for Existing Carib Cementand Other Sources Model Runs

Table 5.2.1 demonstrates that the Carib Cement facility is not the main contributor of the NO_x and SO_2 peak impacts. This is because these impacts are occurring closer to the other sources that were modelled. In order to get more accurate results for impacts caused by the Carib Cement facility, these other sources must be left out of the future plant models that include the expansion project. These future models will then show how the Carib Cement facility is impacting the surroundings. To determine the main cause for impacts in this area more detailed modelling would need to be done for the other sources in order to determine which sources are causing these large impacts.

For the modified Carib Cement sources model run, the results (Table 5.7) revealed that SO_2, lead, ozone, and carbon monoxide (CO) all met the NAAQS minus the background for all applicable averaging periods. NO_x annual average meets the standard once it is assumed that 75% of NO_x is NO_2 as recommended by the Air Quality Guideline Document. However, the NO_x 1-h predicted concentration exceeds the standards even after the 75% conversion is applied.

Hence, the Ozone Limiting Method (OLM) as an approach recommended by the USEPA was utilized to generate predictions that fall within the 1-h NO_x standard. For the OLM the following general equation was applied:

$$[NO_2]_{1\text{-hour}} = (0.1) \times [NO_x]_{pred} + [O_3]_{1\text{-hour max}}$$

where:

$[NO_2]_{1\text{-hour}}$ is the predicted 1-hour NO_2 concentration

$[NO_x]_{pred}$ is the model-predicted 1-hour NO_x concentration

$[O_3]_{1\text{-hour max}}$ is the maximum 1-hour ambient ozone concentration

The maximum measured 1-hour ozone concentration was 101 µg/m^3, and this was measured at Ewarton in 2004, 48 km (30 miles) west of the proposed project site. This ozone concentration was considered representative of the project area, since ozone is a regional pollutant.

Pollutant	Regulation	Avg. Period	Background (µg/m^3)	Standard (µg/m^3)	Model Results (µg/m^3)
TSP/PM_{10}	JAAQS	24-hr	60	150	98
		Annual	15	50	37
	Increment	24-hr		80	23
		Annual		21	0
NO_x	JAAQS	1-h	0	400	257[a]
		Annual	0	100	74.3
	Increment	24-hr		80	171.5
		Annual		21	34
SO2	JAAQS	1-hr	0	700	524.5
		24-hr	0	280	136
		Annual	0	60	38
	Increment	24-hr		80	111
		Annual		21	19
CO	JAAQS	1-hr	0	40000	1067
		8-hr	0	10000	685
	Increment	1-hr		2000	941
		8-hr		500	598
Ozone (VOC)	JAAQS	1-hr	0	235	0.1582
	Increment	1-hr			
Lead	JAAQS	Monthly	0	2	0.00004
	Increment	Monthly			

[a] Concentration obtained when using OLM

Table 5.7 Results for Modified Carib CementPlant Model Run

PM exceeds the NAAQS standard minus the background by 8 µg/m^3 for the annual average and only by 2 µg/m^3 for the 24-h averaging period. Now if backgrounds obtained by averaging several counties in Florida that have similar populations to Kingston are considered (see Table 5.8), then the predicted PM concentrations would meet the NAAQS minus the new backgrounds.

While PM does not meet the model target it is not a significant impact for PM. For there to be a significant impact of PM there must be at least an increment of 21.0 µg/m^3 for an annual average or a 24-hour average of 80.5 µg/m^3. The increment model run gave results of an annual average less than 0 µg/m^3 and a 24-hour average of 23 µg/m^3; hence, there is no significant impact for PM.

County	State	Populations	24-hr PM Background (µg/m^3)
Miami-Dade	FL	2,253,362	45
Duval Co	FL	778,879	40
Broward	FL	1,623,018	52
Average		1,551,753	46

Table 5.8 24-hr PM Background Emissions for Highly Populated Urban Florida Counties

Figures 5.0 through 5.8 show the contour plot files for the modified Carib Cement facility. It is obvious from these plot files that the area most impacted by the predicted pollutant concentrations is the northwestern section of the Carib Cement facility. This pattern is consistent with the fact that the most predominant wind direction blows from the southeast.

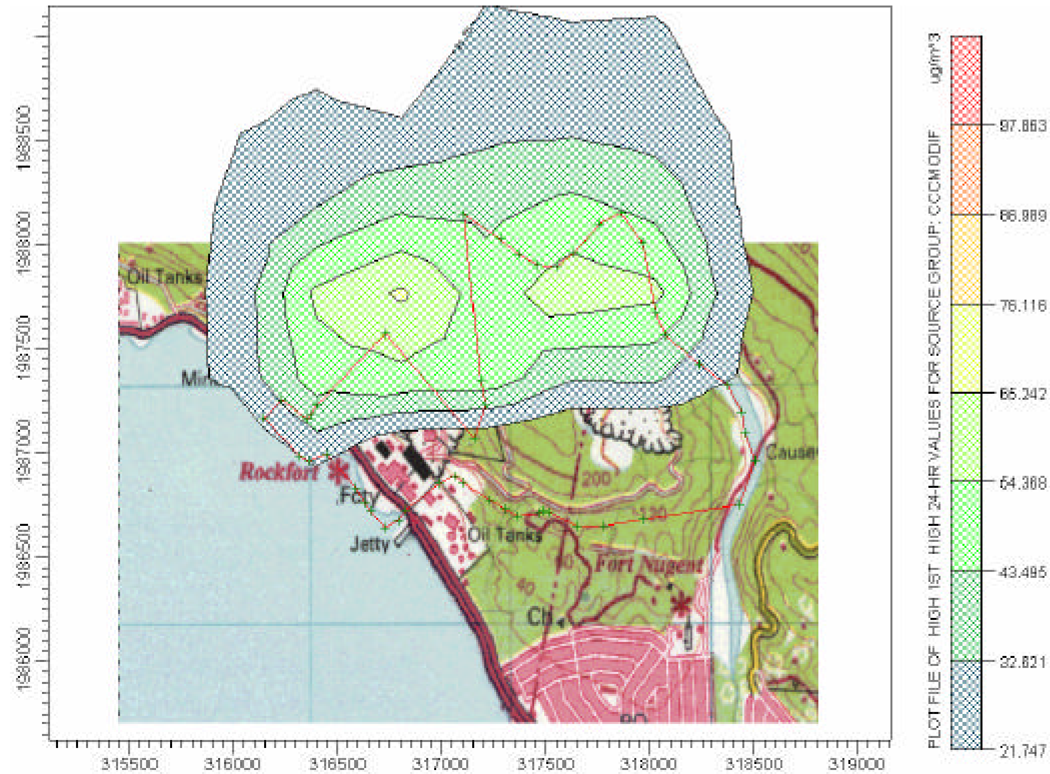

Figure 5.0 Modified Carib Cement Plant-PM24-Hr

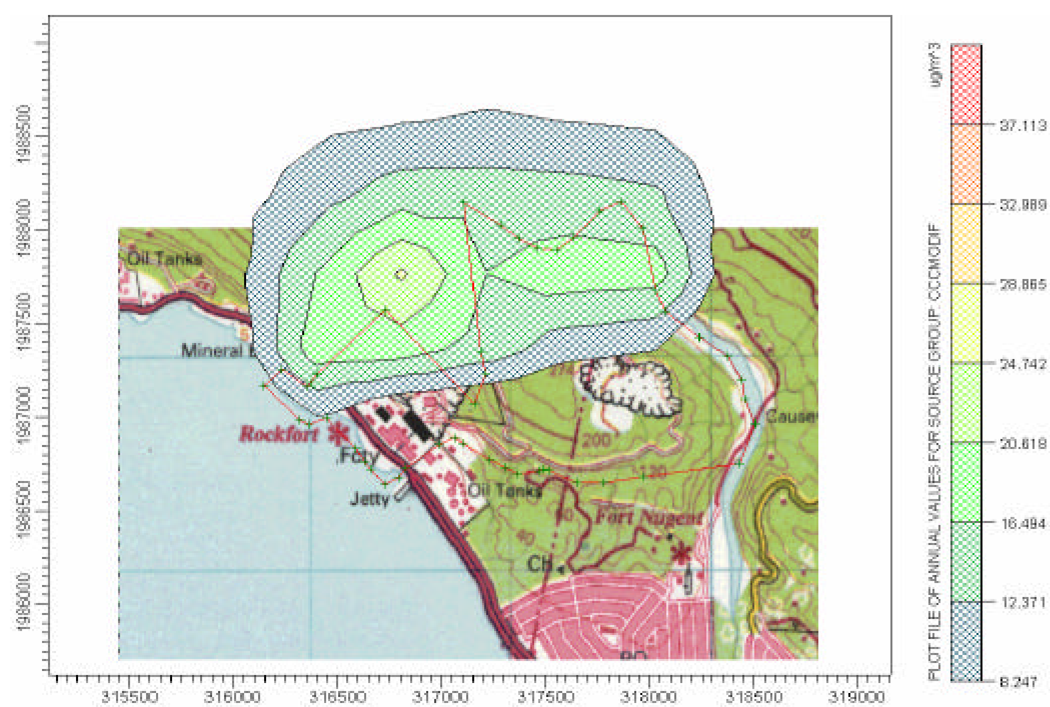

Figure 5.1 Modified Carib Cement Plant –PM Annual

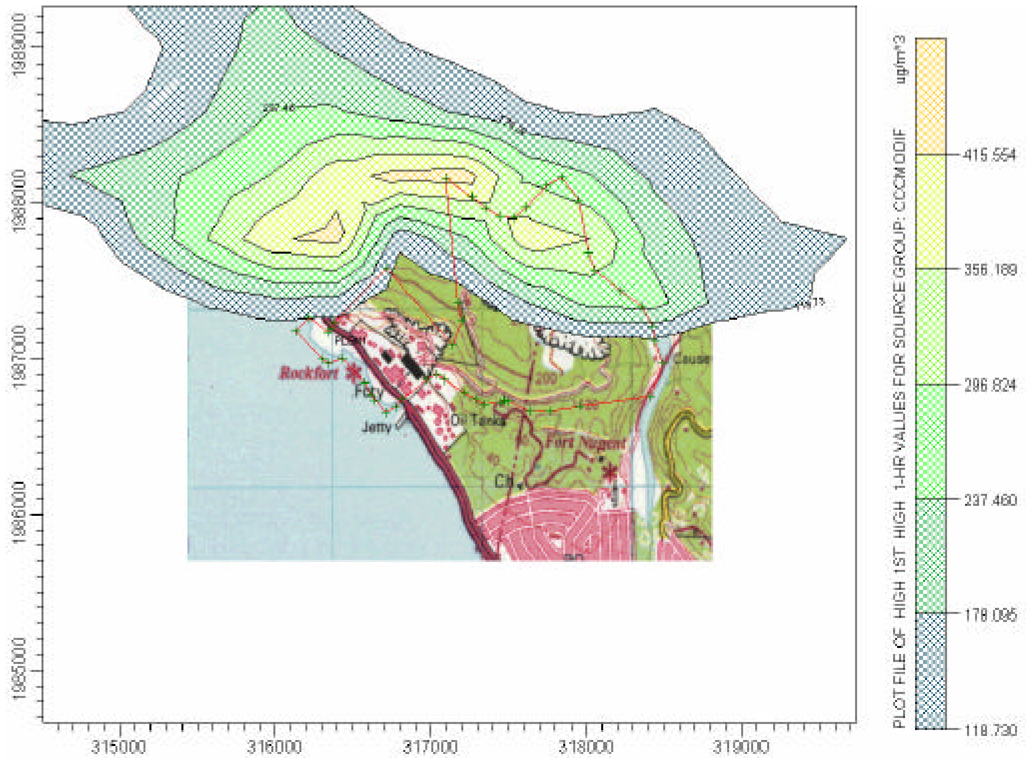

Figure 5.2 **Modified Carib Cement Facility –SO_2 1=Hr**

Figure 5.3 **Modified Carib Cement Facility –SO_2 24-Hr**

Figure 5.4 Modified Carib Cement Facility –SO_2 Annual

Figure 5.5 Modified Carib Cement Plant- NO_x Annual

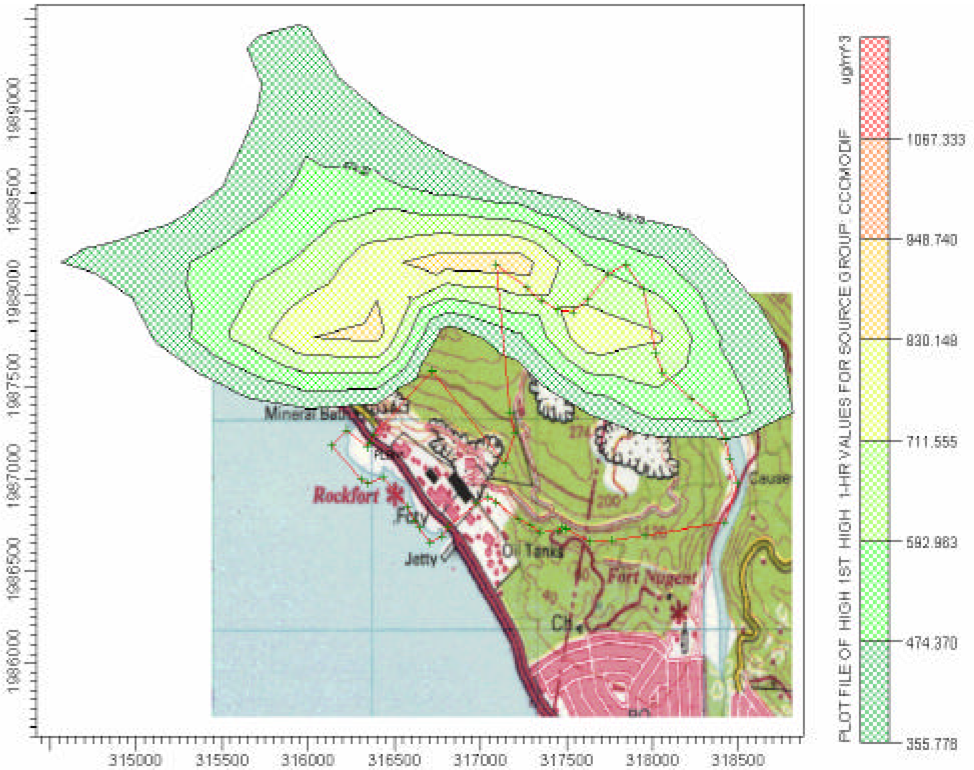

Figure 5.6 Modified Carib Cement Plant- Lead Monthly

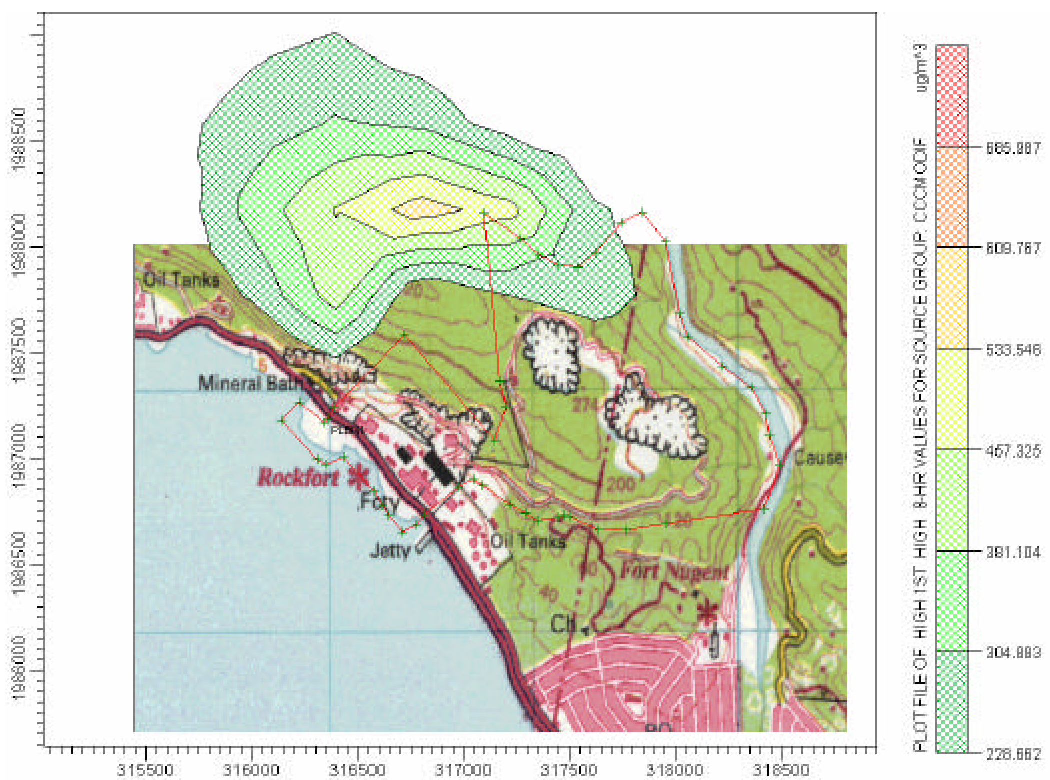

Figure 5.7 Modified Carib Cement Plant –CO 1Hr

Kilns 4 and 5 also release some priority air pollutants (PAPs). The peak impacts of these air pollutants can be found by taking a ratio of PM concentration and emission rates multiplied by the emission rates of the PAPs. Based on these calculations the Carib Cement facility meets all PAP requirements. Table 5.9 shows the JAAQS guideline concentration for the PAPs and the results calculated for Carib Cement impacts.

Pollutant Name	JAAQS Standard µg/m3	24-hr Concentration µg/m3
Acetone	48000	0.0187
Ammonia	3600	0.5015
Arsenic	0.3	0.0006
Cadmium	2	0.0001
Chromium	1.5	0.0069
Copper	50	0.2557
Formaldehyde	65	0.0226
Mercury	2	0.0012
Xylenes	2300	0.0064

Table 5.9 JAAQS Standards and Results of PAPs Released by Kilns 4 and 5.

5. 3 SUMMARY IMPACTS AND MITIGATION MEASURES

Summary potential impacts and mitigation measures, as recommended by the consultants, are presented in Tables 5.10 and 5.11. The environmental aspect is highlighted and the corresponding potential impacts and recommended mitigation measures presented.

The plant expansion will take place within the footprint of the current operations and is intended to improve process efficiency, reduce energy consumption, reduce air emissions and expand output. The major issues relate therefore to Air quality, Coastal Water Quality, Waste Management, Public Health and Safety, and Vehicular transportation along the main road. Each of these is dealt with in the following Matrix tables. The issues are given as Impacts on the Natural Environment (Table 5.10) and Impacts on the Built Environment (Table 5.11).

Table 5.10 Natural Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures

Environmental Aspect	Potential Impacts	Recommended Mitigation Measures
Air Quality	***Site Preparation and Construction Phase*** Movement of trucks and heavy-duty equipment to and from the project area, as well as construction work and stockpiling of earth material, will contribute to dust emissions. Construction activities will also result in the removal of vegetation that will expose and loosen soil which can become airborne with medium to strong winds. This would add fugitive dust to the area, which is already dust- prone because of previous land clearance. The transport of aggregate for road and drainage culvert construction will also contribute to the fugitive dust levels. Construction vehicles will emit air contaminants such as nitrogen and sulphur oxides as well as particulates.	***Site Preparation and Construction Phase*** 1. Watering of un-vegetated areas and stripped road surfaces along which construction vehicles and trucks travel should control dust emissions by up to 70%. A full-time watering truck will be maintained on site for watering road surfaces as needed to minimize fugitive dust emissions. Over-saturated conditions, which would cause outgoing trucks to track mud onto public streets, are to be avoided. Watering would not be necessary on days when rainfall exceeds 2.5 mm. 2. Stock piling of earth materials for construction should be carried out within temporarily constructed enclosures to limit fugitive dust. Vehicles transporting earth materials will be covered en route. Mixing equipment should be sealed properly and vibrating equipment will be equipped with dust removing devices. Stockpiles of fines will be covered on windy days. 3. A monitoring programme for dust will be developed to assess the effectiveness of control measures in meeting ambient air quality standards. 4. Provide dust masks to operators in order to protect them from dust impacts.

Table 5.10 Natural Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures		
Air Quality	***Operation Phase*** The modelling analysis has shown that the Carib Cement modified facility is marginally non-compliant for PM, even after kiln 5 has been constructed, kiln 4 improved with the replacement of the existing electrostatic precipitator with a fabric filter, and kiln 3 retired.	***Operation Phase*** A range of solutions will have to be examined to further reduce dust emissions from the facility, especially at the area sources and the various vents associated with the dust collectors. One such solution is a programme that systematically inspects and maintains all of the dust collectors. All dust collectors should be routinely maintained as per manufacturer's specifications. Carib Cement will establish a facility-wide dust suppressant programme. This programme should especially target the material transfer areas in order to minimize all dust emissions. Roads will also be swept to eliminate dust build-up. Employees will be trained to recognise when dusting limit is occurring and take mitigating steps to isolate or shut down the offending operation.

Table 5.10 Natural Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures

Noise	***Site Preparation and Construction Phase*** The noise level is expected to increase during site preparation and construction with the use of heavy machinery and earth moving equipment, and during piling. ***Operation Phase***	***Site Preparation and Construction Phase*** 1. Although not expected to create a significant negative impact, noise impacting on the existing components of the development from construction activities will be minimized by limiting noisy construction activities to the hours between 7 am and 6 pm, where construction is in close proximity to residential areas. Construction machinery and vehicles will be serviced at regular intervals in order to keep noise to a minimum. 2. Workers must be equipped with earplugs or earmuffs as appropriate, and wearing must be enforced. Employees will be trained on noise abatement and PPE topics. 3. Adhere to NEPA noise standards. ***Operation Phase*** Occupational safety standards should be followed in terms of the wearing of earmuffs. The noise level for the equipment for the new plant has been specified more stringently than the OSHA standards to ensure compliance with the NEPA standards.

Table 5.10 Natural Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures

Marine Water Quality	***Operational Phase*** The impact on the marine environment from the proposed expansion could occur from three sources: 1. Run off of drainage water from the plant into the sea, affecting water quality. 2. Cooling water discharge. This too could affect water quality and the marine benthos. 3. Discharge of sewage effluent, nutrients and bacteria can reduce the quality of the receiving waters.	***Operational Phase*** Carib Cement has an ongoing bimonthly monitoring programme that should detect any unusual situations and implement corrective action.
Vegetation	***Site Preparation and Construction Phase*** Site preparation and construction activities will not result in removal of significant vegetation, as the new kiln will occupy an area within the current footprint of the factory.	No mitigation measures are required.

Table 5.11 Social Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures

Environmental Aspect	Potential Impacts	Mitigation Measures
Traffic, Transportation and Access Roads	***Site Preparation and Construction Phase*** Site preparation and construction activities will see an increase in the movement of heavy vehicles and construction equipment. ***Operation Phase*** Disruption to traffic is not anticipated during the operation phase. Exit ramps from the main road to access property on both the north and the south side of the property should be considered.	***Site Preparation and Construction Phase*** 1. Scheduling of construction work will seek to minimise disruption to traffic flow along the main north coast artery and allow for the movement of material and heavy equipment. 2. Arrangements for parking and storage of material will be made on-site as is feasible for efficient operations. 3. Properly trained flag persons and roadside signs will be used where the movement of heavy machinery and construction equipment may cross the main road. ***Operation Phase*** Discussion will be had with the National Works Agency regarding the provision of underpasses and exit ramps.
Business Enterprises	No business enterprises will be disrupted.	No mitigation measures are required.
Employment	***Site Preparation and Construction Phase*** Employment opportunities will be created during the site preparation and construction phases. This will mostly be unskilled labour for the duration of the construction activities. Additionally, economic opportunities will	***Site Preparation and Construction Phase*** 1. Casual labour will find employment and this is expected to be a positive impact for the surrounding communities. 2. Workers should be briefed on traffic management,

Table 5.11 Social Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures

	involve the sourcing of construction material and linkages created with local and regional suppliers and industries. ***Operations Phase*** Employment opportunities may be created with the increased production.	solid and liquid waste disposal, dust management, parking, idling of equipment and oil spill control. 3. The "politicisation" of employment opportunities often poses some challenge to contractors, and the need for security and relevant dialogue have to be factored into construction planning. ***4.*** A comprehensive training programme, paid for by Carib Cement and facilitated by HEART has been employed to train community members for employment in the project. To date, 122 participants have graduated and 38 of these have already been employed on the operating plant in Carib Cement's most recent plant turnaround. The second phase of the programme is in progress. ***Operations Phase*** Employees will require training to operate new equipment.
Solid Waste Management	**Site Preparation and Construction Phase** Solid waste generated from the site preparation and construction activities will include construction debris, solid waste generated from the construction camp and	**Site Preparation and Construction Phase** 1. Construction sites generate considerable waste and provision must be made for suitable separation and storage of waste in designated and labelled areas throughout the Carib Cement site.

Table 5.11 Social Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures

	decommissioned equipment/structures.	2. Collection of waste by certified contractors and disposal at an approved site, as recommended and approved by the National Solid Waste Management Authority. 3. Any hazardous waste will be separated and stored in areas clearly designated and labelled, for future entombing and disposal as directed by the National Solid Waste Management Authority. 4. Worker training will include instructions on how to dispose of food and drink containers emphasizing the need to protect the coastal environment. 5. Portable chemical toilets must be provided, maintained and removed by a certified contractor. 6. Decommissioned structures will be properly disposed of at the regional landfill in consultation with the NSWMA.
Public Health and Safety	***Site Preparation and Construction Phase*** Site preparation and construction will involve transportation and storage of significant volumes of construction material, and proper disposal of	As described above.

Table 5.11 Social Environment – Potential Impacts, Cumulative Impacts and Mitigation Measures		
	construction spoil and any hazardous waste. Fugitive dust and construction noise levels will increase and are also public health issues.	

6.0 CONSIDERATION OF ALTERNATIVES

6.1 ALTERNATIVE SITE

Selection of an alternative site was not an option for Carib Cement as the project involved improvement of process technology and production efficiency within the existing footprint. In addition, siting of Carib Cement was informed initially by proximity to raw materials and shipping access.

6.2 NO ACTION ALTERNATIVE

The proposed project seeks to improve energy efficiency and to implement pollution abatement measures. The description of existing air quality (Section 4.2) and the air quality analysis (Air Quality Assessment, Section 5.1 and Dispersion Model, Section 5.2) clearly demonstrated the need for improved air quality within the sphere of influence of the Cement plant. The NRCA (Air Quality) Regulations, the Public Health Act and the Clean Air Act (Section 3.2) require that pollutants that compromise air quality be reduced or eliminated, and therefore “no action” is not a desirable alternative.

6.3 CLOSURE OF CARIB CEMENT AND IMPORTATION OF CEMENT

The closure of Carib Cement’s operations is not a viable option, as the negative impacts will be great. There will be a loss of employment, not only within the plant, but also in raw material supply (quarries) and transport. Carib Cement is a significant contributor to GDP, both directly and indirectly and also pays significant taxes to the Government of Jamaica.

There is a high demand for cement in Jamaica. Importation of cement to replace that manufactured by Carib Cement will increase foreign exchange spending and increase trade imbalances. Not only does cement manufacture reduce foreign exchange spending, it makes use of mineral resources already existing in the country. Presently, thee are cement shortages in over half of the states in the U.S.A. as well as the Middle East, Asia and Europe. This has lead to cement prices doubling in many of these districts. A local cement industry is now seen as strategic to national development in all of these territories.

7.0 DEVELOPMENT OF ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

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

APPENDIX A

TERMS OF REFERENCE FOR ENVIRONMENTAL IMPACT ASSESSMENT

Ref. No. 2004-01017-EA00174

19th November 2004

Mr. Melvin Howell
Caribbean Cement Company
PO Box 448
Rockfort
Kingston 2

Dear Mr. Howell

Re: **Application for Permit under Section 9 of the Natural Resources Conservation Authority (NRCA) Act, 1991, in respect of the Expansion of the Cement Plant at Rockfort, Kingston 2.**

Following a detailed review of the captioned application and a site visit conducted on November 4, 2004, please be advised that an Environment Impact Assessment (EIA) must be conducted (The EIA must be inclusive of a Detailed Dispersion Model as outline in the NRCA Ambient Air Quality Guideline Document - The Model must include modeling for both Point sources (Stacks, chimneys, etc.) and Open pits for the mining operations) to facilitate the further processing of the application.

Please view the attach Generic Terms of Reference for the Mining and Mineral Processing.

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

Yours sincerely

Patroy Foster
for Chief Executive Officer

cc: Dr. Margaret Jones Williams - Senior Consultant, ESL Management Solutions Limited.
Mr. Lincoln Evans - Acting Town Clerk, Kingston and St. Andrew Corporation
Mr. Peter Knight - Director, Environmental Health Unit (EHU)
Dwight Diedrich - Civil Aviation
Lindon Matocks - Assistant Commissioner, Fire Prevention Department
Mellisa McHargh - National Solid Waste Authority

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